Trinity Consultants
1580 Columbia Turnpike, Building 1, Suite 1; Castleton-On-Hudson, NY 12033 / P 518.460.8036 / **trinityconsultants.com**

Submitted via IBM Aspera Only
Attention: dep.r7@dec.ny.gov

NON-CONFIDENTIAL VERSION

March 7, 2025

Mr. Kevin Balduzzi
Regional Permit Administrator
Division of Air Resources, Region 7
New York State Department of Environmental Conservation
5786 Widewaters Parkway, Syracuse, NY 13214-1867

RE: Micron New York Semiconductor Manufacturing, LLC, Clay, NY
PSD/NNSR Air Permit Application 2 for the Proposed Air Permit Project
NON-CONFIDENTIAL VERSION

Dear Mr. Balduzzi:

On behalf of Micron New York Semiconductor Manufacturing, LLC (Micron), Trinity Consultants (Trinity) is submitting a PSD/NNSR and Title V air permit application for the construction and operation of the Proposed Air Permit Project in Clay, New York. Micron, a Delaware limited liability company (LLC) and wholly owned subsidiary of Micron Technology, Inc., is proposing to construct a semiconductor manufacturing campus (the Micron Campus) in the Town of Clay, New York, at the White Pine Commerce Park (WPCP), an approximately 1,400-acre industrial park currently controlled by the Onondaga County Industrial Development Agency (OCIDA). The stationary air emission sources to be located on the Micron Campus constitute the 'Proposed Air Permit Project'. This permit application is submitted electronically through the New York State Department of Environmental Conservation (NYSDEC) through IBM Aspera only. No other copies will be submitted.

The Proposed Air Permit Project will be a major facility under the Title V air permitting program, a major source of hazardous air pollutants (HAP) and a major new facility under both the Prevention of Significant Deterioration (PSD) and the Nonattainment New Source Review (NNSR) programs. As such, this permit application includes details on the Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) levels of control and emission limits. The applicability of NYSDEC regulations, federal New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAP) is identified and associated requirements are detailed in the enclosed permit application package. Air dispersion modeling to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) and 6 NYCRR Part 212 will be submitted under a separate cover.

An initial application (Permit Application 1) using preliminary design information was submitted to the NYSDEC in April 2024. Micron is submitting this updated application (Permit Application 2) using refined engineering design information. Micron has included responses to comments received from the NYSDEC on Permit Application 1 and incorporated several updates and changes throughout the application.

This submittal has been redacted to protect commercial information that is considered proprietary, confidential business information, and/or trade secret information to Micron ("confidential business information"). Micron continues to request that its confidential business information be protected from disclosure in accordance with Title 6 of the New York Codes, Rules and Regulations (6 NYCRR), Part 616, New York Public Officers Law Section 87(2)(d), and similar laws and regulations. Three versions of this permit application have been submitted to NYSDEC: 1) a confidential unredacted copy that contains Micron's confidential business information (dated March 7, 2025), 2) a confidential "live redact" copy that identifies Micron's confidential business information (dated March 7, 2025), and 3) a redacted non-confidential version that may be released to the public (the enclosed document). The confidential copies contain information that would cause substantial injury to Micron's competitive position and place Micron at a significant competitive disadvantage if disclosed to a competitor. The information provided in the confidential copies of the application is closely protected within Micron and with select non-Micron personnel with whom applicable non-disclosure agreements are in place.

If you have any questions regarding this application, please contact me at (724) 442-6809 or tmuscenti@trinityconsultants.com

Sincerely,

Tom Muscenti, P.E.
Regional Director
Trinity Consultants

ecc cover letter only:

- Mr. Robert Jacobs, NYSDEC
- Mr. Mark Nowak, NYSDEC
- Mr. Scott Gatzemeier, Micron
- Ms. Ashley Kunz, Micron
- Ms. Brittany Sanders, Micron
- Ms. Holli Feichko, Micron
- Ms. Katie Birchenough, Micron
- Ms. Jesse McMahon, Micron
- Ms. Kailin Schwan, Micron
- Mr. Jacob Bugiera, Trinity Consultants
- Mr. Sundar Sadashivam, Trinity Consultants

MICRON CLAY
PSD/NNSR AIR PERMIT APPLICATION

Micron New York Semiconductor Manufacturing, LLC
Clay, NY

Prepared By:

TRINITY CONSULTANTS
1580 Columbia Turnpike, Bldg. 1, Ste. 1
Castleton-On-Hudson, New York 12033

March 2025
Project 223302.0048

NON-CONFIDENTIAL

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ACRONYMS

AGC	Annual Guideline Concentration
ALD	Atomic Layer Deposition
AQCR	Air Quality Control Region
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
BHP	Brake Horsepower
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CCS	Carbon Capture and Storage
CFR	Code of Federal Regulations
CHIPS Act	Creating Helpful Incentives to Produce Semiconductors and Science Act of 2022
CLCPA	Climate Leadership and Community Protection Act
CMP	Chemical-Mechanical Planarization
CP-29	Commissioner's Policy 29
CUB	Central Utilities Building
CVD	Chemical Vapor Deposition
DAC	Disadvantaged Community
DAR	Division of Air Resources
DGEIS	Draft Generic Environmental Impact Statement
DRE	Destruction and Removal Efficiency
EIS	Environmental Impact Statement
EJ	Environmental Justice
EPA	United States (US) Environmental Protection Agency
ER	Environmental Rating
ERC	Emission Reduction Credits
ERP	Emission Rate Potential
ESD	Empire State Development Corporation
ESP	Electrostatic Precipitator
F-GHG	Fluorinated Greenhouse Gas
FGR	Flue Gas Recirculation
FLM	Federal Land Manager
FR	Federal Register
GACT	Generally Available Control Technology
GHG	Greenhouse Gas
GWP	Global Warming Potential
HAP	Hazardous Air Pollutant
HPM	Hazardous Process Material
HTAC	High Toxicity Air Contaminant
HTF	Heat Transfer Fluid
IPCC	Intergovernmental Panel on Climate Change
LAER	Lowest Achievable Emission Rate
LNB	Low NO_x Burners
MACT	Maximum Achievable Control Technology
MEL	Mass Emission Limit
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System

NCDENR	North Carolina Department of Environment and Natural Resources
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMHC	Non-Methane Hydrocarbons
NNSR	Non-attainment New Source Review
NSPS	New Source Performance Standards
NSR	New Source Review
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
OAQPS	Office of Air Quality Planning and Standards
OCIDA	Onondaga County Industrial Development Agency
OTR	Ozone Transport Region
PEEC	Process Equipment Exhaust Conditioner
PES	Process Emission Sources
POTW	Publicly Owned Treatment Works
POU	Point of Use
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
PVD	Physical Vapor Deposition
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
RCRA	Resource Conservation and Recovery Act
RCS	Regenerative Catalytic Systems
RCTO	Rotor-Concentrator Thermal Oxidizer
RICE	Reciprocating Internal Combustion Engines
RTO	Regenerative Thermal Oxidizers
SCR	Selective Catalytic Reduction
SEQRA	New York State Environmental Quality Review Act
SGC	Short-term Guideline Concentration
SGEIS	Supplement to Generic Environmental Impact Statement
SI	Spark Ignition
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SPT	Significant Project Threshold
SNCR	Selective Non-Catalytic Reduction
TDS	Total Dissolved Solids
TO	Thermal Oxidizers
TSP	Total Suspended Solids
TPY	Tons Per Year
ULNB	Ultra-low NO_x Burners
ULSD	Ultra-low Sulfur Diesel
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
VOL	Volatile Organic Liquid
WBV	Water Bath Vaporizer
WESP	Wet Electrostatic Precipitator
WPCP	White Pine Commerce Park
WWTP	Wastewater Treatment Plant

1. INTRODUCTION

Micron New York Semiconductor Manufacturing LLC (Micron), a Delaware limited liability company (LLC) and wholly owned subsidiary of Micron Technology, Inc., is proposing to construct a semiconductor manufacturing campus (the "Micron Campus", illustrated in Figure 1-1) in the Town of Clay, New York, at the White Pine Commerce Park (WPCP), an approximately 1,400-acre industrial park.

The construction and operation of the Micron Campus is critical to Micron's ability to meet market and customer demand for its products. The market demand for memory chips continues to grow with the continued expansion of devices and goods that use chips Micron produces. The semiconductor manufacturing campus will increase domestic supply of leading-edge memory, create nearly 50,000 New York jobs and represent the largest private investment in New York state history. Micron will design, build and operate the facility in accordance with its sustainability goals. Micron's project is aligned with the goals of the CHIPS and Science Act Notice of Funding Opportunity (NOFO) to enhance U.S. economic and national security by securing a leading edge in critical technologies and rebuilding a highly complex but critical manufacturing sector in the U.S. Micron has been awarded $6.1 billion in federal funding under the CHIPS and Science Act to pursue leading-edge manufacturing at the Micron Campus in New York and in Boise, Idaho.[1]

The timing of construction of the Micron Campus is affected by the issuance of several state and federal environmental permits and authorizations and non-environmental authorizations, including the Title V air permit. Planning for environmental permitting has been a collaborative effort between Micron, its consultants, the New York State Department of Environmental Conservation (NYSDEC) and other state and federal agencies. Micron appreciates the collaboration to date and is looking forward to continued collaboration to facilitate a thorough and expeditious review with the goal of receiving an air permit by March 2026 or sooner. Additional details of the project and proposed permit timing are included in Section 1.3.

As described in more detail in Section 1.2, the scope of this Title V permit application is for the "Proposed Air Permit Project," which consists of the stationary air emission sources located on the Micron Campus. An initial application (Permit Application 1) using preliminary design information and conservative assumptions was submitted to the NYSDEC in April 2024. The NYSDEC issued a Notice of Incomplete Application (NOIA) on June 3, 2024, and a Technical Review (TR) comment letter on July 19, 2024, in response to Permit Application 1. Micron is submitting this updated application (Permit Application 2) using the current detailed engineering design information. Micron has included responses to comments received from the NYSDEC on Permit Application 1 and incorporated several updates and changes throughout the application. Key details of this application that are new or have been revised from Permit Application 1 are highlighted in yellow in the confidential version of this application to facilitate NYSDEC's review.

[1] $6.1B in CHIPS and Science Act Funding for Historic Planned Investment in Domestic Leading-Edge Memory Manufacturing in Idaho and New York, https://www.micron.com/manufacturing-expansion/ny, Accessed January 2, 2025.

A larger group of activities is currently undergoing review pursuant to the National Environmental Policy Act (NEPA) and the New York State Environmental Quality Review Act (SEQRA). This NEPA/SEQRA review encompasses both the Micron Campus and ancillary development on nearby properties.

Throughout this Permit Application 2 and appendices, Micron will use the following terms and descriptions to identify different aspects of this project and associated permitting/approvals:

- Micron Campus: The main property associated with this project on which Micron is proposing to construct a semiconductor manufacturing campus, beginning with two semiconductor fabrication facilities and related support structures (the facility).
- NEPA/SEQRA Proposed Project: The Micron Campus, together with ancillary development on nearby properties. These facilities have been referred to collectively as the "Proposed Project" for the purposes of the federal NEPA environment impact analysis and the New York State SEQRA evaluation. To avoid confusion in this application, we refer to this collection of facilities as the NEPA/SEQRA Proposed Project.
- Proposed Air Permit Project: The stationary air emission sources located on the Micron Campus owned and operated by Micron associated with the operation of Fab 1 and Fab 2, which are the focus of this Title V permit application.
- Micron Clay Air Permit Application: The primary air permit application package which includes this introduction, an air permitting regulatory analysis and supporting appendices which collectively meet the requirements for a complete air permit application.
- Permit Application 1: The first Micron Clay PSD/NNSR Air Permit Application that included information known to Micron at the time of submittal in April 2024.
- Permit Application 2: This application.

The Proposed Air Permit Project will be a major facility under the Title V air permitting program,[2] a major source of hazardous air pollutants (HAP), and a major new facility under both the Prevention of Significant Deterioration (PSD) and the Non-attainment New Source Review (NNSR) programs (collectively, the PSD/NNSR program).[3] As such, this Permit Application 2 includes details on the Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) levels of control and emission limits. The applicability and requirements of NYSDEC regulations and air toxics dispersion modeling, federal New Source Performance Standards (NSPS)[4] and National Emission Standards for Hazardous Air Pollutants (NESHAP)[5] are also detailed in this Permit Application 2 package. Air dispersion modeling to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS)[6] will be submitted to the NYSDEC under separate cover.

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[2] Title 6 of the New York Codes, Rules and Regulations (6 NYCRR) Subpart 201-6 and Title 40 of the Code of Federal Regulations (40 CFR) Part 70.

[3] 6 NYCRR Part 231

[4] 40 CFR Part 60

[5] 40 CFR Part 63

[6] 40 CFR Part 50

1.1 Micron Campus

The Micron Campus, illustrated in Figure 1-2, is primarily located in the Town of Clay, which is located in Onondaga County, located approximately 9.5 miles north of Syracuse, New York. The approximate center point of the campus is located at 43.190275° N, 76.150296° W. The Micron Campus is part of a NEPA/SEQRA Proposed Project which consists of the following:

- Construction of the Micron Campus, which will include four individual memory fabrication facilities (fabs), ancillary support facilities, driveways, and parking;
- Construction of a childcare and health care center located at 9100 Caughdenoy Road, Brewerton, NY;
- Construction of a connection to the National Grid substation, adjacent to the Micron Campus, and
- A rail spur on the west side of Caughdenoy Road adjacent to the proposed facility.

The Proposed Air Permit Project covers the construction of the first two fabs on the Micron Campus (Fab 1 and Fab 2). Micron intends to start land clearing activities for Fab 1 and Fab 2 in Q4 2025, with the two fabs becoming operational by approximately 2030. Assuming economics and business plans continue to support further expansion, two more fabs (Fab 3 and Fab 4) would be constructed and operational by approximately 2041.

The Micron Campus is planned for a greenfield site that currently primarily consists of residential and agricultural land. The property that constitutes the Micron Campus will be made up of several parcels of land. All of the properties on the Micron Campus have been acquired by the Onondaga County Industrial Development Agency (OCIDA) and the majority of the structures, including residences, were removed in late 2023. Micron anticipates that all of the Micron Campus will be owned and controlled by Micron by the time of operation of the Proposed Air Permit Project.

Figure 1-1. NEPA/SEQRA Proposed Project Map

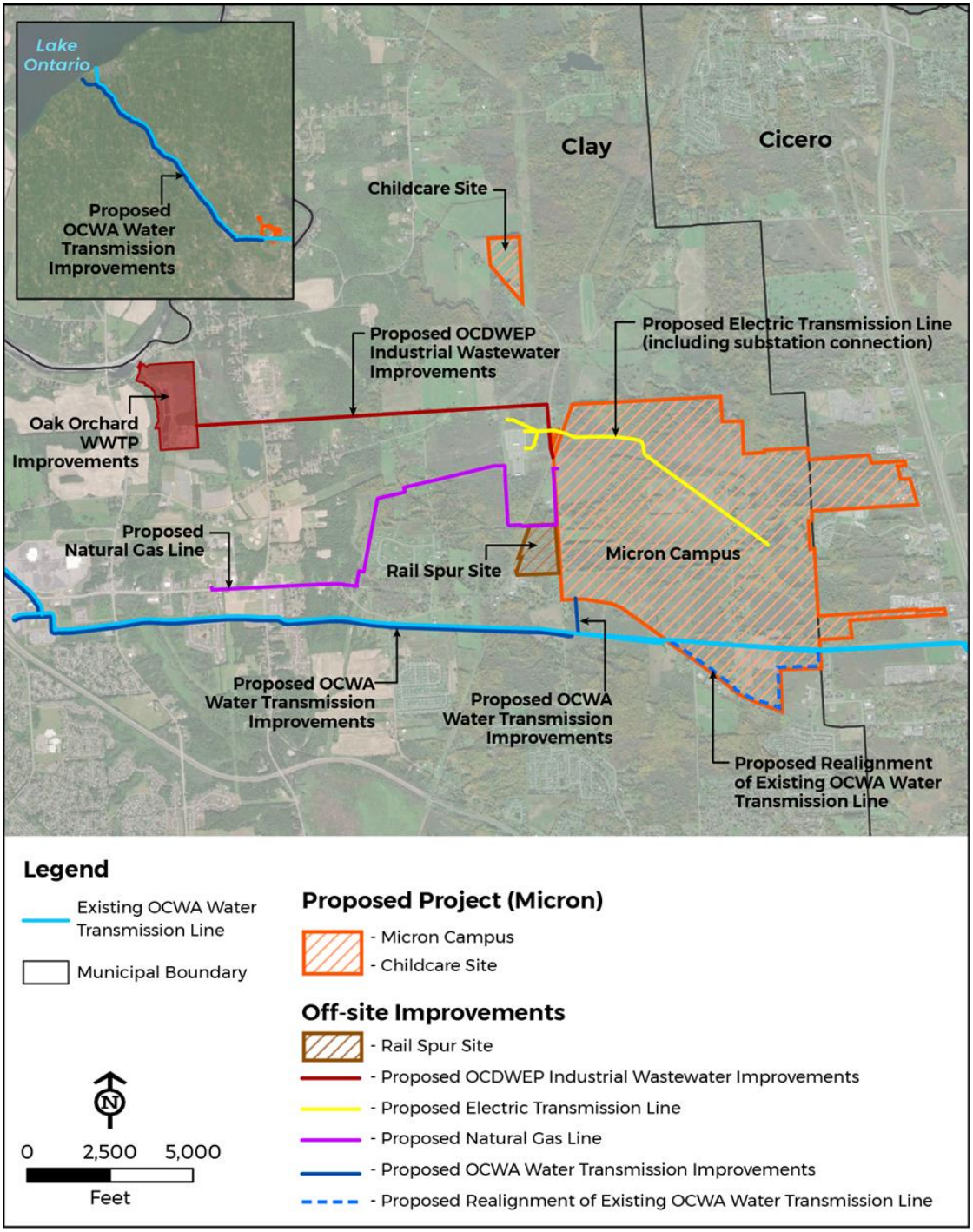

Figure 1-2. Location of NEPA/SEQRA Proposed Project

1.2 Scope of Air Permit Application

This application (Permit Application 2) encompasses the Proposed Air Permit Project, which is a subset of the NEPA / SEQRA Proposed Project. Specifically, this Permit Application 2 addresses emissions from operation of Fabs 1 and 2 and support buildings owned and operated by Micron, on which Micron plans to start construction as soon as the regulatory process will allow.

1.2.1 Determination of the Facility Subject to Air Permitting

When evaluating if multiple properties or operations should be considered for inclusion in the air permit application, the properties must meet the definition of "facility," and must meet the criteria for being included as part of the "major stationary source" as defined in Title 6 of the New York Codes, Rules and Regulations (6 NYCRR) Sections 200.1 and 201-1.2, respectively. In addition, the addition of multiple properties or operations over time must be evaluated to determine if they should be considered the same "project" based on guidance issued by the United States Environmental Protection Agency (EPA) ("project aggregation").

1.2.1.1 Facility and Major Stationary Source Criteria

The term "facility" is defined in 6 NYCRR 200.1(aa) as "All emission sources located at one or more adjacent or contiguous properties owned or operated by the same person or persons under common control."

The portion of the definition of "major stationary source" in 6 NYCRR 201-2.1(b)(21) that pertains to this evaluation is:

> *Any stationary source or any group of stationary sources, any source or any group of sources, or any facility or any group of facilities, that is located on one or more contiguous or adjacent properties and is under common control, belonging to a single major industrial grouping. … For the purposes of this definition,* a stationary source, source*, or* facility *or* group of stationary sources, sources*, or* facilities *shall be considered part of a single industrial grouping if all of the air pollutant or air contaminant emitting activities at such stationary source, source, or facility, or any group of stationary sources, sources, or facilities on contiguous or adjacent properties belong to the same major group (*i.e.*, all have the same two-digit code), as described in the* Standard Industrial Classification Manual*, 1987. …*

EPA guidance further clarifies that "permitting authorities must assess three factors – same industrial grouping, location on contiguous or adjacent properties, and under common control – to determine whether or not pollutant-emitting activities should be considered a single source when determining applicability of NSR and title V permitting requirements."[7]

[7] Memorandum from Anne L. Idsal, Acting Assistant Administrator, U.S. EPA to U.S. EPA Regional Administrators, Regions 1 – 10, November 26, 2019.

Once the scope of the facility is determined, the potential to emit (PTE) of the facility is compared to relevant emission thresholds listed 6 NYCRR 201-2.1(b)(21) to determine if the facility is a major stationary source, and for what air contaminants.

Micron's proposed semiconductor manufacturing operations are classified by the U.S. Department of Labor Standard Industrial Classification (SIC) Code 3674 (semiconductors and related devices). As a matter of reference, this equates to the North American Industry Classification System (NAICS) code of 334413 related to semiconductor devices, memory chip and wafer manufacturing. Therefore, the SIC major group for this is 36.

Each of the properties that are ancillary to the Proposed Air Permit Project is evaluated per the criteria listed above to determine if they should be included as part of the Proposed Air Permit Project.

1.2.1.1.1 Rail Spur Site and Other Construction Equipment

In conjunction with the Proposed Air Permit Project, certain support activities and facilities will be undertaken by third parties. Micron plans to enter into a contract with a third-party to construct, operate and own (or lease) a rail spur that will be adjacent to the Micron Campus. The rail spur along the existing CSX corridor would be constructed on an approximately 38-acre parcel on the west side of Caughdenoy Road, adjacent to the Micron Campus (see Figure 1-1). The following facts apply to the rail spur site:

- A third-party will own the rail spur conveyance system and other equipment associated with the rail spur site. The third-party will lease/rent railcars used at the rail spur site from CSX.
- The third-party owner of the rail spur equipment will hire and manage employees to operate the rail spur site.
- The third-party owner of the rail spur equipment will manage day to day activities. The equipment owner will provide labor force to operate rail spur equipment. No Micron employees will be involved in the operation of the rail spur equipment.
- The third-party owner will manage all operations, including that of any air pollution control devices.
- The third-party owner of the equipment will determine the ultimate use of the rail spur. Micron would contract the use of the rail spur to support the delivery aggregate material and construction materials such as rebar, precasts, etc. At this time, the materials plan does not include utilizing the rail spur for production related materials. Production related materials will utilize truck delivery. Loading docks have been designed to accommodate the deliveries required by production.

Potential stationary sources on the rail spur site would not be considered contiguous or adjacent to the Micron Campus. In addition, the potential stationary sources on the rail spur site would not be under "common control" under NYSDEC or EPA guidance.[8] Therefore, the rail spur does not fall within the scope of the Proposed Air Permit Project and Permit Application 2 does not include any sources associated with the proposed rail spur site. However, the third party will be required to

8 See NYSDEC Declaratory Ruling (DR) 19-19 (Sept. 9, 2011), and subsequent U.S. EPA clarification in the Meadowbrook guidance. Meadowbrook Energy and Keystone Landfill Common Control Analysis dated April 30, 2018.

secure necessary authorizations for any potential stationary sources associated with the rail spur site.

Similarly, construction equipment such as batch plants, crushers, and screeners to be located on the Micron Campus will be owned and operated by a third party. As such, this construction equipment would not be considered under "common control" with the Proposed Air Permit Project, and therefore does not fall within the scope of this Permit Application 2. Instead, the third-party construction contractor will be obligated to secure necessary approvals and authorizations for that contract equipment. This obligation is conveyed throughout Micron's procurement and contracting processes.

Micron is in the process of procuring vendors to own (or lease) and operate the rail spur site and other construction equipment. It is anticipated that air emissions sources associated with these activities will be authorized through the Department's Minor Facility Registration program. As of this submittal, it is anticipated that the relevant third parties will submit their respective Minor Facility Registration applications in or about September 2025.

1.2.1.1.2 Childcare Center

The Childcare Center would be located on a 30-acre parcel on Caughdenoy Road, approximately three-quarters of a mile north of the Micron Campus and is not adjacent. The property between the Micron Campus and the Childcare Center will not be owned by Micron and the property is not contiguous. The sites will also not share a primary SIC code. Therefore, it is not part of the same facility as defined above and cannot be part of the same major stationary source. The Childcare Center is not included in the scope of the Proposed Air Permit Project.

1.2.1.2 Project Aggregation Analysis

1.2.1.2.1 Proposed Project Timing

Key dates for air permit application timing for the NEPA/SEQRA Proposed Project are summarized in Table 1-1. The installation of foundations requires that an air permit has been issued by the NYSDEC.

Table 1-1. Major Milestones of Fab Construction and Operation

Fab	Site Prep / Construction Starts	Ready for Equipment	Building Construction Ends	Operations Start
1	Q4 2025	Q2 2028	Q2 2028	Q1 2029
2	Q3 2028	Q3 2030	Q4 2030	Q4 2030
3*	Q3 2033	Q3 2035	Q4 2035	Q4 2035
4*	Q2 2039	Q2 2041	Q3 2041	Q3 2041

*Anticipated dates assuming economic and business plans continue to support further expansion

Micron's plans to construct and begin operation of Fab 1 and Fab 2 fall within the years 2025 through 2030. Until its Title V and PSD/NNSR air permit is issued, Micron will only engage in allowable pre-construction (e.g., site-clearing) activities. However, the construction for Fab 3 and Fab 4 is not planned to start until 2033. This is consistent with the public announcements that Micron has made indicating that the overall investment in the project will be over approximately 20 years.[9]

1.2.1.2.2 "Substantially Related" Test

The United States EPA has issued guidance suggesting that projects should be aggregated for PSD/NNSR purposes if they are "substantially related."[10] A key factor to be considered when evaluating if projects are substantially related is to determine if there is a relationship "between the physical and/or operational changes, or a complementary relationship whereby a change at a plant may exist and operate independently, however its benefit is significantly reduced without the other activity."[11]

The guidance also indicates that the EPA has established a "rebuttable presumption that activities that occurred more than three years apart are not "substantially related" and therefore, generally, should not be aggregated" for determining they are part of a single action as a matter of policy.[12] The 2018 Federal Register notice also clarifies that the three years should be measured between permitting actions authorizing the construction.[13]

As illustrated in Table 1-1, the preparation and construction for Fab 3 would not begin earlier than 2033, whereas the permit will be required to allow construction to begin on Fab 1 in 2025, a period of over eight years. Due to the considerable timeline between the desired permit issuance for Fab 1 and Fab 2 and the estimated timeline for Fab 3, the 2018 FR notice indicates that these two aspects of the NEPA/SEQRA Proposed Project should not be considered as one air permitting effort.

Additionally, the 2018 FR notice indicates that projects that are not technically interconnected should not be considered part of the same permitting effort. One indication of technical interdependence is if the engineering for the project is completed at the same time. The detailed design for Fab 1 and Fab 2 is occurring in 2025. The semiconductor industry demands constant, rapid changes in technology to maintain a competitive edge. Due to this nature, the process technology, and in turn the emissions sources and design characteristics for Fab 3 and Fab 4, are uncertain at this time and cannot reasonably be foreseen. Indeed, Micron anticipates that some of the technologies that will be utilized in Fab 3 and Fab 4 do not yet exist. The development of these new technologies will depend on evolving technology and market demands throughout the industry. This rapid development of technology is summarized by Micron in an online article regarding Moore's Law:

> *The effect that Moore's law has had on the electronics industry cannot be overstated. The idea that the number of transistors in a dense integrated circuit*

[9] https://www.micron.com/ny/fact-sheet, Accessed November 29, 2024
[10] 83 FR 57324, November 15, 2018
[11] 83 FR 57327
[12] 83 FR 57326
[13] 83 FR 57327

> *doubles approximately every two years was advanced in a paper written by Gordon E. Moore in 1965 and was validated over the course of the next half a century. The law has been used in the semiconductor industry to guide long-term planning and to set targets for research and development.*[14]

In order to effectively integrate more transistors, semiconductor industry technology needs to evolve to allow for the creation of smaller circuit components. Although the pace of advancement predicted by Moore's law has slowed in recent years, during the eight years between when the Fab 1 and Fab 2 air permit is received and when Fab 3 is projected to initiate construction, the number of transistors in a dense integrated circuit could increase by up to sixteen times. Achieving this level of change will require technological development and advancement that is not yet available and commercial.

Finally, the main concern addressed by the 2018 project aggregation FR notice is to avoid the following scenario:

> *a source could conceivably carve up a higher-emitting project into two or more lower-emitting "projects" and avoid triggering major NSR requirements. "Project aggregation," therefore, ensures that nominally-separate projects occurring at a source are treated as a single project for NSR applicability purposes where it is unreasonable not to consider them a single project.*[15]

As illustrated in Section 1.2, this Permit Application 2 for Fab 1 and Fab 2 will be a major PSD and major NNSR permit application subject to the requirements of air dispersion modeling, BACT and LAER. Thus, the intent of separating the permitting action for Fab 1 and Fab 2 from Fab 3 and/or Fab 4 is not to circumvent PSD/NNSR permitting.

Therefore, the permit action for Fab 1 and Fab 2 is not substantially related to possible future permitting actions for Fab 3 and/or Fab 4. Accordingly, Fabs 3 and 4 are not included in this Permit Application 2.

1.2.2 Proposed Air Permit Project

Micron's Proposed Air Permit Project and this Permit Application 2 package consist of two semiconductor fabrication facilities (Fab 1 and Fab 2) and associated supporting facilities.

Fab 1 and Fab 2 will manufacture semiconductors and other devices on silicon-based wafers. To remain competitive, Micron must constantly adapt to changing product mix, architecture, and functionality. The nature and rapid pace of constant technological change affects the type, number, and configuration of semiconductor process equipment (also known as "tools" or "process tools" in the industry and throughout this permit application and its appendices) required to fabricate devices.

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[14] Moore's Law and Dennard Scaling, https://www.micron.com/about/blog/company/insights/metamorphosis-of-an-industry-part-2, Accessed March 14, 2024.

[15] 83 FR 57325

1.2.2.1 Semiconductor Fabrication Facilities

Both Fab 1 and Fab 2 will generally consist of the following operations which allow independent operation of either fab:

- A main production cleanroom space of approximately 600,000 square feet (sq. ft.) that includes a mix of process tools;
- A sub-fab area that prepares and stores raw materials (e.g., process gases, chemical mixtures/slurries in the liquid state, etc.) used in the fab buildings;
- Support buildings storing bulk raw materials and waste materials (hazardous process material [HPM] building) and preparing raw materials that are transferred to the fab or sub-fab;
- A central utilities building (CUB);
- Bulk gas storage yards;
- An administrative (Admin/Probe) building that includes a quality control laboratory;
- Ancillary support equipment including cooling towers and emergency generators; and,
- Wastewater treatment plant (WWTP) operations, including high fluoride waste treatment and general industrial waste treatment housed in one building (WWT), and biological wastewater treatment housed in its own building (BIO).

Refer to Section 1.4 for additional details of semiconductor manufacturing processes within the fabs.

1.3 Air Permit Timing and Applications

1.3.1 Project Timing

The timing of construction and operation of the NEPA/SEQRA Proposed Project is critical to Micron's ability to meet market and customer demand for its products. The timing of the project is affected by the issuance of several state and federal environmental permits and authorizations and non-environmental authorizations, including the Title V air permit.

This Permit Application 2 is being submitted using the current engineering design information. The detailed design will continue after the submission of Permit Application 2. Micron does not anticipate that refinements during further detailed design will substantially change the information that forms the basis for the permit application. However, as noted above, the technology within the semiconductor manufacturing space moves rapidly. Micron will work with NYSDEC to address any technology changes that may be warranted in the design following submittal of Permit Application 2.

1.3.2 Air Permit Timing

Key milestone dates proposed by Micron related to the Micron Clay Air Permit Application and associated air dispersion modeling submittal timing are summarized below.

- February 2025: Air Permit Application 2 Submittal.
- February 2025: Air Dispersion Modeling Protocol 2 Submittal.
- March 2025: Air Dispersion Modeling Report Submittal.
- November 2025: Micron initiates land clearing activities.
- March 2026: Micron initiate installation of underground utilities for Fab 1 pending receipt of final Title V Air Permit.

To meet this schedule, **Micron would like to receive an air permit by March 2026** as described above. To aid in expediting the NYSDEC's review, Micron and Trinity would appreciate the opportunity to continue to meet with and work with the NYSDEC staff on a periodic basis following the submittal of this application.

1.4 Semiconductor Process Overview

The Proposed Air Permit Project will house state-of-the-art manufacturing operations to produce memory chips to be used in electronic devices. The core manufacturing operations will take place in cleanrooms within the fab. Cleanrooms are engineered spaces designed to maintain high air quality with low levels of particulates to avoid contamination of products in the manufacturing process. To successfully operate a modern fab, air in a clean room must be exchanged frequently to meet the strict temperature, humidity, and purity requirements of the cleanroom. Process tools and other support equipment are housed within the cleanroom. Below the fab, support operations, such as exhaust management and raw material supply, will occur in the "subfab".

The manufacturing of semiconductor devices involves many specialized processes that can each generate air emissions in a distinct manner. For the purposes of this air permit application, these processes have been grouped into seven distinct categories, each of which is described in a subsection below. Each of these process categories will have many individual pieces of equipment that carry out the intended operation, each referred to as a "process tool" or simply a "tool."

1.4.1 Fab Process Categories

The semiconductor manufacturing process begins with thin disks of high-purity silicon called wafers, which undergo a large number of individual process steps. The seven process categories described below each play a unique and critical role in generating a memory chip. Each wafer will undergo some or all of these processes in a specific order to achieve a desired end result. A wafer may be processed by one tool multiple times throughout the production process if its design requires the same operation to be performed more than once.

1.4.1.1 Thin Films / Diffusion Deposition

The "thin films" processes each deposit a thin film of a specific material onto a wafer. This category includes processes that occur within the functional area within a fab known as "diffusion" but involve the deposition of a layer of material onto a wafer. The deposition can be performed either via a chemical reaction (chemical vapor deposition [CVD]) or a physical deposition (physical vapor deposition [PVD]). As the industry advances and semiconductor components become smaller over time, atomic layer deposition (ALD) processes have become more common. Gaseous raw materials are used in the deposition process to create a film of a specific portion of the raw material molecule on a wafer.

In thin films operations, the chamber is filled with gases intended to deposit onto a wafer(s). Due to the physics of having gaseous materials in a volume, not all compounds that are in the vapor can be deposited onto the wafer. Therefore, some raw material may be exhausted from a tool without being deposited on a wafer. Individual ions may be left on the walls of a tool chamber. To remove leftover ions and prepare for the next process, a thin films tool may be cleaned with a fluorinated

gas. Chamber cleaning is distinct from other semiconductor processes in that it does not occur in the presence of a wafer. The most common gas used to clean thin films tool chambers is nitrogen trifluoride (NF_3) using the "remote clean" process, in which NF_3 is cracked into ionic radicals prior to entering the tool chamber. In the chamber, leftover positively charged ions react with fluorine to form compounds that can be exhausted from the tool chamber.

Air emissions from thin films tools include gaseous raw materials or cleaning gases that are not consumed, byproducts that are formed from partial decomposition and/or combustion of gaseous raw materials in thermal oxidation devices, some of which are criteria pollutants or HAP, and products of combustion of natural gas in thermal oxidation devices.

A PVD process known as "sputtering" is used to deposit metal ions onto a wafer by physically dislodging ions from a solid metal "target" using argon plasma, then directing them onto a wafer. This operation occurs within a tool that is closed during the sputtering process with no vent. Due to the nature of the metal ions in the vapor space of the tool, metal ions not deposited on a wafer will coat the inside of the tool prior to the tool being opened to remove the wafer(s). Therefore, this process does not generate emissions to the atmosphere and is not considered further in this air permit application.

1.4.1.2 Diffusion Non-Deposition

"Diffusion non-deposition" involves the diffusion of ions through a set of wafers to create specific electrochemical properties. These processes may also take place in the "diffusion" functional area of a fab, but do not add material to a wafer. Their goal is to modify the electrochemical properties of the existing material. Gases such as nitrous oxide (N_2O) may be used in this process.

Air emissions from diffusion non-deposition tools include gaseous raw materials not consumed, byproducts that are formed from partial decomposition and/or combustion of gaseous raw materials in thermal oxidation devices, some of which are criteria pollutants or HAP, and products of combustion of natural gas in thermal oxidation devices.

1.4.1.3 Plasma Etch

Plasma etch or dry etch processes remove material from a wafer surface in a pre-determined pattern. Prior to etching, a photoresist layer is placed onto a wafer to protect the area that should not be etched. Plasma etching is performed by removing air from a process tool, introducing an etchant and carrier gas, and creating plasma in the tool chamber. Etchant gases are often fluorinated hydrocarbon compounds (fluorocarbons), as the fluoride ion (F^-) is a very effective etchant. Under plasma conditions, the fluoride ion and carbon-fluorine fluoride radicals are freed, which will strike a wafer surface and remove material from areas not covered by the photoresist layer.

Processing requirements for high-aspect ratio plasma etching continue to become more stringent, requiring both fluoride ion to etch and the right carbon-to-fluorine ratio to ensure successful etching results. The molecular shape of each fluorocarbon is critical to the manufacturing process because it defines the ability for the fluorocarbon etching gas to achieve the desired geometry and etch rate.

Plasma etch processes are a source of GHG emissions, as many of the etchant gases used in the industry are GHGs that can form other GHGs while in the plasma state. Point-of-use (POU) control devices, discussed in Section 1.4.3 below, are often installed to combust these high-GWP gases and reduce GHG emissions on a GWP basis. Where possible, Micron is opting to install centralized regenerative catalytic systems (RCS) to control GHG emissions while using less fuel.

In addition to these process GHG emissions, air emissions from plasma etch processes include other unreacted etchant gas byproducts that are formed from partial decomposition and/or combustion of etchant gases, some of which are criteria pollutants or HAP, byproducts that are formed from reaction of etchant gases with a metal substrate on a wafer being etched, and products of combustion of natural gas in POU control devices and RCS.

1.4.1.4 Photolithography

Photolithography is the process of imaging a pattern onto a wafer. Photoresist material, which contains solids in a solvent solution, is first applied to a wafer in an even layer, then heat treated to remove a portion of the solvent material. A "mask" is then placed over the wafer, and light of a specific wavelength is projected through transparent areas of the mask, forming a specific pattern.

After the photoresist layer has been exposed in certain areas through the mask, it is "developed" in a solution designed to remove only the exposed or unexposed portion of the material. The wafer is then rinsed to remove any excess developer solution. At this point, the wafer is still partially covered in photoresist material in a designated pattern, with the remainder of the wafer exposed. The wafer will move to another process to have a specific operation, such as etching or deposition, performed on only the remaining portion. Once it is no longer needed, the remaining photoresist material can be removed from the wafer in a process called "ashing", in which the organic solids of the photoresist material are oxidized.

Air emissions from photoresist process tools include VOC emissions from evaporation of photoresist and developer solvents. Organic compounds may be oxidized by the control devices discussed in section 1.4.3. below, generating NO_X, SO_X, and CO_2. The ashing process generates additional emissions of CO and CO_2.

1.4.1.5 Wet Etch/Wet Clean

Aqueous solutions are used in wet etch and wet clean tools to achieve multiple objectives in wafer processing. Inorganic solutions are used to remove material from a wafer in a predetermined area. Separately, aqueous inorganic and organic solutions are used to remove impurities from wafer surfaces in between processing steps. In some cases, multiple solutions are dispensed onto a group of wafers in a single tool chamber, called a single wafer tool, in lieu of separate chambers for each solution. Process tool parts may also be cleaned.

Wet processes, regardless of whether they are designed to etch a wafer, clean a wafer, or clean process tool parts, generate air emissions through the evaporation of the organic or inorganic solvent being used. Emissions from each solution, which can include VOC and HAP, will be exhausted to an appropriate emissions control device.

1.4.1.6 Ion Implant

Ion implant processes, also known as "doping", insert specific chemical elements into a silicon layer on a wafer to create a semiconductor. Like etching, ion implant occurs after a photoresist step, which protects certain portions of the wafer and leaves other portions exposed. A wafer is placed in an implanter tool, the air is removed, and then a dopant gas, such as arsine or phosphine, is introduced. A plasma environment is created to generate free metal ions from the dopant gas, which are electromagnetically accelerated to allow them to embed into exposed areas of the wafer. Air emissions from ion implant processes are generated from dopant gas that is not utilized as part of the process.

1.4.1.7 Chemical-Mechanical Planarization

Chemical-mechanical planarization (CMP) is the process of polishing a wafer surface into an even layer, which is accomplished using slurries containing abrasive particles suspended in other chemicals. Many different chemicals are used for the slurries to remove different materials from a wafer. After completing a CMP process, a wafer might then be cleaned to remove any excess particles or other materials.

Depending on the volatility of the chemicals used in the slurry, which could include VOC or ammonia, the CMP process can result in air emissions due to evaporation of a portion of the slurry.

1.4.1.8 Fab Support Chemicals

Isopropyl alcohol (IPA) is used extensively throughout the fab to clean process tool chambers, work benches, parts, floors, or other items, and is a VOC. Several heat transfer fluids (HTFs) that are GHGs are used in process temperature control loops that have the potential for fugitive emissions from flanges, connections, etc. These sources of emissions are the only sources from the main fab not covered under one of the previous seven process categories discussed above.

1.4.2 Fab Exhaust Management

Due to the complexity and variety of semiconductor process operations described above, resultant exhaust must be managed effectively to not only control air emissions but to protect equipment and employees.

1.4.2.1 Managing Safety Hazards

Like other semiconductor manufacturers, the Proposed Air Permit Project will operate a number of process tools that in some cases exhaust a variety of different materials that must be managed to minimize safety hazards and protect facility systems. To manage these materials, certain tools will exhaust to Process Equipment Exhaust Conditioners (PEECs), which are required safety equipment and an inherent part of the semiconductor manufacturing process.[16] Exhausts from thin films tools containing pyrophoric, flammable, and/or toxic materials are generally required to be managed to ensure personnel safety and facility protection. Wet process and single wafer tools using chemicals incompatible in exhaust require management to avoid the formation of hazardous reaction

[16] Letter from D. Solomon, EPA Office of Air Quality Planning and Standards, to T. Mohin, Intel Government Affairs (Nov. 27, 1995)

byproducts that clog ductwork and to prevent damage to or failure of exhaust ductwork and control equipment. If left unmanaged, pyrophoric, flammable or reactive materials could pose a safety hazard by exceeding 25% of the Lower Flammability Limit within the duct work. In addition, exhausts containing acids and ammonia in the same vent system must generally be managed because untreated streams would generate reactions that form solids, plug the vent headers, and/or damage the control devices.

A fab cannot operate safely without PEECs in place and operational. Redundant PEECs will be installed as part of the Proposed Air Permit Project to ensure uninterrupted hazard management and to maximize the time during which process tools can operate. PEECs are considered exhaust conditioners, not air pollution control devices, because they are installed to address the safety and facility integrity issues that occur when pyrophoric, flammable, and/or incompatible materials are present in a vent stream. Indeed, no modern semiconductor manufacturing facility would be designed without PEECs, regardless of whether environmental regulations existed to limit emissions.

1.4.2.2 Exhaust Segregation

In addition to operation of PEECs, semiconductor fabs can further minimize the occurrence of undesirable chemical reactions in exhaust systems by segregating different classes of chemicals to separate exhausts. Mixing incompatible process tool exhaust streams can result in undesirable reactions, collection of solids and/or flammable material within the ductwork, and other undesirable results. In addition, different vent streams require different construction materials to prevent corrosion and/or failure of ductwork, and process tools are programmed and designed to operate only when these vent streams are separated. For example, acid gases and ammonia will rapidly form ammonium compounds when combined in the exhaust duct of process tools not equipped with PEECs, which may result in visible emissions from stacks. To avoid this and similar issues, modern semiconductor fabs utilize separate exhausts ductwork, systems and air pollution control for streams containing acidic compounds, caustic compounds, and organic compounds.

Exhaust from the Proposed Air Permit Project will be routed to the compound-specific common vent header to one of five exhaust types: acid exhaust, CVD exhaust, ammonia exhaust, solvent exhaust, and general exhaust. Each exhaust type is described in detail in Section 1.4.2 and serves a unique purpose, collecting and routing a specific category of process exhaust to control devices or the atmosphere directly as necessary. The exhaust from several process tools in each subsection of the fab will be routed to a common exhaust header appropriate for the type of the exhaust, and then will be distributed from the header to multiple similar control devices along the length of the header, each of which is equipped with stacks to the atmosphere. Each exhaust type will have dozens of individual stacks at Fab 1 and Fab 2. This redundant arrangement will ensure that adequate control is provided at all times, even during maintenance of control devices. Fab 1 and Fab 2 will be divided into two (2) "halves" each, and each half will be equipped with one common vent header for each exhaust type.

1.4.3 Fab Control Devices

For each exhaust type introduced in Section 1.4.2.2 above, with the exception of general exhaust, a unique type of control device will be used. In addition, plasma etch processes will be equipped with POU control devices and centralized RCS to reduce emissions of GHGs. Each type of control device is discussed in the sections below.

1.4.3.1 Centralized RCS

The Proposed Air Permit Project will employ centralized RCS where feasible to control GHG emissions from plasma etch processes. Each RCS will include a pre-wet scrubbing stage, a natural gas-fired catalytic oxidation stage, and a post-wet scrubbing stage. Exhaust from each RCS will be routed to a fab acid scrubber, discussed below, for further treatment. The RCS will use significantly less natural gas than POU control devices. RCS cannot be used to control exhaust from plasma etch tools in which metal substrates are etched ("metal etch" tools), as metal compounds could form in the catalytic section and damage the catalyst.

1.4.3.2 Point-of-Use Control Devices

POU control devices will be used at or near metal etch process tools to control emissions from metal etch processes, since RCS are not feasible. Thermal oxidation is used as a part of POU control devices to control emissions of fluorinated GHG by thermally treating exhaust streams from process tools that utilize GHG. These POU control devices also use wet scrubbing systems to control the resultant acid gases.

1.4.3.3 Fab Exhaust and Centralized Control Devices

As introduced above, process emissions from each of the seven process categories described in Section 1.4.1 above will be emitted through segregated ductwork designed to manage one of five exhaust types. Each exhaust type, along with the planned control equipment, is described in detail in this section.

1.4.3.3.1 Acid Exhaust

Exhaust streams containing acid gases, including hydrogen fluoride (HF) and hydrogen chloride (HCl), will be routed to this exhaust type. Process categories that generate acid-containing exhaust include plasma etch and diffusion non-deposition, in which acid gases are generated as byproducts of the processes, POU control devices, and/or RCS, and wet etch/wet clean, in which acids may evaporate. Micron is proposing to control emissions from the acid exhaust using centralized wet scrubbers.

1.4.3.3.2 CVD Exhaust

CVD and ALD processes, both subsets of the thin films category, can generate emissions of both acid gases and PM that each need to be controlled. Acid gases may be formed due to decomposition of fluorinated or chlorinated deposition gases, and PM and NO_X may be formed due to oxidation in POUs. To control both categories of pollutants, Micron is proposing to install ionizing wet scrubbers that include both acid scrubbing and electrostatic precipitating technologies. Micron anticipates installing ionizing wet scrubbers with DeNOx technology to remove NO_2 through wet scrubbing.

1.4.3.3.3 Ammonia Exhaust

Ammonia is used in aqueous solution in both the CMP and wet etch/wet clean processes. In addition, other ammonia-based compounds are used in the photolithography process. Exhaust containing these chemicals must be segregated from exhaust containing acids and VOCs. Therefore, exhaust from certain areas of these three processes will be treated separately. Micron is proposing to install centralized ammonia scrubbers on this stack type.

1.4.3.3.4 Solvent Exhaust

Both the photolithography and wet etch/wet clean processes use solvents that can evaporate during the process, resulting in VOC emissions. Exhaust streams from these processes that contain organic compounds will be routed to this exhaust type, hence the term Solvent Exhaust or VOC Exhaust. Micron proposes to use rotor-concentrator thermal oxidizers (RCTOs) to reduce emissions of VOC from this exhaust type. These devices will adsorb organic compounds from high-flowrate streams onto a pair of zeolite rotors, then desorb them into lower-flowrate streams that will be pre-heated and thermally oxidized.

1.4.3.3.5 General Exhaust

The fab operations discussed above are conducted in a carefully controlled cleanroom environment. To successfully operate a modern fab, air must be exchanged frequently to meet the strict temperature, humidity, and purity requirements of the cleanroom. Therefore, many stacks will be dedicated to exhausting air that does not meet strict cleanroom requirements. These stacks will emit air contaminants that are evaporated into the main fab clean room such IPA used for wipe cleaning.

1.4.4 Support Operations

In addition to the core fab processes described in the above sections, the proposed air permit project will also include a number of essential support operations. These operations will not take place in the main fab, but in one of several support buildings or outdoors. Air emissions from these support operations will not exhaust through the main fab stacks described above, but may exhaust through separate stacks of the same exhaust type (acid exhaust, ammonia exhaust, etc.). This section includes operations specific to semiconductor facilities, or to the Proposed Air Permit Project. Typical air emission sources (i.e., emergency generators) are also planned for the Proposed Air Permit Project.

1.4.4.1 Wastewater Treatment

Semiconductor manufacturing generates wastewater that can include inorganic solvents, metals, ammonia, organic compounds, and other pollutants. Micron intends to construct on-site wastewater treatment operations to reduce concentrations of these pollutants before discharging to the local publicly owned treatment works (POTW).

Wastewater treatment operations will be conducted in an industrial wastewater treatment (WWT) building and a biological treatment (BIO) building. High-fluoride wastewater and general industrial wastewater will be pretreated in the WWT building. The WWT building effluent, along with other organic-containing wastewater streams, will be routed to the BIO building to undergo anaerobic digestion.

Emissions from the WWT building will be segregated into acid, ammonia, and solvent exhausts. Emissions from the BIO building will include hydrogen sulfide (H_2S), and therefore will be routed through an odor scrubber prior to release.

1.4.4.2 Water Bath Vaporizers

The proposed air permit project will include a cryogenic air separation plant to generate pure utility gases to be used in the fab. These chemicals will be generated in liquid form and will need to be vaporized in order to be useful. Heat from the fab can often be used to accomplish this vaporization but may not be sufficient in some cases. Therefore, water bath vaporizers (WBVs) will be installed as a backup heat source, which will heat baths of water using natural gas combustion so that heat transfer lines containing liquid chemicals are vaporized before entering the fabs.

1.4.4.3 Spin-on Dielectric Waste Treatment

The spin-on dielectric (SOD) process is a subset of the thin films processes that results in the formation of an unstable liquid waste byproduct. The SOD waste, a mixture of polysilazane and dibutyl ether, will be transferred to an HPM building for treatment before shipment offsite. A rinse solvent will be transferred along with the SOD waste to ensure that it is removed from the tool. In the HPM building, the SOD waste will be reacted with ethanol and potassium hydroxide into a stable silicon-based product for safe shipment. Byproducts of the reaction will include silane, ammonia, and hydrogen. The RCTOs in the HPM building will oxidize the silane- and ammonia-containing exhaust before it is emitted to atmosphere.

2. EMISSIONS QUANTIFICATION

This section provides the detailed potential to emit (PTE) calculation methodologies for air emissions sources planned for the Proposed Air Permit Project. Appendix F includes the emission calculations described in this section.

2.1 Semiconductor Manufacturing Process Emissions

The semiconductor manufacturing processes described in Section 1.4 include several fab processes that each will exhaust through one or more of five exhaust types. The process flow diagrams in Appendix E illustrate the relationship between the fab processes and exhaust types. The methods used to quantify emissions from fab processes are described in this section.

2.1.1 Projected Material Use Inventory

The PTE from the semiconductor manufacturing process operations is based on the chemical material use inventory that Micron currently projects will be required for operation of Fab 1 presented in Table 6-1 of Appendix F. The chemical material use inventory has been updated for this application based on more recent design information. This inventory includes both raw materials that are incorporated into the product as well as materials used to support the manufacturing process, such as gases used to clean process equipment. In Permit Application 1, Fab 2 was projected to require approximately 75% of the raw materials used in Fab 1. In this application, Fab 2 is projected to have equal material usage to Fab 1. Therefore, the annual projected quantities for Fab 1 were multiplied by 2 to estimate total usage in both Fab 1 and Fab 2.

As discussed above, the nature of Micron's business requires rapidly-changing product mix, architecture, and functionality to meet customer needs. The nature and rapid pace of constant technological change affects the type, number, and configuration of semiconductor process tools required to fabricate devices. The need for this flexibility extends to use of raw materials, process gases, etc. The process categories and exhaust types planned for the fabs described in this application represent typical industry operations and are not expected to change substantially. However, the specific operations, equipment, and materials to be used in each process category have the potential to change throughout the remainder of detailed design and operation of the fabs to keep pace with evolving technology. Many materials that are commonly used in the industry will remain the same. However, evolution of technology may result in the requirement to use different materials and/or change the total quantity of materials projected to be used. Therefore, Micron cannot predict the exact identity and quantity of materials that will be used in the semiconductor manufacturing process operations in Fab 2 and recognizes that the projected material use inventory for Fab 1 may change prior to commencement of operation. To account for this further possible refinement in emission calculations, the PTE for process equipment was developed using conservative assumptions discussed in detail in Appendix G.

2.1.2 Manufacturing Process Categories

Materials used in the manufacturing process (Table 6-1 of Appendix F) have been aligned with one or more of the process categories described in Section 1.4.1. This alignment is documented in the "Process Category" column of Table 6-1 of Appendix F. The process category in which a material will be used determines what the resulting air emissions and exhaust type will be.

Some materials are projected to be used in multiple process categories. For these materials, Micron has projected the percent of the total quantity of each primary chemical that will be used in each process category. This percentage is shown in the "% of Total Usage" column in Table 6-1 of Appendix F. The total quantity of each material projected to be used in each process category is listed in the "Projected Usage in Process Category" column of the same table. The quantity of each primary chemical may be listed multiple times if there is more than one emission chemical associated with the primary chemical for a process category. This is to facilitate calculation of emissions of each emission chemical and the repeated values in the "Projected Usage in Process Category" column for primary chemicals in each process are not additive.

2.1.3 Determination of Emission Chemicals

Table 6-1 of Appendix F refers to "Emission Chemicals" as those that have the potential to be emitted to the atmosphere as a result of using raw materials, process gases and other materials in the manufacturing process, which are collectively listed as "Primary Chemicals" in the same table. The emission chemicals may be the primary chemicals themselves or may be formed due to chemical reactions occurring as part of semiconductor process operations, or through oxidation in tool-level thermal oxidation systems or RCTOs. Materials used in multiple process categories may have different emission chemicals for each process in which they are used. The emission chemicals resulting from the use of each primary chemical were identified using published emission factors and semiconductor process knowledge. An explanation of emission chemical selection is provided in Appendix G. Emission chemicals proposed by the NYSDEC in TR Comment #12 are incorporated into Table 6-1 of Appendix F and Appendix G.

For fluorinated greenhouse gases (F-GHGs), emission chemicals were determined in part by using emission factors presented by the Intergovernmental Panel on Climate Change (IPCC) in the 2019 refinement to the 2006 Guidelines for National Greenhouse Gas Inventories for semiconductor industry manufacturing operations[17] (the "2019 Refinement"). F-GHGs have the potential to react and form other F-GHGs as part of the process. The 2019 Refinement prescribes the F-GHG emission chemicals for each F-GHG based on the semiconductor manufacturing process category in which it is used. In addition, chemical engineering judgement was used to identify emission chemicals from treating F-GHGs in a thermal oxidation system, notably hydrogen fluoride (HF), carbon dioxide (CO_2), carbon monoxide (CO), and other oxidation products.

To determine emission chemicals for primary chemicals for which there are no published emission factors, Micron evaluated the use of each primary chemical in each semiconductor manufacturing process and how each may be treated by thermal oxidation systems. For example, silane (SiH_4) gas will be used in thin films/diffusion processes to deposit silicon atoms onto wafers. Any gaseous silane not utilized for this purpose will react in exhaust ductwork or in a thermal oxidation system to form silicon dioxide, the emission chemical. In addition, some materials will be used as liquid solvents in photolithography processes. A portion of these materials may evaporate and then oxidize in a RCTO to form CO_2, SO_2 and/or NO_X, which are the emission chemicals.

2.1.3.1 Carbon Monoxide Emission Calculation

Carbon monoxide potentially could be generated as a byproduct of thermal oxidation for any of the primary chemicals listed in Table 6-1 to Appendix F that contain a carbon atom. Carbon monoxide emissions also may be generated from incomplete combustion of fuels in thermal oxidation systems. Because of the nature

[17] IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6: Electronics Industry Emissions, Table 6.11.

of the semiconductor process operations, the ratio of CO to CO_2 generation from carbon-based process gases and raw materials in semiconductor manufacturing operations is not easily quantifiable. To account for this, the air emission calculations for CO are based on assumptions presented in a semiconductor exhaust management and control book on this topic, the relevant excerpt of which is included in Appendix U.[18] This approach assumes that CO emissions for all operations can be conservatively estimated using an emission factor equal to five times the emission factor for CO in AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Table 1.4-1. This approach is used to estimate emissions of both process-based CO (i.e., that is generated from chemical reactions of process gases) and from incomplete combustion.

2.1.4 Emission Factors

For each emission chemical listed in Table 6-1 of Appendix F a "Process Emission Factor" is given in pounds of emission chemical emitted per pound of primary chemical used (lb emitted / lb used). These emission factors were developed as described previously in this section and as documented in Appendix G.

A large number of primary chemicals listed on Table 6-1 of Appendix F are available to be emitted from semiconductor manufacturing process operations in a quantity equal to the "Projected Usage in Process Category", either directly or through formation of an emission chemical. However, for other chemicals, such as liquids that are emitted by evaporation, a portion of the material used is collected as waste or otherwise is not available to be emitted from the process tool. The "Process Emission Factor" for direct emissions of such primary chemicals accounts for this fact. However, when there is an emission chemical created from a primary chemical, an additional step in the emission calculations in Table 6-1 is necessary. This step includes multiplying the "Process Emission Factor" for each emission chemical by the "Process Emission Factor" for the primary chemical. This additional calculation step accounts for the fact that only the material released into the exhaust stream has the potential to convert from the primary chemical into the emission chemical.

For example, 1-methoxy-2-propanol (PGME) is used in the liquid phase as a solvent in photolithography processes and is assigned a "Process Emission Factor" of 0.2 lb emitted / lb used, indicating that up to 20% of PGME used is assumed to evaporate and enter the exhaust. When PGME is oxidized in an RCTO, CO_2 is generated. Only the 20% of PGME which evaporates is available to be oxidized; therefore, the emission factor for CO_2, 1.95 lb CO_2 / lb PGME (per Table 3-1 of Appendix F), must be multiplied by the "Process Emission Factor" for PGME, 0.2, to calculate mass of CO_2 emitted per quantity of PGME used in production (lb CO_2 / lb PGME used). Emission chemicals for which this adjustment is made are indicated with an "X" in the column "Emission Chem Formation Depends on Primary Chem EF?" in Table 6-1 of Appendix F.

2.1.5 Exhaust Treatment Efficiencies

In Table 6-1 of Appendix F, each emission chemical is assigned an exhaust type based on the identity of the primary chemical and the process category in which it is used. The exhaust types are described in more detail in Section 1.4.3. Table 6-1 of Appendix F includes factors for how semiconductor manufacturing process equipment emissions will be changed prior to exhaust to the atmosphere. Those factors are described below. It is assumed that POU control devices and centralized control devices will be operating 100% of the time during which tools are operating.

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[18] J. Michael Sherer, *Semiconductor Industry Wafer Fab Exhaust Management*, pg. 166, published 2005 by CRC Press, Taylor & Francis Group, Boca Raton, FL.

2.1.5.1 Equipment for Employee, Process, and Facility Safety

Thin films and wet etch/clean process tools require PEECs to minimize hazards in the ductwork and protect personnel and equipment, as introduced in Section 1.4.2 above. PEECs are essential to the safe operation of semiconductor fabrication facilities, and, in the process, they may also incidentally reduce certain chemical compounds in the exhaust beyond those they are intended to manage. The estimated effect of PEECs is summarized in Table 5-1 of Appendix F, based on preliminary information available from potential vendors and conservative engineering estimates. For GHGs, the fraction treated is based on the default values published by the IPCC in the 2019 Refinement.

2.1.5.2 POU Destruction and Removal Efficiency

POU control devices will be installed on a subset of plasma etch tools that etch metal substrates ("metal etch" tools) to mitigate emissions of F-GHGs. These POUs will consist of a thermal oxidizer in series with a wet scrubber (known as burn/wet units). Micron is evaluating alternative POU technologies that will achieve the equivalent performance without combusting natural gas. The GHG destruction and removal efficiency (DRE) of the POU control devices, summarized in Table 5-2 of Appendix F, is based on default values provided in the IPCC 2019 Refinement. For other contaminants used alongside F-GHGs, the DRE is based on preliminary information available from potential vendors and conservative engineering estimates.

2.1.5.3 Centralized Control DRE

As described in Section 1.4.3 above, each exhaust type will be controlled by a unique control device, other than general fab exhaust. The DRE values used in PTE calculations for each of these control devices are summarized in Tables 5-3 and 5-4 of Appendix F. For this application, Micron has updated the DRE values to reflect the most recent available information from potential vendors, as well as updated engineering estimates. As described in Section 1.4.3, Micron plans to equip the ionizing wet scrubbers on the CVD exhausts with DeNO$_X$ technology. Micron also plans to install RCS units on non-metal plasma etch tools rather than POUs to provide reductions in natural gas usage. The DRE values for F-GHGs abated in the RCS units are based on default values provided in the IPCC 2019 Refinement.

Micron has begun the procurement process with potential vendors for centralized control devices but has not selected vendors at this time. In lieu of vendor specification sheets, Micron has provided outlines of its expectations for potential vendors in Appendix V. These documents are for use in the procurement process to help select vendors that are able to meet these specifications.

2.1.6 Process Tool and Operations Emissions

PTE for each emission chemical was calculated using the usage quantities, emission factors, PEEC exhaust management, and DRE values discussed above. Emissions are displayed at the outlet of semiconductor process operations, at the outlet of POUs, and at the exhaust to atmosphere in the "Process Emissions Quantification" section in Table 6-1 of Appendix F as described below.

2.1.6.1 Process Emissions

Emissions at the outlet of the semiconductor manufacturing process equipment are shown for each emission chemical in the "Process Emissions" column in Table 6-1 of Appendix F. These values were determined by multiplying the "Projected Usage in Process Category" of each primary chemical by the "Process Emission Factor" for the emission chemical. If indicated with an "X" in the "Emission Chem Formation Depends on

Primary Chem EF?" column of the same table, the result was then multiplied by the "Process Emission Factor" for direct emissions of the primary chemical. Finally, exhaust management from PEECs listed in the "PEEC Fraction Managed" column was accounted for.

For example, for the example discussed in Section 2.1.4 of CO_2 emitted as an emission chemical for PGME, the value in the "Process Emissions" column was determined by multiplying the "Projected Usage in Process Category" for PGME, 35,817 lb/yr, by the "Process Emission Factor" for CO_2 as an emission chemical of PGME, 1.95. Since an "X" is listed in the "Emission Chem Formation Depends on Primary Chem EF?" column, the product is then multiplied by the "Process Emission Factor" for direct emissions of PGME, 0.2. This value is then multiplied by (1 – "PEEC Fraction Managed"), which in this case is 1 since CO_2 is not managed in a PEEC. This calculation results in the "Pre-Control Process Emissions" quantity of 13,993 lb CO_2/yr for CO_2 as an emission chemical of use of PGME in photolithography.

2.1.6.2 Post POU or RCS Control Device Emissions

Emissions at the outlet of POU control devices, if applicable, are shown for each emission chemical in the "Post POU or RCS Emissions" column in Table 6-1 of Appendix F. This calculation was performed by multiplying the process emissions described above by (1 – "POU or RCS DRE"), where POU DRE is the fraction of emission chemical expected to be controlled by the POU. Emissions at the outlet of the RCS control devices were calculated using the same methodology, where applicable.

2.1.6.3 Post Control Emissions

Emissions from the exhaust stack to atmosphere are shown for each emission chemical in the "Post Control Emissions" column in Table 6-1 of Appendix F. This calculation was performed by multiplying the "Post POU or RCS Emissions", or the "Pre-Control Process Emissions" if a POU is not used, by (1 – "Centralized Control DRE"), where Centralized Control DRE is the fraction of emission chemical expected to be controlled by the applicable centralized control device. Emissions in this column represent the post control emissions of each emission chemical for the specific primary chemical used, process category it is used in, and exhaust type.

2.1.7 Additional Fab Process Emissions

Emissions from certain cleanroom operations were calculated independently from the emissions described in Sections 2.1.1 through 2.1.6. These operations include use of HTFs in process chillers, cleaning with IPA, the photoresist ashing processes, and generation of ozone. The separate methodologies used to calculate these emissions are described below.

2.1.7.1 Heat Transfer Fluid Losses

Various manufacturing processes will require the use of HTFs to maintain appropriate operating temperatures for equipment or components. The HTFs currently projected to be used in Fab 1 are listed in Table 9-1. Micron is currently developing and soliciting U.S. EPA approval for alternative HTFs with lower GWPs than the fluorocarbons compounds currently projected to be used. Potential greenhouse gas emissions are conservatively estimated based on the current usage projections. Emissions from HTF use are a result of losses from process chiller systems components (e.g., valves, connectors, etc).

The 100-year GWPs in units of kg CO_2e/kg HTF were determined based on information available in the IPCC 2019 Refinement. The projected usage in lb/year of each HTF was based on usage information available

from similar processes at other Micron facilities. The annual emissions of HTFs were assumed to be equal to the projected usage (i.e., the amount of fluid added to chillers is expected to equal the amount of fluid lost).

Each HTF was analyzed to determine whether it would contribute to total potential VOC or HAP emissions. The chemical structure of each HTF and documentation provided by manufacturers[19] were used to determine VOC status with respect to the definition in 6 NYCRR 200.1(cg). No HTF planned to be used in the Proposed Air Permit Project are defined as HAP. To calculate total CO_2e emissions (on either a 100-year or 20-year basis) from each HTF, the appropriate GWP of each HTF was multiplied by the corresponding HTF usage quantity.

2.1.7.2 Fab Cleaning Emissions

IPA will be used for miscellaneous cleaning operations conducted by hand, including cleaning process equipment, workspaces and other surfaces within the semiconductor fab. This use is separate from IPA used in wet etch/wet clean process tools for cleaning wafers and is purely for routine maintenance as opposed to semiconductor process operations. The quantity of IPA used for wiping is estimated based on the current detailed engineering design information. Since IPA is a volatile solvent, 100% of IPA used for cleaning is assumed to be emitted from the fab. Total annual emissions are presented in Table 10-1 of Appendix F.

IPA used for cleaning will evaporate into the cleanroom air and be dispersed. Therefore, IPA used for cleaning is assumed to exhaust through each stack type at a rate proportional to the total flowrate through all stacks of each type. Each solvent exhaust is divided into two stacks, one at the outlet of the pair of zeolite rotors, and one at the outlet of the thermal oxidizer. For the purpose of this calculation, they are treated as one stack. The annual emissions of IPA through each stack type is calculated in Table 10-2 of Appendix F by dividing the total flowrate for all stacks of each type by the total flowrate for all fab stacks, then multiplying by the total annual emissions of IPA. Emissions are also calculated on an hourly basis per quadrant and per stack by applying a variance factor of 25% to account for potential variability in operations from hour to hour, then dividing by the appropriate number of halves (four for Fab 1 and Fab 2 combined) or stacks.

2.1.7.3 Ozone Emissions

Ozone (O_3) is used as a raw material in thin films processes and will be generated onsite as opposed to being purchased from a supplier. Therefore, it is not included on the Projected Material Use Inventory. Micron has conservatively estimated the amount of O_3 that will be generated per year based on demands for similar manufacturing facilities. Ozone that is not utilized in the process will be managed by PEECs that serve to prevent safety and odor issues in the fab if reentrainment of O_3 were to occur. These assumptions are documented in Table 11-1 of Appendix F.

Emissions of ozone will exhaust through centralized acid scrubbers and CVD scrubbers along with other emissions from thin films processes. Using a similar methodology to calculate emissions as is used for IPA , O_3 is assumed to be emitted through acid and CVD exhausts at rates proportional to the total flowrate of all stacks of each type. The methodology described in Section 2.1.7.2 above that is used for IPA is also used to calculate annual emissions per stack type, hourly emissions per half, and hourly emissions per stack of O_3 in Table 11-2 of Appendix F.

[19] Details of the analysis of exclusions from being a VOC per 6 NYCRR 200.1(cg) are presented with Table 9-1 in Appendix F.

2.1.7.4 Photoresist Ashing

As described in Section 1.4.1.4, photoresist material, which is composed of solids in a solvent solution, is selectively applied to wafers to protect certain areas of the wafer during processes like etching. When the photoresist remaining on the wafer is no longer needed, it is combusted in a process called "ashing" and is oxidized to form CO_2 and CO. Emissions associated with this process are presented on Tables 8-1 and 8-2 of Appendix F.

Multiple materials on the material use inventory are used to formulate photoresist mixtures, and some of those may be used for other purposes as well. To calculate emissions of CO_2 and CO, the total annual photoresist usage quantity for the Proposed Air Permit Project was projected based on available design information. The percentage of remaining photoresist material assumed to be solid material that could remain on a wafer was 30%, based on semiconductor process knowledge. Of the total amount of photoresist solids, 5% were assumed to remain on the surface of wafers after the "development" of the photoresist material, in which photoresist material is removed from areas exposed to light. These remaining photoresist solids were conservatively assumed to be composed of 100% carbon atoms for the purposes of calculating potential CO and CO_2 emissions. It was assumed that, on a molar basis, 50% of the carbon solids would oxidize to CO while 50% would oxidize to CO_2. In reality, some photoresist material may react with process gases used in the plasma etch process before it has the potential to be combusted in the ashing process, forming F-GHG byproducts. These emissions are captured as part of the IPCC 2019 Refinement emission factors discussed in Appendix E.

The total amount of material to be oxidized into either pollutant during combustion was calculated by multiplying each percentage by the total estimated usage of photoresist material. The amount of material to be oxidized into each pollutant in lb/year was then multiplied by the ratio of the molar weight of each pollutant in pounds per pound-mole (lb/lb-mole) to the molar weight of carbon in lb/lb-mole. This calculated pollutant-specific emission rates of CO_2 and CO in lb/year. These emission rates were converted to final pollutant-specific ton per year (tpy) potential emission rates.

2.2 Emissions from Combustion Sources

The following sections detail the different pieces of equipment that will combust fossil fuels as part of the Proposed Air Permit Project and the calculation methodology associated with each that was used to calculate potential emissions from combustion.

2.2.1 Diesel Fuel-Fired Emergency Generators and Emergency Fire Pump Engine

As part of the Proposed Air Permit Project, diesel fuel-fired generator sets will be installed to provide power during emergency events for health and safety purposes. One diesel fuel-fired emergency fire pump engine will be used to provide fire water supply in the event of an emergency during which the primary electric fire pump cannot be used. Emission calculations using information from potential vendors are shown on Tables 17-1, 17-2, and 17-3 of Appendix F for the generators, and Tables 32-1, 32-2, 32-3 of Appendix F for the fire pump.

Diesel fuel-fired generator sets will be compliant with Tier 4 exhaust emissions standards.[20] Therefore, these standards were used to determine potential emissions of criteria pollutants. Criteria pollutant emission

[20] 40 CFR 1039 Subpart B

factors for combustion of ultra-low sulfur diesel (ULSD) were obtained from AP-42[21] for pollutants for which Tier 4 emissions standards have not been set. The AP-42 emission factors were multiplied by the brake horsepower (bhp) provided in specifications from potential vendors at full load to calculate the emission rate of each pollutant in lb/hr. To calculate emissions using the Tier 4 emission standards, the bhp rating was converted to kilowatts (kW) and then multiplied by the provided emission factors in grams per kW hour. These emission rates were then converted to units of pounds per hour (lbs/hr).
Hazardous air pollutant (HAP) emission factors in pounds per million British thermal unit (lb/MMBtu) were obtained from AP-42.[22,23] These emission factors were multiplied by the conversion of MMBtu to brake horsepower-hour (bhp-hr) and subsequently multiplied by the brake horsepower of the engines at full load to calculate the emission rate of each HAP in lb/hr.

The diesel fuel-fired emergency fire pump will be compliant with Tier 3 exhaust emissions standards.[24] Therefore, these standards were used to determine potential emissions of criteria pollutants, supplemented with AP-42[25] factors for other criteria pollutants and for HAP.

The emission factor for CO_2 was obtained from 40 CFR Part 98 Table C-1,[26] while the emission factors for methane (CH_4) and nitrous oxide (N_2O) were obtained from 40 CFR Part 98 Table C-2.[27] The greenhouse gas (GHG) emission factors were provided in units of kilograms per million British thermal units (kg/MMBtu). These emission factors were converted to units of lb/hr using both the conversion from kilograms to pounds and by multiplying the conversion from MMBtu to bhp-hr by the brake horsepower of each generator set engine model at full load.

Potential carbon dioxide equivalent (CO_2e) emissions were calculated across a 20-year and 100-year period using established global warming potentials (GWPs) for CH_4 and N_2O.[28] The GWPs of both CH_4 and N_2O were multiplied by the respective calculated lb/hr emission rate of each gas and summed with the CO_2 lb/hr emission rate. To calculate potential annual emissions from these generator sets, the emission rates from each generator set were multiplied by the proposed 100 hr/yr limit for each generator, then multiplied by the total estimated amount of generator sets to be installed as part of the Proposed Air Permit Project. To calculate potential annual emissions from the fire pump, the emission rates were multiplied by the required 500 hr/yr limit to maintain emergency status. Upstream emissions as a result of the extraction and

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[21] AP-42 Vol. I, Chapter 3.4: Large Stationary Diesel and All Stationary Dual-fuel Engines, Table 3.4-1: Gaseous Emission Factors for Large Stationary Diesel and All Stationary Dual-fuel Engines and Table 3.4-2: Particulate and Particle-sizing Emission Factors for Large Uncontrolled Stationary Diesel Engines

[22] AP-42 Vol. I, Chapter 3.4: Large Stationary Diesel and All Stationary Dual-fuel Engines, Table 3.4-3: Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines

[23] AP-42 Vol. I, Chapter 3.4: Large Stationary Diesel and All Stationary Dual-fuel Engines, Table 3.4-4: PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines

[24] 40 CFR 1039 Subpart B

[25] AP-42 Vol. I, Chapter 3.3: Gasoline and Diesel Industrial Engines

[26] 40 CFR Part 98, Table C-1: Default CO_2 Emission factors and High Heat Values for Various Types of Fuel

[27] 40 CFR Part 98 Table C-2: Default CH_4 and N_2O Emission Factors for Various Types of Fuel

[28] 20-year GWPs per 6 NYCRR Part 496. 100-year GWPs per 40 CFR Part 98, Table A-1: Global Warming Potentials

transmission of ULSD were quantified using emission factors published by the NYSDEC in the 2024 NYS Statewide GHG Emissions Report, Table A1.[29]

2.2.2 Tool-Level Thermal Oxidation Systems and RCS

Tool-level thermal oxidation systems, which include metal etch POUs and thin films PEECs, will be utilized as described in Section 1.4.2. RCS will be used on non-metal plasma etch tools that would otherwise require POUs. The operation of these devices will require the combustion of natural gas. Emission calculations are shown on Tables 13-1, 13-2, and 13-3 of Appendix F for tool-level thermal oxidation systems, and on Tables 31-1, 31-2, and 31-3 of Appendix F for RCS.

To calculate potential emissions from natural gas use, the total estimated natural gas usage for metal etch POUs and thin films PEECs was estimated based on available design information in Table 13-1 of Appendix F. RCS natural gas usage is based on the required burner size.

Emission factors for criteria pollutants, greenhouse gases, and HAPs were obtained from AP-42[30] in units of pounds per million standard cubic feet (lb/MMscf). The emission factors for PM_{10} and $PM_{2.5}$ were conservatively assumed equal to the emission factor for total PM, which is the sum of the emission factors for filterable and condensable PM. These emission factors were multiplied by the estimated total annual natural gas usage in MMscf/year to determine emission rates in lb/year. The emission factor for CO was multiplied by a safety factor of five to account for the incomplete oxidation of process chemicals and the incomplete combustion of natural gas, as described in Section 2.1.3.1 above. To calculate the 20-year and 100-year CO_2e emission rates, the GWPs[31] of both CH_4 and N_2O were multiplied by the respective lb/year emission rate of each gas and summed with the CO_2 lb/year emission rate. Upstream emissions as a result of the extraction and transmission of natural gas were quantified using emission factors published by the NYSDEC in the 2024 NYS Statewide GHG Emissions Report, Table A1.

The annual emission rates were divided by the total operational stack count by oxidation system exhaust type to determine per-stack emission rates in units of tpy. To determine pollutant-specific lb/hr emission rates per stack, a conversion factor of 8,760 hours of operation per year was applied. Multiplying the per-stack pollutant-specific tpy emission rates by each respective total operational stack count yielded the total pollutant-specific tpy emission rate by device-specific stack type.

2.2.3 Rotor-Concentrator Thermal Oxidizers

Rotor-concentrator/thermal oxidizer (RCTO) units will be employed as part of the Proposed Air Permit Project to control emissions from certain semiconductor manufacturing processes. Emission calculations are presented in Tables 14-1, 14-2, and 14-3 of Appendix F.

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[29] Emission Factors for Use by State Agencies and Applicants, Appendix A to the 2024 NYS Statewide GHG Emissions Report, Table A1

[30] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Tables 1.4-1 through 1.4-4

[31] 20-year GWPs per 6 NYCRR Part 496. 100-year GWPs per 40 CFR Part 98, Table A-1: Global Warming Potentials

Natural gas will be combusted in the burners as part of the operation of the RCTOs. Emission factors for criteria pollutants, greenhouse gases, and HAPs were obtained from AP-42[32] in units of pounds per million standard cubic feet (lb/MMscf). The emission factor for CO was multiplied by a safety factor of five as described in Section 2.1.3.1 above.

Each pollutant-specific emission factor in lb/MMscf was multiplied by the natural gas flow rate in MMscf/hr to each RCTO model type, the latter of which was calculated using the model-specific burner rating in MMBtu/hr and the Btu/scf heat value of natural gas established in AP-42,[33] to calculate emission rates in units of lb/hr. To calculate the 20-year and 100-year CO_2e emission rates, the GWPs[34] of both CH_4 and N_2O were multiplied by the respective calculated lb/hr emission rate of each gas and summed with the CO_2 lb/hr emission rate. Upstream emissions as a result of the extraction and transmission of natural gas were quantified using emission factors published by the NYSDEC in the 2024 NYS Statewide GHG Emissions Report, Table A1.

The pollutant-specific per-RCTO lb/hr emission rates were converted to per-RCTO tpy emission rates using a potential 8,760 hours of operation per year. Total potential tpy emission rates were calculated by multiplying the per-RCTO tpy emission rates by the projected number of operational RCTOs.

2.2.4 Water Bath Vaporizers

WBVs will be installed to heat large baths of water to vaporize nitrogen when needed to supplement the supply from the onsite air separation unit. Potential combustion emissions were calculated as shown in Tables 15-1, 15-2, and 15-3 of Appendix F.

The natural gas flow rate to the burners in scf/hr was calculated using the proposed burner rating and the Btu/scf heat value of natural gas established in AP-42.[35] Potential emissions for NO_X, CO, and VOC were based on applicable BACT or LAER emission limits for WBVs. Emission factors for other criteria pollutants, greenhouse gases, and HAPs were obtained from AP-42[36] in units of pounds per million standard cubic feet (lb/MMscf). Pollutant-specific per-WBV lb/hr emission rates were calculated by multiplying the natural gas flow rate to the burners in MMscf/hr by the lb/MMscf emission factors. To calculate the 20-year and 100-year CO_2e emission rates, the GWPs[37] of both CH_4 and N_2O were multiplied by the respective calculated lb/hr emission rate of each gas and summed with the CO_2 lb/hr emission rates. Upstream emissions as a result of the extraction and transmission of natural gas were quantified using emission factors published by the NYSDEC in the 2024 NYS Statewide GHG Emissions Report, Table A1. All hourly emission rates were converted to per-WBV tpy emission rates using a proposed limit of 8,000 total hours of operation per year.

The potential per-WBV pollutant-specific emission rates in lb/hr and tpy were multiplied by the projected total count of operational WBVs to calculate total potential lb/hr and tpy emission rates for the operation of

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[32] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Tables 1.4-1 through 1.4-4

[33] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion

[34] 20-year GWPs per 6 NYCRR Part 496. 100-year GWPs per 40 CFR Part 98, Table A-1: Global Warming Potentials

[35] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion

[36] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Tables 1.4-1 through 1.4-4

[37] 20-year GWPs per 6 NYCRR Part 496. 100-year GWPs per 40 CFR Part 98, Table A-1: Global Warming Potentials

WBVs as part of the Proposed Air Permit Project. Emissions from redundant WBVs were assumed to be zero, as Micron will operate the four redundant and four operational WBVs for a total of no more than 8,000 hours per year.

2.2.5 Natural Gas-Fired Boilers

Micron plans to install natural gas-fired boilers as part of the Proposed Air Permit Project to supplement heat recycled within the fab when necessary. Emission calculations are shown in Tables 16-1, 16-2, and 16-3 of Appendix F.

Potential emissions for NO_X, CO, and VOC were based on applicable BACT or LAER emission limits for natural gas-fired boilers. Other criteria pollutant, greenhouse gas, and HAP emission factors from AP-42 Chapter 1.4 in units of lb/MMscf for natural gas combustion were divided by the standard heat value of natural gas in Btu/scf before being multiplied by the burner rating of the boilers to calculate pollutant-specific lb/hr emission rates. To calculate the 20-year and 100-year CO_2e emission rates, the GWPs[38] of both CH_4 and N_2O were multiplied by the respective calculated lb/hr emission rate of each gas and summed with the CO_2 lb/hr emission rate. Upstream emissions as a result of the extraction and transmission of natural gas were quantified using emission factors published by the NYSDEC in the 2024 NYS Statewide GHG Emissions Report, Table A1.

These potential emission rates were converted to units of tpy using the proposed limit of 6,000 hours of operation per year.

2.3 Facility Support Emissions

Outside of emissions generated from combustion and from semiconductor fab manufacturing processes, several pieces of equipment to be installed as part of the Proposed Air Permit Project will result in air emissions during daily operation. The following sections describe the different methodologies that were used to calculate potential emissions for each type of facility support equipment.

2.3.1 Cooling Towers

As part of the Proposed Air Permit Project, cooling towers will be installed in the CUB and gas yard for heat dissipation purposes. Specifications sheets provided by potential vendors were used to determine the drift loss and flow rate in gallons per minute (gal/min) of each cooling tower model for use in the emissions calculations.

To begin the calculation, lb/hr emission rates of total dissolved solids (TDS) were calculated by multiplying together the density of water in pounds per gallon (lb/gal), the flow rate to each cooling tower model in gallons per minute (gpm), the drift loss percentage of each cooling tower model, and the concentration of TDS in the circulating water in parts per million by weight (ppmw) (converted to a percentage). Then, percentages of TDS emissions that were PM_{10} or $PM_{2.5}$ based on the drift loss percentages of each cooling tower model were interpolated based on droplet diameter and total PM concentration data compiled by

[38] 20-year GWPs per 6 NYCRR Part 496. 100-year GWPs per 40 CFR Part 98, Table A-1: Global Warming Potentials

Environmental Canada.[39] These pollutant-specific emission percentages were multiplied by the lb/hr emission rate of TDS to obtain per-unit lb/hr emission rates of PM_{10} and $PM_{2.5}$. The per-unit lb/hr emission rates were converted to per-unit tpy emission rates using 8,760 hours/year of operation, which were subsequently multiplied by the estimated total cooling tower count to calculate the total tpy emission rates.

To calculate speciated particulate matter emissions from the cooling towers, the inventory of additives to the cooling water was evaluated to determine constituents that could potentially emit as particulate matter. The speciated particulate matter PTE from the cooling towers is based on the potential annual usage of the additives and weight percent of each constituent in each additive, as shown in Table 20-3 of Appendix F. The average concentration of each additive constituent in the cooling water was estimated by dividing the total annual projected constituent usage by the total annual projected cooling water flow. Then, the ratio of the constituent concentration to the estimated total TDS concentration was multiplied by the total estimated TDS emissions to calculate the total estimated constituent emissions.

2.3.2 Storage Tanks

Storage tanks will be used as part of the Proposed Air Permit Project to store both raw chemical components and waste from manufacturing processes. A list of projected storage tanks is provided on Table 21-1 of Appendix F. The proposed storage tanks will all be equipped with fixed roofs, and the majority will be installed indoors. For indoor tanks, breathing losses were not considered since the tanks will not be exposed to direct sunlight or outdoor temperature fluctuations. Potential working loss emissions of volatile chemicals from all storage tanks were calculated. The working loss equations referenced below were obtained from AP-42 Chapter 7.1.[40]

For outdoor tanks, the tank emissions calculation software tool BREEZE TankESP™ was utilized to calculate potential breathing losses based on historical meteorological data for near Clay, NY and projected attributes of the tanks (i.e., design, color, and capacity). BREEZE TankESP™ uses the emission estimation procedures from Chapter 7 of U.S. EPA's Compilation of Air Pollutant Emission Factors (AP-42) to estimate emissions from tanks. Breathing loss estimates are presented in Table 23-3 of Appendix F.

The throughput for each tank in terms of gal/day of raw material was based on projected raw material needs and waste generation capacities. A default filling rate of 2,500 gal/hr was assumed for all bulk chemical tanks, while waste tanks were assumed to be filled constantly based on continual fab operation. The filling rate of waste tanks was calculated by dividing the annual throughput in gal/year by 8,760 hours of operation per year.

The molecular weight and vapor pressure of each chemical projected to be stored is documented on Table 22-1 of Appendix F. Using this information, working losses were calculated as shown on Table 23-2. A normalized mole percentage of each component by tank was calculated based on the projected weight percent of chemicals in solution in each tank. The weight percent of the particular chemical in the raw material delivered was divided by the molecular weight of the chemical. These ratios, representative of the pound-moles (lb-mole) of each individual chemical constituent per pound of stored material, were then

[39] https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions/wet-cooling-tower-particulate-guide.html, Accessed February 1, 2024

[40] AP-42 Vol. I, Chapter 7.1.3.1: Routine Losses From Fixed Roof Tanks

divided against the sum of all ratios belonging to the same particular raw material to calculate a normalized mole percentage.

The methodology summarized in Table 23-1 of Appendix F was used to calculate working losses. The stock vapor density in lb/gal was calculated by multiplying the vapor pressure of the component in pounds per square inch absolute (psia) by the molecular weight of the vapors of the raw material in lb/lb-mole and dividing by the product of the temperature of the bulk raw material loaded into the tank (assumed to be 540 degrees Rankine (˚R)) and the ideal gas constant in units of psia*scf/lb-mole*˚R. The stock vapor density of each component was multiplied by the throughput in gal/year, the dimensionless working loss turnover factor (calculated using the amount of annual turnovers), the dimensionless working loss product factor, the dimensionless vent setting correction factor, and the vapor weight percent of the component to calculate the working loss emissions in units of lb/year. The working loss product factor and vent setting correction factor were both assumed equal to one for the purposes of these calculations.

The pre-control lb/year working loss emission rates for each group of tanks were converted to total tpy. The "Control Efficiency" for each group of tanks is shown in Table 23-2. The control efficiencies for each group and pollutant are determined based on specifications that Micron has required of vendors and conservative engineering estimates. Controlled lb/yr working and breathing loss emission rates were calculated by multiplying the pre-control emission rates by (1 – "Control Efficiency"). Emissions that were classified as HAP or VOC emissions based on the constituent in question were added to the total potential facilities emissions.

2.3.3 Storage Silos

Bulk material storage silos will be installed as part of the Proposed Air Permit Project to store lime. The calculation methodology described below was used to estimate emissions of particulate matter from daily use of the storage silo, as shown on Tables 24-1 and 24-2 of Appendix F.

It was assumed that filters will be installed on the silos to control particulate emissions. A particulate capture rate of 100% was assumed along with a 99.5% control efficiency. To estimate emissions of total PM, PM_{10}, and $PM_{2.5}$, emission factors were obtained from AP-42[41] in units of lb/ton of material processed. The factor for "product loading to an enclosed truck" was used as truck loading operations were deemed representative of the operations taking place at the storage silos. Emission factors for PM_{10} and $PM_{2.5}$ were conservatively assumed equivalent to total PM.

The pollutant-specific emission rate in lb/hr for each silo was calculated by multiplying the emission factor by the throughput of lime in ton per day and applying the 99.5% control efficiency. The emission rate in lb/hr was then converted to units of tpy by multiplying by 8,760 hours/yr of operations. To determine the final potential emission rates of particulate matter from all silos, the per-silo emission rates were multiplied by the total silo count.

[41] AP-42 Vol. I, Chapter 11.17: Lime Manufacturing, Table 11.17-4: Emission Factors for Lime Manufacturing Raw Material and Product Processing and Handling

2.3.4 Process Wastewater Emissions

The treatment of wastewater generated in the semiconductor fab manufacturing process will result in the emission of certain organic and inorganic compounds to the atmosphere. Estimates of these emissions are provided in Table 12-1 of Appendix F.

These emission estimates were developed using the Toxchem modeling software developed by Hydromantis. Toxchem is a steady-state mass balance simulator capable of predicting the fate of organic and inorganic compounds in water streams. Toxchem uses the Henry's Law constant for each organic and inorganic compound to simulate emission rates attributable to liquid-to-gas mass transfer as influenced by specific design criteria (e.g., liquid surface area, agitator horsepower) for each wastewater treatment operation.

The wastewater flow rates used in the Toxchem model originate from Micron's water balance for Fab 1 and Fab 2. The concentrations of organic and inorganic compounds in these wastewater streams are conservative engineering estimates derived from chemical usage rates, design data, and process simulations. Certain compounds that may be present in the wastewater streams from Fab 1 and Fab 2 are not represented in Toxchem's chemical database. In order to simulate emissions of these compounds, representative surrogate compounds were selected based on similarities in chemical structure.

Although Toxchem is capable of simulating the biodegradation rate for various compounds in biological treatment units, Toxchem does not quantify the generation of secondary compounds such as hydrogen sulfide and nitrates. Emissions of these secondary compounds were calculated manually assuming stoichiometric conversion of the incoming biodegraded compounds (e.g., sulfur-bearing compounds and ammonia) along with the biodegradation rate predicted by Toxchem.

2.3.5 Roadway Emissions

Traffic on roadways surrounding Fab 1 and Fab 2 has the potential to generate PM emissions by disturbing silt present on the surface. These roads will be paved to minimize such emissions, which was determined to be PM BACT as discussed in Appendix K. An estimate of PM emissions from roadways is provided in Table 26-1 of Appendix F.

To estimate PTE from this source, industrial truck traffic expected to travel on roads surrounding Fab 1 and Fab 2 for trucks delivering raw materials and removing waste was considered. For raw materials expected to be delivered or accumulated for shipment and stored in bulk, identified as the "Materials Hauled" in Table 26-1, the location of the storage vessel/container was determined based on the current site master plan, and an "Estimated Round Trip Distance Traveled" was calculated based on the difference between the destination and nearest entrance from a public roadway. Process materials were assumed to be delivered to the buildings in or near which they will be stored (e.g., HPM, WWT, BIO, or Fab).

Emissions were calculated using the equation and table in AP-42 Chapter 13[42] for particulate emissions from ubiquitous paved roads (i.e., not roads used for heavy industry). The equation is presented in footnote 4 to Table 26-1. A silt loading factor of 1.5 was chosen to conservatively estimate emissions assuming winter conditions occur for half of the year. It was assumed that traditional rock salt would be used in winter. The

[42] AP-42 Vol. I, Chapter 13.2.1: Paved Roads, Equation 2, and Table 13.2.1-2: Ubiquitous Silt Loading Default Values with Hot Spot Contributions from Anti-Skid Abrasives (g/m^2)

average weight of each shipment was calculated using an "Estimated Weight When Empty" for each truck, the specific gravity or density of each material being transported in bulk, and an estimated capacity of each shipment. The number of shipments of each material in a year was determined by dividing the total annual "Material Throughput" by the "Estimated Load Weight" (for throughputs in tons) or an estimated load volume of 5,000 gallons (for throughputs in gallons). The total number of vehicle miles traveled (VMT) to transport each material was calculated by multiplying the number of "Pickup / Delivery Trips" by the "Estimated Round Trip Distance Traveled" for each trip. Then, Equation 2 from AP-42 Chapter 13.2.1 was used to calculate the emissions of PM as total suspended particulate (TSP), PM_{10} , and $PM_{2.5}$.

2.3.6 Electrical Insulation Emissions

High-voltage equipment, such as circuit breakers and ion implant tools, require the use of insulating gases such as sulfur hexafluoride (SF_6). These gases have the potential to leak over time and are therefore a source of air emissions.

The projected total usage of SF_6 in all circuit breakers and similar equipment was multiplied by a manufacturer guaranteed leak rate of 0.5% per year to calculate PTE. To calculate the 20-yr and 100-yr CO_2e emission rates, the GWPs[43] of SF6 were multiplied by the calculated lb/yr emission rate.

2.3.7 Lab Process Emissions

The Proposed Air Permit Project includes two laboratories to support each fab with testing and quality assurance, one in each Probe building and WWT building. Lab operations are exempt from permitting per 6 NYCRR 201-3.2(c)(40), therefore only criteria pollutant and HAP emissions were considered for the purpose of determining PTE with respect to relevant Title V and PSD/NNSR thresholds, consistent with 6 NYCRR 201-3.1(b).

An inventory of projected chemicals to be used in each lab was reviewed to identify VOC and HAP compounds, as well as compounds that may react to form criteria pollutants through use in the labs. Constituents present in amounts below the thresholds in 6 NYCRR 201-3.3(c)(94) were not considered. For each chemical, the potential amount of VOC, HAP, or criteria pollutant present after use was estimated by multiplying the projected annual usage by the appropriate concentration and/or conversion rate. It was conservatively assumed that the entire amount of each constituent used/generated is emitted. These calculations are shown on Tables 29-1 and 29-2 of Appendix F.

2.3.8 Solvent Waste Neutralization Emissions

The spin-on dielectric (SOD) process is a subset of the thin films processes that results in the formation of an unstable liquid waste byproduct. The SOD waste, a mixture of polysilazane and dibutyl ether, will be transferred to an HPM building for neutralization required to ensure safe shipment offsite. A rinse solvent will be transferred along with the SOD waste to ensure that it is removed from the tool. In the HPM building, the SOD waste will be reacted with ethanol and potassium hydroxide into a stable silicon-based product for safe shipment. Byproducts of the reaction will include silane, ammonia, and hydrogen. The RCTOs in the HPM building will oxidize the silane- and ammonia-containing exhaust before it is emitted to atmosphere.

[43] 20-year GWPs per 6 NYCRR Part 496. 100-year GWPs per 40 CFR Part 98, Table A-1: Global Warming Potentials

The PTE from the SOD waste neutralization process is based on the potential generation rate of SOD waste, including rinse solvent, and estimated usage of reactant, as shown in Table 30-1 of Appendix F. The methodology used in Table 30-2 is very similar to that used on Table 6-1 to calculate emissions from fab process operations. Refer to Section 2.1 for details on that methodology.

2.4 Emissions Summaries

All of the emission calculations described in the sections above are summarized on an annual PTE basis, and also on an hourly basis as needed. These emissions summaries are described in this section.

2.4.1 Annual Emissions Summaries

Table 1-1 of Appendix F summarizes the PTE for the Proposed Air Permit Project for criteria pollutants on an annual basis. The "Semiconductor Process Tools" column represents the sum of all relevant rows in the "Post Control Emissions (lb/yr)" column in Table 6-1 of Appendix for each pollutant, plus photoresist ashing emissions. The classification of each emission chemicals in Table 6-1 is shown in the "Emission Chemical Classifications" set of columns.

Table 1-2 of Appendix F summarizes criteria pollutants by proposed emission unit. These quantities should be used as a basis for setting specific emission limits in permit conditions. Refer to the emission unit matrix in Appendix Q, which identifies the emission sources and processes that are part of each proposed emission unit.

Table 1-3 of Appendix F summarizes the total annual emissions subject to 6 NYCRR Part 212 for each toxic air contaminant, including individual PM, HAP, VOC, and GHG. Each row in the "Total Emissions (lb/yr)" columns represents the sum of the "Post control Emissions (lb/yr)" column in Table 6-1 for all rows where the emission chemical is the chemical listed in Table 1-3. Additional information relevant to analysis under 6 NYCRR Part 212, discussed in Section 3.3.4 below, is provided.

For certain emission chemicals, structural and/or toxicological similarity was used to create groups that should be evaluated as a whole under 6 NYCRR Part 212. Combined emission rates for these groups are provided in Table 1-4. This concept is discussed in more detail in Section 3.3.4.5 below.

Compliance with Part 212 PM grain standards is assessed on a facility-wide basis in Table 1-5.

2.4.2 Fab Process Hourly Emissions Calculations

For the emissions sources discussed in Sections 2.1.7, 2.2 and 2.3, hourly emissions are presented alongside annual emissions in each table. For the emissions from semiconductor manufacturing processes discussed in Section 2.1, hourly emissions from each exhaust type are summarized in Tables 7-1 through 7-3 of Appendix F. In Table 7-1, each potential exhaust type through which each emission chemical may emit is identified.

In Tables 7-1 and 7-2, a row exists for each unique pair of emission chemical and exhaust type. Table 7-1 summarizes emissions for toxic air contaminants, while Table 7-2 summarizes emissions for criteria pollutants that require air dispersion modeling. The total annual pre-control emissions in each row, shown in the "Annual Pre-Control Emissions" column, is determined by summing relevant rows in the "Process Emissions (lb/yr)" column in Table 6-1. The "Average Hourly Pre-Control Emissions" column is calculated

simply by dividing the annual pre-control emissions by 8,760 hours per year. To account for the fact that in any one given hour, emissions may fluctuate due to variability in manufacturing operations, a 25% variance factor is added to the "Average Hourly Pre-Control Emissions" to conservatively estimate maximum hourly emissions. Using this factor and dividing emissions by the 4 total halves that will comprise Fab 1 and Fab 2 combined, the "Emission Rate Potential per Half" column was generated. The values in this column are used in the analysis with respect to 6 NYCRR Part 212 described in Section 3.3.4 below. The "POU or RCS DRE" and "Centralized Control DRE" used in Table 6-1 calculations are presented on this table for reference. Finally, emissions per stack were determined by dividing the "Annual Potential Emissions" by the number of stacks of each exhaust type by 8,760 to calculate the "Average Hourly Emissions Per Stack" and adding the Variance Factor to calculate the "Maximum Hourly Emissions Per Stack". These values are used for air dispersion modeling where required. Note that the number of stacks of each exhaust type used to calculate "Maximum Hourly Emissions Per Stack" was set to the projected number of operational stacks, and excluded the redundant stacks to calculate an accurate per-stack emission rate.

All emissions from organic compounds from solvent exhaust are listed in Table 7-3. As described in Section 2.1.7.2, each RCTO is equipped with two separate stacks, one at the outlet of the pair of zeolite rotors, and one at the outlet of the thermal oxidizer. The column layout and calculations align with that described above for Tables 7-1 and 7-2. However, for each Emission Chemical, the "Exhaust Type" column is labelled as either "Solvent Exhaust" or "RCTO Burner Exhaust" to clarify the exhaust stack. It is assumed based on semiconductor process experience that 95% of total emissions of each emission chemical from each RCTO will be from the stacks at the outlet of the zeolite rotors, indicated as "Solvent Exhaust". The remaining 5% of emissions are assumed to be emitted from the stacks at the outlet of the thermal oxidizers, indicated as "RCTO Burner Exhaust".

3. REGULATORY APPLICABILITY

3.1 Federal New Source Performance Standards

New Source Performance Standards (NSPS), located in Title 40 CFR Part 60, require new, modified, or reconstructed sources in applicable source categories to control emissions to the level achievable by the best demonstrated technology as specified in the applicable provisions. Any source which is subject to provisions under an NSPS subpart is also subject to the general provisions of 40 CFR Part 60, Subpart A. The potentially applicable NSPS standards for the Proposed Air Permit Project are:

- 40 CFR Part 60, Subpart Db (NSPS Subpart Db) – Industrial-Commercial-Institutional Steam Generating Units
- 40 CFR Part 60, Subpart Dc (NSPS Subpart Dc) – Small Industrial-Commercial-Institutional Steam Generating Units
- 40 CFR Part 60, Subpart Kb (NSPS Subpart Kb) – Volatile Organic Liquid Storage Vessels
- 40 CFR Part 60, Subpart Kc (Proposed NSPS Subpart Kc) – Volatile Organic Liquid Storage Vessels
- 40 CFR Part 60, Subpart IIII (NSPS Subpart IIII) – Stationary Compression Ignition Internal Combustion Engines
- 40 CFR Part 60, Subpart JJJJ (NSPS Subpart JJJJ) – Stationary Spark Ignition Internal Combustion Engines

3.1.1 40 CFR Part 60, Subpart Db – NSPS for Industrial-Commercial-Institutional Steam Generating Units

NSPS Subpart Db applies to steam generating units constructed, modified, or reconstructed after June 19, 1984, and that have a maximum rated heat input capacity greater than 100 MMBtu/hr. All proposed combustion sources have rated heat input capacities less than 100 MMBtu/hr. Therefore, NSPS Subpart Db does not apply to the Proposed Air Permit Project.

3.1.2 40 CFR Part 60, Subpart Dc – NSPS for Small Industrial-Commercial-Institutional Steam Generating Units

NSPS Subpart Dc applies to steam generating units constructed, modified, or reconstructed after June 9, 1989, and that have a maximum rated heat input capacity greater than or equal to 10 MMBtu/hr and less than 100 MMBtu/hr.

There are two types of proposed combustion sources at the Proposed Air Permit Project that meet the definition of steam generating unit: the Water Bath Vaporizers (WBVs) and the boilers. Although the WBVs meet the definition of steam generating unit under NSPS Subpart Dc, they have been determined to be a distinct source type from boilers for the purposes of the BACT and LAER outlined in Section 5. There are three (3) proposed boilers, with a combined heat input rating of approximately 100 MMBtu/hr. Both the water bath vaporizers and the boilers have heat input ratings greater than 10 MMBtu/hr and less than 100 MMBtu/hr and are subject to the rule.

The water bath vaporizers and boilers are fired with natural gas exclusively. As such, the PM and SO_2 emission limits in NSPS Subpart Dc are not applicable.

The applicable requirements for the units are the initial notification requirements in 40 CFR 60.48c(a) and the monthly natural gas usage recordkeeping requirements in 40 CFR 60.48c(g) and (i).

3.1.3 40 CFR Part 60, Subpart Kb – NSPS for Volatile Organic Liquid Storage Vessels

NSPS Subpart Kb applies to volatile organic liquid storage vessels with storage capacity greater than 75 cubic meters (19,810 gallons) and constructed, reconstructed, or modified after July 23, 1984, and on or before October 4, 2023. The proposed storage tanks will be constructed after this window. Therefore, this subpart is not applicable.

3.1.4 40 CFR Part 60, Subpart Kc – Proposed NSPS for Volatile Organic Liquid Storage Vessels

On October 15, 2024 (89 FR 83319), EPA finalized NSPS Subpart Kc, which applies to volatile organic liquid storage vessels constructed, reconstructed, or modified after October 4, 2023. The proposed storage tanks will be constructed after this date and so could be regulated under this subpart.

The NSPS Subpart Kc affected facility is a storage vessel with a capacity of 20,000 gallons or more used to store a volatile organic liquid. The proposed tanks with a storage capacity greater than 20,000 gallons include 21,000-gallon aqueous sodium hydroxide, 20,000-gallon aqueous sodium hypochlorite, and 20,000-gallon aqueous sodium carbonate tanks. The aqueous, inorganic solutions stored in these tanks do not meet the definition of volatile organic liquid within 40 CFR 60.111c. Therefore, this subpart is not applicable.

3.1.5 40 CFR Part 60, Subpart IIII – NSPS for Stationary Compression Ignition Internal Combustion Engines

NSPS Subpart IIII applies to stationary compression ignition (CI) internal combustion engines (ICE) constructed, reconstructed, or modified after various dates depending on engines service and design.

Micron is proposing compression ignition ICE manufactured after the latest applicable date in NSPS Subpart IIII. The units include emergency generators with a maximum engine power greater than 3,000 hp and an emergency fire pump with a maximum engine power of 250 hp. Micron is proposing the Tier 4 Final emission standards as the BACT limit for CO and PM and the BACT and LAER limit for NO_X for diesel-fired emergency generator engines and will procure engines for the Proposed Air Permit Project that meet these standards. Additionally, Micron is proposing Tier 3 emission standards as the BACT limit for CO and PM and the BACT and LAER limit for NO_X for the diesel-fired emergency fire pump and will procure an engine for the Proposed Air Permit Project that meets these standards. Refer to Appendices H, K and J for additional details.

Micron will purchase engines compliant with the applicable emission standards in 40 CFR 60.4202 referenced by 60.4205(b). Micron will comply with the fuel requirements in 40 CFR 60.4207 and the applicable compliance requirements in 40 CFR 60.4211 (e.g., operating the engine according to the manufacturer's emission-related instructions, operation in accordance with the emergency engine provisions). Emergency engines are not subject to initial notification requirements.

3.1.6 40 CFR Part 60, Subpart JJJJ – NSPS for Stationary Spark Ignition Internal Combustion Engines

NSPS Subpart JJJJ affects owners and operators of stationary spark ignition (SI) ICE that commence construction, reconstruction or modification after June 12, 2006. Applicability dates are based on the manufacture date for new engines. The applicability dates for new engines range from July 1, 2007, to January 1, 2009, depending upon the engine horsepower and application.

Micron is no longer proposing any SI ICE for the Proposed Air Permit Project. Therefore, this subpart is not applicable.

3.2 Federal National Emission Standards for Hazardous Air Pollutants

National Emission Standards for Hazardous Air Pollutants (NESHAP) are generally applicable to sources of HAP. The NESHAP regulations in 40 CFR Part 61 are pollutant-specific while 40 CFR Part 63 contains source type--specific NESHAP allowable emission limits, established on the basis of a maximum achievable control technology (MACT) and/or generally available control technology (GACT) determination for a particular source. The Proposed Air Permit Project is a major source with respect to HAP. The potentially applicable major-source NESHAP standards for the Proposed Air Permit Project are:

- 40 CFR Part 61, Subpart Q (NESHAP Subpart Q) – Industrial Process Cooling Towers
- 40 CFR Part 63, Subpart ZZZZ (NESHAP Subpart ZZZZ) – Stationary Reciprocating Internal Combustion Engines
- 40 CFR Part 63, Subpart BBBBB (NESHAP Subpart BBBBB) – Semiconductor Manufacturing
- 40 CFR Part 63, Subpart DDDDD (NESHAP Subpart DDDDD) – Industrial, Commercial and Institutional Boilers and Process Heaters

In addition to source-specific standards, the general provisions of 40 CFR Part 63, Subpart A (NESHAP Subpart A) are applicable as referenced by specific subparts. This application serves to fulfill the application for approval of construction of a major source of HAP under 40 CFR 63.5(d) and (f) as well as the notification of intention to construct a new major-emitting source under 40 CFR 63.9(b)(4).

All sources of HAP proposed are specifically regulated or exempted under one of the subparts discussed in this section. Therefore, the case-by-case determination in 40 CFR 63.42(c) is not applicable to the proposed project.

3.2.1 40 CFR Part 63, Subpart Q – Industrial Process Cooling Towers

NESHAP Subpart Q applies to all new and existing industrial process cooling towers that are operated with chromium-based water treatment chemicals that are major sources or integral parts of facilities that are major sources. Micron is not proposing to use chromium-based water treatment chemicals in its cooling towers; therefore, this regulation does not apply to the proposed project.

3.2.2 40 CFR Part 63, Subpart ZZZZ – Stationary Reciprocating Internal Combustion Engines

This rule regulates reciprocating internal combustion engines (RICE) located at major and area sources of HAP. The proposed facility will be a major source of HAP.

The proposed RICE, which include both the emergency generators and emergency fire pump, are new emergency stationary RICE (construction commenced after the latest applicable date in NESHAP Subpart ZZZZ). There are limited requirements for emergency RICE at major sources based on the site rating of the engine:

- Per 40 CFR 63.6590(b)(1)(i), new emergency stationary RICE with a site rating of more than 500 brake horsepower (bhp) do not have to meet the requirements of NESHAP Subparts A and ZZZZ except for the initial notification requirements of 40 CFR 63.6645(f).

- Per 40 CFR 63.6590(c)(6), new emergency RICE with a site rating of less than or equal to 500 bhp must comply with NESHAP Subpart ZZZZ by meeting the requirements of NSPS Subpart IIII or JJJJ, as applicable.

The proposed emergency generators are RICE rated over 500 brake horsepower (bhp); therefore, initial notification elements under NESHAP Subpart ZZZZ in 40 CFR 63.6645(f) will apply. The proposed emergency fire pump is a RICE rated less than 500 bhp; therefore, it will comply with NESHAP Part ZZZZ by meeting the requirements of NSPS Subpart IIII.

3.2.3 40 CFR Part 63, Subpart BBBBB – Semiconductor Manufacturing

NESHAP Subpart BBBBB establishes standards for HAPs emitted from semiconductor manufacturing facilities. The subpart regulates semiconductor manufacturing process units that emit HAP at major sources of HAP. Per 40 CFR 63.7182 and the definitions in 40 CFR 63.7195, the affected source subject to this subpart is:

> *The collection of all semiconductor manufacturing process units used to manufacture p-type and n type semiconductors and active solid-state devices from a wafer substrate, including research and development activities integrated into a semiconductor manufacturing process unit. A semiconductor manufacturing process unit includes the equipment assembled and connected by ductwork or hard-piping including furnaces and associated unit operations; associated wet and dry work benches; associated recovery devices; feed, intermediate, and product storage tanks; product transfer racks and connected ducts and piping; pumps, compressors, agitators, pressure-relief devices, sampling connecting systems, open-ended valves or lines, valves, connectors, and instrumentation systems; and control devices.*

As defined, both Fab 1 and Fab 2 will be a NESHAP Subpart BBBBB affected source as both individually meet the definition of a semiconductor manufacturing process unit. Both proposed semiconductor manufacturing process units at the Proposed Air Permit Project will commence construction after May 8, 2002, and will be classified as new affected sources and will be required to comply upon startup. The notification requirements are included in 40 CFR 63.7189.

The emission limitations in 40 CFR 63.7184 are summarized as:

- Reduce organic HAP emissions from organic HAP process vents (other than process vents from storage tanks) by 98 percent or to less than 20 parts per million by volume,

- Reduce inorganic HAP emissions from inorganic HAP process vents (other than process vents from storage tanks) by 95 percent or to less than 0.42 parts per million by volume,
- Reduce inorganic HAP emissions from storage tanks with capacity greater than 1,500 gallons by 95 percent or to less than 0.42 parts per million by volume, and
- Reduce HAP emissions from combined HAP process vents[44] (other than process vents from storage tanks) to less than 14.22 parts per million by volume.

The limitations can be met through venting emissions through a closed vent system to a control device meeting the requirements of 40 CFR 63.983 (closed vent system requirements), 40 CFR 63.994 (halogen scrubber requirements), and 40 CFR 63.982(a)(2) (process vent control requirements) as well as the applicable general monitoring requirements of 40 CFR 63.996 and 40 CFR 63.7188.

The process units and process vents planned for the Proposed Air Permit Project that will be subject to NESHAP Subpart BBBBB include all manufacturing tools, piping and other associated equipment that contain HAP, covering all exhaust stacks for the main fabs. Storage tanks in the HPM and WWT buildings that will store HAP, along with their respective exhausts, will also be subject to Subpart BBBBB. Wastewater treatment processes are not subject to NESHAP Subpart BBBBB since they are excluded from the definitions of both "process vent" and "storage tank" in 40 CFR 63.7195. The type of process units subject to NEHSAP, exhaust type and the method of compliance for each type of process vent is summarized in Table 3-1 below. Emission points associated with combustion equipment and cooling towers are not process vents under NESHAP Subpart BBBBB.

Table 3-1: Method(s) of Compliance by Process and Exhaust Type

Area	Exhaust Type	HAP Emitting Process Unit(s)	Type of Process Vent	Allowable Method(s) of Compliance
Fab	Acid Exhaust	Thin films / diffusion, diffusion non-deposition, plasma etch, wet etch / wet clean, and ion implant process tools and associated equipment	Inorganic HAP	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
Fab	CVD Exhaust	Thin films / diffusion process tools and associated equipment	Inorganic HAP	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
Fab	Ammonia Exhaust	No NESHAP Subpart BBBBB process units are directly vented to the ammonia exhaust. However, there is the potential for trace inorganic HAP due to potential intermingling with fab acid and CVD exhausts	Inorganic HAP	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
Fab	Solvent Exhaust	Photolithography process tools and associated equipment	Organic HAP	Organic HAP emissions ≤20 ppmv or reduced by 98%

[44] Per 40 CFR 63.7195, combined process vents are defined in 40 CFR 63 as a *process vent* that emits both inorganic and organic HAP to the atmosphere.

Area	Exhaust Type	HAP Emitting Process Unit(s)	Type of Process Vent	Allowable Method(s) of Compliance
Fab	General Exhaust	Methanol or other organic HAP used for cleaning	Organic HAP	Organic HAP emissions ≤20 ppmv or reduced by 98%
HPM	Acid Exhaust	Tanks storing acidic raw materials that are HAP	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
HPM	Ammonia Exhaust	Trace inorganic HAP due to potential intermingling with HPM acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
HPM	Solvent Exhaust	Trace inorganic HAP due to potential intermingling with HPM acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
WWT	Acid Exhaust	Tanks storing acidic waste materials that are HAP	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
WWT	Ammonia Exhaust	Trace inorganic HAP due to potential intermingling with WWT acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
WWT	Solvent Exhaust	Trace inorganic HAP due to potential intermingling with WWT acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%

Compliance is demonstrated as outlined in 40 CFR 63.7187 and the monitoring and reporting requirements are included in 40 CFR 63.7188 and 63.7190. Specific compliance requirements that will apply to the Proposed Air Permit Project are identified in applicable Federal Requirements section of the NYSDEC Air Permit Application forms in Appendix A. Initial performance test requirements are acknowledged in the Stack Test Plan in Appendix T.

3.2.4 40 CFR Part 63, Subpart DDDDD – Industrial, Commercial, and Institutional Boilers and Process Heaters

NESHAP Subpart DDDDD applies to industrial, commercial, and institutional boilers and process heaters of various sizes and fuel types at major sources of HAP. The affected source is each new boiler or process heater (new sources are constructed after June 4, 2010). Compliance for new sources is required upon startup or April 1, 2013, whichever is later.

Micron is proposing units that meet the definition of boiler and/or process heater, including the boilers and water bath vaporizers. As mentioned in Section 3.1.2, the boiler and water bath vaporizers are addressed separately in BACT and LAER analyses. The proposed units fall under the "Units designed to burn gas 1 fuels" subcategory in 40 CFR 63.7499(l). The requirements for these units are the work practice standards in 40 CFR 63.7500(e) and Table 3 of NESHAP Subpart DDDDDD, which are periodic tune-ups depending on unit size and design specifications. No emission limits in Tables 1 and 2 or Tables 11 through 15, operating limits in Table 4 of NESHAP Subpart DDDDD are applicable.

The initial tune-up compliance timelines are included in 40 CFR 63.7510(g), with subsequent tune-ups required as outlined in 40 CFR 63.7515(d). The notification, reporting, and recordkeeping requirements are included in 40 CFR 63.7545, 40 CFR 63.7550, and 40 CFR 63.7555, respectively.

3.3 New York State Regulatory Review

3.3.1 6 NYCRR Part 201: Permits and Registrations

The owners and operators of air contamination sources in New York State are required to obtain applicable authorizations pursuant to Part 201, which dictates permitting and permit application content requirements. Facilities in New York State can fall into one of four categories for the purposes of air pollution control permitting. Those categories include sources that operate only emission sources that are exempt from permitting (Subpart 201-3), facilities that are required to file minor facility registrations (Subpart 201-4), Air State Facility permitted facilities (Subpart 201-5), and Title V facilities (Subpart 201-6).

Per 6 NYCRR 201-6.1(a)(1), any major facility as defined under Subpart 201-2 shall obtain a Title V permit pursuant to Subpart 201-6. Per 6 NYCRR 201-2.1(b)(21)(iv)(c), the major source threshold for attainment areas of the State within the ozone transport region is 100 tons per year of NO_X and 50 tons per year of VOC. Per 6 NYCRR 201-2.1(b)(21)(i), the major source threshold for all other criteria pollutants (PM_{10}, $PM_{2.5}$, SO_2, CO) is 100 tons per year. Because the Proposed Air Permit Project's potential to emit is greater than the applicable major source threshold for certain criteria pollutants, the Proposed Air Permit Project is considered a major source and is subject to the requirements of Subpart 201-6.

This Permit Application 2 meets the application content requirements of 6 NYCRR 201-6(2)(d) and includes the required air permit application form and supporting information in Appendices A, B, C, E and P. This application also addresses comments received by the NYSDEC in the Notice of Incomplete Application (NOIA) and Technical Review (TR) dated June 3, 2024, and July 19, 2024, respectively. Additional appendices provide information required by other regulatory requirements (e.g., BACT analyses) and additional information regarding the Proposed Air Permit Project.

3.3.1.1 Subpart 201-3 – Permit Exempt and Trivial Activities

Subpart 201-3 details options for combustion installations and other sources to be exempt from permitting requirements. The following activities at the Proposed Air Permit Project will be exempt from permitting or trivial. Additional details on exempt activities are provided in Appendix B.

- 118 diesel fuel-fired emergency generators – Exempt per 201-3.2(c)(6);
- One (1) diesel fuel-fired emergency fire pump engine – Exempt per 201-3.2(c)(6);
- 222 non-contact water cooling towers - Exempt per 201-3.2(c)(7);
- Eight (8) Diesel storage tanks with storage capacities less than 300,000 barrels – Exempt per 201-3.2(c)(21);
- 76 storage tanks with capacities less than 10,000 gallons and not subject to Part 229 - Exempt per 201-3.2(c)(25);
- Four (4) solid material storage silos – Exempt per 201-3.2(c)(27);
- Four (4) chemical laboratory operations – Exempt per 201-3.2(c)(40); and
- 114 storage tanks with capacities less than 750 gallons – Trivial per 201-3.3(c)(44).

3.3.2 6 NYCRR Part 205: Architectural and Industrial Maintenance (AIM) Coatings

Part 205 applies to any person who applies any architectural coating within the State of New York. Per 6 NYCRR 205.2(g), an architectural coating is a coating to be applied to stationary structures and their appurtenances at the site of installation, to portable buildings at the site of installation, to pavements, or to

curbs. Micron is not proposing to apply any architectural coatings as a part of the Proposed Air Permit Project and is therefore not subject to Part 205. This regulation also applies to any architectural coatings applied as a part of the construction process. These coatings will comply with the VOC content requirements outlined in 6 NYCRR 205.3. Any surface coating of equipment and buildings related to maintenance and construction is considered trivial per 6 NYCRR 201-3.3(c)(45) and is not discussed further.

3.3.3 6 NYCRR Part 211: General Prohibitions

In accordance with 6 NYCRR 211.1, the Proposed Air Permit Project will not cause any particulate, fume, gas, mist, odor, smoke, vapor, pollen, toxic or deleterious emissions, either alone or in combination with others to be emitted to the outdoor atmosphere in such quantity, characteristic, or duration with are injurious to human, plant, or animal life, or to property, or which unreasonably interferes with the comfortable enjoyment of life or property.

6 NYCRR 211.2 defines general opacity limits for sources of air pollution in New York State. General applicable requirement facility-wide visible emissions are limited to 20 percent opacity (6-minute average) except for one continuous six-minute period per hour of not more than 57 percent opacity. The Proposed Air Permit Project will comply with this requirement.

3.3.4 6 NYCRR Part 212: Process Operations

Part 212 applies to process emission sources (PESs) and/or emission points (EPs) from process operations from facilities in New York. The provisions of Part 212 will apply to the Proposed Air Permit Project upon issuance of the air permit.

3.3.4.1 Process Emission Source Alignment

As described in Section 1.4, the Proposed Air Permit Project includes several process tools, a configuration of associated vent collection headers, and a series of redundant control devices that are unique to semiconductor fab operations. The requirements of Part 212 apply to PESs and/or EPs from process operations based on specific configurations and the potential to comingle air contaminants. This section clarifies how the requirements of Part 212 are analyzed for the Proposed Air Permit Project. To support this analysis, select definitions from Part 212 related to this determination are presented in this section.

A process emission source is defined in 6 NYCRR 212-1.2(b)(19) as:

> *Any apparatus, contrivance or machine, including any appurtenant exhaust system or air cleaning device capable of causing emissions of any air contaminant to the outdoor atmosphere from a process operation.*

A process operation is defined in 6 NYCRR 212-1.2(b)(18) as:

> *Any industrial, institutional, commercial, agricultural or other activity, operation, manufacture or treatment in which chemical, biological and/or physical properties of the material or materials are changed, or in which the material(s) is conveyed or stored without changing the material(s) if the conveyance or storage system is equipped with a vent(s) and is non-mobile, and that emits air contaminants to the outdoor atmosphere. A*

process operation does not include an open fire, operation of a combustion installation, or incineration of refuse other than by-products or wastes from a process operation(s).

The industrial processes planned to be installed as part of the Proposed Air Permit Project meet these definitions, except as described in Section 3.3.4.2.

Part 212 General Provisions in 6 NYCRR 212-1.5(a) through (c) describe how to address instances in which emissions from multiple PESs are emitted through the same EP and when emissions from a single PES are emitted from more than one EP. As described in more detail in Section 1.4 above, the emissions from multiple process tools and associated PEECs will vent into common headers based on the compatibility of the exhaust streams and appropriate control technology, then emissions from the headers will be exhausted to a bank of control devices with built-in redundancy.

For PESs that follow this configuration, 6 NYCRR 212-1.5(b) indicates that the sum of emissions from all of the connected emission points must not exceed the emissions if they were vented through the same emission point. Per 6 NYCRR 212-2.1(b), the allowable emission rate for any air contaminant is dictated by the contaminant's emission rate potential (ERP) and the associated degree of air cleaning (i.e., control percent) required is based the contaminant's Environmental Rating and Tables 3 or 4 of Part 212. As defined in 6 NYCRR 200.1(u), the ERP is the "maximum rate at which a specified air contaminant from an emission source would be emitted to the outdoor atmosphere in the absence of any control equipment…" and is measured in pounds per hour prior to an air pollution control device. The Environmental Rating of an air contaminant is described in detail in Section 3.3.4.4.

For the Proposed Air Permit Project, the ERP prior to the control device(s) is the total emission rate measured at each common header due to comingling of emissions from multiple processes therein. Therefore, the collection of process tools and equipment vented to the same vent header is considered one PES. The general exhaust system exhausting air from the cleanroom workspace is not controlled and ERP equals PTE for the small quantity of air contaminants emitted through the general exhaust.

Fab 1 and Fab 2 will be divided into two halves each. Each half of the Fab will be equipped with one centralized vent header of each exhaust type to collect exhaust from many tools. The header and vent types include those described in Section 1.4.3, Fab Exhaust Types.

To summarize the conclusions from this analysis:

- PESs for semiconductor manufacturing operations consist of the group of process tools and supporting equipment that are vented to a common header.
- The ERP for process tools will be determined at each common header and will be the sum of emissions from all ducts exhausting from the common header.
- The control efficiency requirements of Tables 3 and 4 (as applicable) of Part 212 apply to a collective bank of control devices connected to the same header on a mass weighted basis.

3.3.4.2 Applicability of Part 212 to Process Operations

This section identifies the aspects of the Proposed Air Permit Project that are process operations/PESs and therefore are subject to Part 212.

3.3.4.2.1 Combustion Installations

Combustion installations are specifically excluded from the definition of process operation. A combustion installation is defined in 6 NYCRR 200.1(l) as:

> *An installation, consisting of a single furnace, device, engine or turbine in which fossil fuel, wood, and/or other solid, liquid, or gaseous fuel is burned with air or oxygen and the air contaminant emissions include only those products resulting from: (1) combustion of the fuel; (2) additives or impurities in the fuel; and (3) material introduced for the purpose of altering air contaminant emissions.*

The following equipment planned to be installed as part of the proposed air permit project meets the definition of combustion installation, and therefore are not PESs subject to analysis under Part 212:

- Natural gas-fired boilers;
- Diesel-fired emergency generators;
- Diesel-fired emergency fire pump engines; and
- Natural gas-fired water bath vaporizers.

3.3.4.2.2 Storage and Conveyance Systems Without Vents

According to the definition cited above, "operation[s]… in which the material(s) is conveyed or stored" are only process operations "if the conveyance or storage system is equipped with a vent(s)". Therefore, conveyance and storage systems not equipped with vents do not meet the definition of process operation.

Fab 1 and Fab 2 will include conveyance systems used to transfer process materials from storage tanks to the tools or waste from the tools to storage / waste handling operations. These conveyance systems are not equipped with a vent and are therefore not process operations subject to regulation under Part 212.

Process chillers containing HTFs that are used to regulate tool temperatures are also conveyance/storage systems in which materials are contained in a closed loop that is not equipped with a vent. These process chillers are not process operations subject to Part 212.

Circuit breakers and other gas-insulated electrical equipment are used throughout the Micron Campus. This type of equipment can be considered a storage system containing SF_6 or other alternative insulating mediums, and is not equipped with a vent. Therefore, circuit breakers and gas-insulated electrical equipment are not process operations subject to Part 212.

3.3.4.2.3 Process Operations

Certain process operations are not subject to Part 212 if covered by one or more of the exceptions listed in 6 NYCRR 212-1.4. The first exception, listed in 6 NYCRR 212-1.4(a), indicates that emission sources designated as exempt or trivial under 6 NYCRR 201-3.2 or 201-3.3, respectively, are not subject to Part 212. The following exempt or trivial activities planned for the Proposed Air Permit Project are therefore not subject to further analysis:

- Non-contact water cooling towers;
- Diesel storage tanks;
- Storage tanks with capacities less than 10,000 gallons and not subject to Part 229;

- Solid material storage silos;
- Storage tanks with capacities less than 750 gallons; and
- Laboratory operations.

Additionally, emissions of ethane are trivial per 201-3.3(c)(94) and emissions of CO_2 and CH_4 are trivial per 201-3.3(c)(95) and are therefore not subject to analysis under Part 212. Emissions of propane are also not subject to analysis under Part 212 per NOIA Comment #58 received from the NYSDEC.

The following individual pollutant emissions from process operations planned for the Proposed Air Permit Project are not subject to further analysis under Part 212 due to meeting one of the other listed exception criteria:

- Emissions of SO_X attributable to sulfur in fuel, as a result of natural gas combustion per 6 NYCRR 212-1.4(i);
- Emissions of CO and VOCs from combustion per 6 NYCRR 212-1.4(m);
- Emissions of NO_X produced by RCTOs, RCS, and POU control devices, as they are thermal oxidizers used as air pollution control equipment, per 6 NYCRR 212-1.4(r); and
- Emissions of VOCs that are not given an A rating in storage tanks subject to Part 229 per 6 NYCRR 212-1.4(f). As described in Section 3.3.8, all tanks storing VOC are subject to Part 229 requirements.

The remaining emissions from process operations associated with the Proposed Air Permit Project are subject to the requirements of Part 212. These process operations are:

- All semiconductor manufacturing process tools and cleaning operations;
- PEECs;
- RCTOs, RCS, and POU control devices;
- Wastewater treatment operations;
- Storage tanks 10,000 gallons or larger, except for those storing B- or C-rated VOC that are subject to Part 229; and
- SOD waste neutralization operations.

Compliance strategies will differ by category of pollutant. Each proposed compliance strategy is described in the subsections below. Tables 1-3 and 1-4 of Appendix F illustrate the compliance strategy that applies to each individual pollutant and analog group with emissions from process operations subject to Part 212.

3.3.4.3 Compliance via Mass-based Thresholds

Both Part 212 and DAR-1, Guidelines for the Evaluation and Control of Ambient Air Contaminants Under 6 NYCRR Part 212[45] include emission rate thresholds that apply to individual chemicals as part of the evaluation of Part 212. In addition, the NYSDEC Division of Air Resources (DAR) Air Toxics Section has established a practice of applying an additional threshold to chemical compounds that are not listed on DAR-1 to confirm they do not meet the criteria for a high toxicity air contaminant (i.e., A-rated – discussed further below) in 6 NYCRR 212-1.2(b)(9). The criteria and associated mass-based thresholds are summarized below:

[45] DAR-1: Guidelines for the Evaluation and Control of Ambient Air Contaminants Under 6 NYCRR Part 212, February 12, 2021

- Chemical compounds that are listed in 6 NYCRR 212-2.2, Table 2 as high toxicity air contaminants (HTAC) and that will have actual annual emissions below the compound-specific Mass Emission Limit (MEL) specified in Table 2 require no further evaluation under Part 212 per 6 NYCRR 212-2.1(a).
- For chemical compounds with less than 100 lb/yr actual emissions, DAR-1 Sections V.A.2 and V.C indicate that an Environmental Rating and ERP are not required to be submitted. Per DAR-1, this applies to compounds that are not Table 2 HTAC and other compounds that are not listed on DAR-1.

Although Part 212 and DAR-1 specifies that actual emissions can be compared to the above thresholds, the thresholds conservatively are applied to the PTE of each compound in this permit application. The PTE accounts for emissions reduction using a federally enforceable control device meeting the provision of 6 NYCRR 212-1.5(g).

Compounds that fall below the mass-based thresholds described above are identified in Tables 1-3 and 1-4 of Appendix F and are not evaluated further under Part 212.

3.3.4.4 Environmental Rating of Air Contaminants

An Environmental Rating is established on a chemical-specific basis for use in permitting based on the toxicity and other properties of the compound. According to DAR-1, a rating must be assigned to determine the compliance requirement for contaminants with emissions greater than the mass-based thresholds discussed above. NYSDEC has established and published toxicity ratings for several compounds in DAR-1, with a three-tiered system: high toxicity compounds are A-rated, moderate toxicity compounds are B-rated, and low toxicity compounds are C-rated. For compounds listed in DAR-1 that are not assigned a toxicity, the Environmental Rating is assumed to be B per DAR-1 Section V.C.1. In this application (including appendices), this is represented as "B*".

For those compounds that are not listed in DAR-1 and that will be emitted from the Proposed Air Permit Project, NYSDEC provided Interim Environmental Ratings that had been previously evaluated by the NYSDEC but have not yet been published in DAR-1[46] NYSDEC DAR Air Toxics Section also has provided feedback on and modifications to toxicity classifications and Interim Environmental Ratings that were proposed by Micron and its consultants, SafeBridge Regulatory & Life Sciences Group (SafeBridge) and Trinity, based on regulatory and literature reviews presented to the agency.

For Interim Environmental Ratings approved by NYSDEC as part of this process or provided directly by the NYSDEC, the Environmental Ratings are presented with the prefix "INT-". For example, a high toxicity rating approved by the DAR Air Toxics Section is presented as "INT-A." Compounds that are not listed in DAR-1 for which a toxicity rating has been proposed by SafeBridge, but not yet been approved by the NYSDEC, will be marked with the prefix "INT-" and the suffix "*". In the event that NYSDEC review requires an amended Environmental Rating, this analysis will be updated.

Table 3-2 below summarizes the Environmental Ratings assigned in this application.

[46] Email from Mr. Donald Ward (NYSDEC) to Trinity Consultants, July 26, 2023, and from Mr. Donald Ward (NYSDEC) to Trinity Consultants, December 21, 2023.

Table 3-2. Summary of Environmental Ratings as Listed in the Micron Clay Air Permit Application

Environmental Rating	Description
A	Compound listed in DAR-1 with high toxicity rating
B	Compound listed in DAR-1 with medium toxicity rating
C	Compound listed in DAR-1 with low toxicity rating
B*	Compound listed in DAR-1 with no toxicity rating
INT-A	Compound not listed in DAR-1, Interim Environmental Rating of A approved by NYSDEC
INT-B	Compound not listed in DAR-1, Interim Environmental Rating of B approved by NYSDEC
INT-C	Compound not listed in DAR-1, Interim Environmental Rating of C approved by NYSDEC
INT-A*	Compound not listed in DAR-1, Interim Environmental Rating of A proposed by SafeBridge but not approved by NYSDEC at the time of this application
INT-B*	Compound not listed in DAR-1, Interim Environmental Rating of B proposed by SafeBridge but not approved by NYSDEC at the time of this application
INT-C*	Compound not listed in DAR-1, Interim Environmental Rating of C proposed by SafeBridge but not approved by NYSDEC at the time of this application

3.3.4.5 Project-Specific Analogous Chemical Combined Evaluation

As part of the collaboration between NYSDEC and SafeBridge, Micron is proposing to characterize the Environmental Rating and establish interim annual and short-term guideline concentrations (AGCs/SGCs) for compounds that have not been previously assessed by the NYSDEC. Part of that assessment includes identifying analogous compounds (i.e., those that have similar structural, toxicological, and/or metabolic properties using a weight-of-evidence approach). For compounds where a proposed analogous compound will also be emitted from the Proposed Air Permit Project, the NYSDEC has requested that Part 212 compliance is assessed for the group of compounds as a whole. Table 1-4 of Appendix F lists the analog groups that have been approved by the NYSDEC.

3.3.4.6 Hazardous Air Pollutants Regulated by a NESHAP

As discussed in Section 3.2 related to NESHAP Subpart BBBBB, emissions of HAP from each "semiconductor manufacturing process unit", which includes fab processes and storage tanks, are subject to NESHAP Subpart BBBBB. The emission sources that are subject to NESHAP Subpart BBBBB for the Proposed Air Permit Project are described in Section 3.2 and cover emissions of all inorganic and organic HAP emitted from process vents and/or storage tanks.

For each HAP regulated by NESHAP Subpart BBBBB, Micron will satisfy the requirements of Part 212 by demonstrating compliance with NESHAP Subpart BBBBB, in accordance with 6 NYCRR 212-1.5(e)(2). NYSDEC has agreed that each individual organic HAP and inorganic HAP is a "respective air contaminant regulated by the Federal standard" in accordance with 6 NYCRR 212-1.5(e)(2). NESHAP Subpart BBBBB regulates organic HAPs and inorganic HAPs categorically.

Two of the inorganic HAPs subject to NESHAP Subpart BBBBB, arsine and formaldehyde, are included in the HTAC list in 6 NYCRR 212-2.2, Table 2. For HTAC subject to a NESHAP, 6 NYCRR 212-1.5(e)(2) requires compliance with either the applicable AGC and SGC through air dispersion modeling, or with the MEL listed in Table 2. Micron will demonstrate compliance with Part 212 by maintaining actual annual emissions of arsine and formaldehyde below the MEL of 10 pounds per year for arsine and 100 pounds per year for formaldehyde, both listed in Table 2, in accordance with §212-2.1(a). Note that arsenic compounds are also a Table 2 HTAC, but arsine is the only arsenic compound emitted from the Proposed Air Permit Project, so the MEL for arsine is used in this analysis.

3.3.4.7 Volatile Organic Compounds Subject to RACT

As discussed in Section 3.3.9, the Proposed Air Permit Project will exceed the VOC thresholds listed in 6 NYCRR 212-3.1(a)(2), so the project is subject to 6 NYCRR 212-3 which requires a VOC Reasonably Available Control Technology (RACT) compliance plan per §212-3.1(f). A VOC RACT plan is included in Appendix N of this permit application.

Per 6 NYCRR 212-1.5(f), facilities that are subject to §212-3 for VOCs are not subject to the VOC control provisions of Subpart 212-2, except for VOC assigned an A rating, which must individually meet Table 4 of Part 212. Micron acknowledges that the NYSDEC reserves the right to assign a final Environmental Rating that is different from the initial Environmental Ratings published in DAR-1 or derived by SafeBridge and approved by the NYSDEC on a case-by-case basis. In the event that the NYSDEC assigns a final Environmental Rating of A to a VOC given a lower initial Environmental Rating, an individual compound analysis of Table 4 of Part 212 will be completed.

3.3.4.8 Particulate Matter

Control requirements for particulate matter (PM) in Part 212 are evaluated according to §212-2.1(c) for solid particulate assigned an Environmental Rating of B or C and according to Table 4 per §212-2.1(b) if not rated B or C.

All solid particulate emitted from the Proposed Air Permit Project has been given an Environmental Rating of B, B* or C in DAR-1 or INT-B, INT-C, INT-B*, or INT-C* through the process described in Section 3.3.4.4. Therefore, the requirements to meet the PM grain standard in 6 NYCRR 212-2.4(b) will apply as all emission sources at the Proposed Air Permit Project will be installed after 1973 and no emission sources at the Proposed Air Permit Project are listed in §212-2.5(a), Table 5. Table 1-5 of Appendix F demonstrates that the combined PM emissions from process operations will meet the applicable PM grain standard.

In the event that the NYSDEC assigns a final Environmental Rating of A to a PM given a lower initial Environmental Rating, an individual compound analysis of Table 4 of Part 212 will be completed.

3.3.4.9 Nitrogen Oxides

As demonstrated in Section 3.3.9 of this permit application, the Proposed Air Permit Project will exceed the thresholds listed in 6 NYCRR 212-3.1(a)(2). Therefore, the Proposed Air Permit Project will be subject to 6 NYCRR 212-3, which requires that a NO_X RACT compliance plan is submitted per §212-3.1(f). A NO_X RACT plan is included in Appendix I of this permit application.

As indicated in 6 NYCRR 212-1.5(f), facilities that are subject to §212-3 for NO_X are not subject to the control provisions of Subpart 212-2 for NO_X. Therefore, compliance with the control requirements of Subpart 212-2 is achieved through demonstrating compliance with the NO_X RACT plan in Appendix I.

3.3.4.10 Carbon Monoxide

Carbon monoxide is generated as a result of certain chemical reactions that take place within process tools, through oxidizing (or "ashing") excess materials used in the photoresist process, and through incomplete combustion of fuels and organic materials in devices used to thermally oxidize emission streams. As described in Appendix G, the emission calculations also assume full oxidation of all carbon atoms that are used in raw materials and processes gases in the semiconductor manufacturing operations to conservatively calculate CO_2 emissions.

Because of the nature of the semiconductor process operations, the ratio of CO to CO_2 generation from carbon-based process gases and raw materials is not readily quantifiable. To account for this, the air emission calculations for CO have made assumptions based on a semiconductor exhaust management and control book as described in Section 2.1.3.1 and cited in Appendix U. This approach assumes that CO emissions for all operations can be conservatively estimated using an emission factor equal to five times the emission factor for CO in AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Table 1.4-1. This approach is used to conservatively estimate emissions of both process-based CO (i.e., that generated from chemical reactions of process gases) and from incomplete combustion.

This conservative approach to calculating air emissions is based on the fact that a large portion of CO emissions from process operations are generated as a result of operating necessary safety equipment or emissions controls for other pollutants. The requirements set forth in Table 3 or Part 212 specify NAAQS compliance for lower levels of emissions (i.e., <10 lb/hr for B- or C-rated compounds) and to achieve an appropriate level of control for higher levels of emissions.

As indicated in Section 3.3.9, the Proposed Air Permit Project is a major new source of CO under the PSD air permitting program and therefore, is subject to both CO BACT and air dispersion modeling to demonstrate compliance with the NAAQS. Since the Proposed Air Permit Project is a new source, every emission source that generates CO is required to be analyzed to demonstrate BACT and to be included in air dispersion modeling, including those that are subject to analysis under Part 212.

Micron is proposing that compliance with the degree of air cleaning and offsite impact requirements of Part 212 for CO in Table 3 are satisfied by the assessment of CO BACT in Appendix J and air dispersion modeling to satisfy the NAAQS in accordance with 6 NYCRR 231-7.6 and 231-12.3, respectively.

3.3.4.11 Sulfur Dioxide

Sulfur dioxide is generated as a result of certain chemical reactions that take place within process equipment, through oxidation of sulfur-bearing compounds in combustion-based control devices and from oxidation of sulfur in fuel. Sulfur dioxide attributable to sulfur in fuel is excluded from Part 212 is per 6 NYCRR 212-1.4(i) and not considered further. SO_2 emissions attributable to sulfur in raw materials used in process operations is included in the analysis in Table 1-3 of Appendix F. Only the sources of SO_2 that are subject to Part 212 will be included in the required air dispersion modeling.

3.3.4.12 Ozone Emissions

Ozone is used as a raw material in thin films processes and will be generated onsite as opposed to purchased from a supplier. Micron has conservatively estimated the amount of ozone that will be generated per year based on demands for similar manufacturing facilities as shown in Table 11-1 and Table 11-2 of Appendix F. Ozone that is not utilized in the process will be managed by PEECs that serve to prevent odor issues in the fab if reentrainment were to occur. Emissions of ozone will exhaust through centralized acid scrubbers and CVD scrubbers along with other emissions from thin films processes. Direct emissions of ozone are not treated as a criteria pollutant themselves, because "ozone is generally considered an unstable secondary pollutant formed in the atmosphere by the photochemical reaction of nitrogen oxides and reactive hydrocarbons in the presence of high temperatures and ultraviolet light,"[47] and the definition of criteria air contaminant in 6 NYCRR 212-1.2(b)(4) lists "ground-level ozone", implying ozone formed by such photochemical reactions. When treated as a non-criteria pollutant for the purposes of Part 212, emissions of ozone would be subject to 6 NYCRR 212-2.1(b) and Table 4. As illustrated in Table 11-2 of Appendix F, the ERP per half (or per PES) is <0.1 lb/hr. Regardless of the Environmental Rating, compliance with Part 212 would be demonstrated by air dispersion modeling. However, DAR-1 indicates that because ozone is considered a secondary air contaminant, "the US EPA and NYSDEC do not have an appropriate model to calculate ozone impacts from a single source."[48] Considering this, Micron includes direct emissions of ozone in this permit application, but recognizes that there is no control or other measures required to satisfy Part 212 for ozone.

3.3.4.13 Air Dispersion Modeling

Air dispersion modeling is required to demonstrate that emissions of several compounds and analog groups meet the requirements of Part 212, per 6 NYCRR 212-2.3 Table 3 and Table 4. As required by Part 212 and DAR-10, NYSDEC Guidelines on Dispersion Modeling Procedures for Air Quality Impact Analysis,[49] an initial air dispersion modeling protocol was submitted to the NYSDEC following Permit Application 1. A revised modeling protocol will be submitted to the NYSDEC under separate cover that aligns with this application. Once the revised protocol is approved by the NYSDEC, a modeling report will be submitted.

3.3.4.14 Emissions Control

For compounds with ERPs exceeding the thresholds listed in 6 NYCRR 212-2.3(b) Table 4, emissions control is required for compliance based on both the Environmental Rating and ERP. The ammonia group, which contains compounds rated C or INT-C only, requires 75% control from the Fab Ammonia and WWT Ammonia exhausts according to Table 4. This level of control will be achieved by the fab ammonia scrubbers and WWT ammonia scrubbers, which are projected to provide 98% control of ammonia based on available vendor information.

The only other compound or group requiring control is nitrous oxide which, as a B-rated compound, requires 90% control from the Fab CVD exhaust according to Table 4. This required level of control is greater than what is required by GHG BACT and what is readily feasible based on published industry information. Therefore, as allowed by DAR-1, Micron will submit a toxics BACT (T-BACT) analysis demonstrating that the

[47] DAR-1, Section V.C.4.

[48] Ibid.

[49] DAR-10: NYSDEC Guidelines on Dispersion Modeling Procedures for Air Quality Impact Analysis, September 1, 2020.

60% incidental removal provided by PEECs is representative of the best available technology as compared to similar sources in New York and throughout the semiconductor industry. This T-BACT analysis will be submitted under separate cover at a later date.

3.3.5 6 NYCRR Part 225: Fuel Composition and Use

Subpart 225-1 applies to facilities which use fuels in combustion installations to regulate sulfur content of fuel. Per 6 NYCRR 225-1.2(d), all distillate oil fired in emission sources is limited to 0.0015 percent sulfur by weight. Micron will ensure that the proposed diesel-fired emergency generators and diesel-fired emergency fire pump are fired exclusively with ultra-low sulfur diesel (ULSD) which meets the applicable sulfur limitation. Part 225 does not contain any limitations on natural gas fuel. All other combustion sources at the Proposed Air Permit Project will fire natural gas and are therefore not subject to limitations under Part 225.

3.3.6 6 NYCRR Part 226: Solvent Cleaning Processes and Industrial Cleaning Solvents

Subpart 226-1 facilities that operate cold cleaners, open-top vapor degreasers, and all types of conveyorized degreasers that carry out solvent cleaning processes of metal and non-metal objects using a solution containing VOCs. The Proposed Air Permit Project does not presently include any equipment that meets the definitions of cold cleaners, open-top vapor degreasers, or conveyorized degreasers and as such the requirements of Subpart 226-1 do not apply. If such equipment is included in the future, the requirements of Subpart 226-1 will be met.

Subpart 226-2 stipulates presumptive VOC RACT for facilities with actual emissions of three tons or more of VOCs from industrial cleaning solvents, on a 12-month rolling basis. Micron is proposing to use isopropanol (IPA, a B-rated compound per DAR-1) for wipe cleaning of tools, workspaces, and other surfaces within the semiconductor fab which may be subject to Subpart 226-2. Per 6 NYCRR 226-2.1(c)(6), the use of cleaning solvents given an A rating by the department or that are already subject to RACT under Part 212 are exempt from the requirements of Subpart 226-2. The Proposed Air Permit Project is subject to VOC RACT requirements under Part 212 as detailed in Section 3.3.4.6 of this application and as such, Micron will comply with RACT through Part 212 rather than Subpart 226-2. A VOC RACT Compliance Plan is included in Appendix N of this permit application.

3.3.7 6 NYCRR Part 227: Stationary Combustion Installations

Subpart 227-1 applies to stationary combustion installations that are not subject to NSPS or NESHAP standards, where the particulate matter standards of the federal regulation are less stringent than the standards established within the subpart.

The particulate emission standards of 6 NYCRR 227-1.3 apply to new stationary combustion installations with a maximum heat capacity equal to or exceeding 1 MMBtu/hr when firing solid fuel and 50 MMBtu/hr when firing oil or oil in combination with other liquid or gaseous fuels.

Micron is not proposing to install any combustion installations firing solid fuel, oil, or oil in combination with other liquid or gaseous fuels exceeding the applicable maximum heat capacity thresholds. As such, 6 NYCRR 227-1.3 does not apply to these combustion installations.

The opacity standards of 6 NYCRR 227-1.4 apply to all combustion installations subject to Subpart 227-1. As such, all combustion installations at the Proposed Air Permit Project are subject to the opacity requirements of 6 NYCRR 227-1.4.

Subpart 227-2 applies to major sources of NO_X that contain boilers, combustion turbines, stationary internal combustion engines or other combustion installations. The Proposed Air Permit Project will be a major source of NO_X and is therefore subject to the NO_X RACT requirements of Subpart 227-2. A detailed NO_X RACT Compliance Plan is included in Appendix I to this application.

3.3.8 6 NYCRR Part 229: Petroleum and Volatile Organic Liquid Storage and Transfer

Part 229 applies to the owner or operator of a gasoline bulk plant, gasoline loading terminal, petroleum liquid storage tank or volatile organic liquid (VOL) storage tank which meets certain applicability criteria specified in the regulation. Micron is not proposing to install any gasoline or petroleum liquid storage tanks that would be potentially subject to Part 229 requirements. Micron is proposing to install eight (8) 25,000-gallon diesel storage tanks as a part of the Proposed Air Permit Project. Per 6 NYCRR 229.2(b)(17) and (22), diesel is not a petroleum liquid or a volatile organic liquid and as such, Part 229 does not apply to these tanks.

Micron is proposing to install several VOL storage tanks with capacities ranging from 2,500 to 10,000 gallons. The Proposed Air Permit Project is in Onondaga County and is subject to 6 NYCRR 229.1(d)(2). Per 6 NYCRR 229.1(f)(4), horizontal volatile organic liquid storage tanks are exempt from Part 229. For tanks containing VOL that do not meet this exemption, the control requirements are in 6 NYCRR 229.3(e)(2)(iv) or (v), depending on size.

3.3.9 6 NYCRR Part 231: New Source Review

The federal NSR program is comprised of two pre-construction permitting programs: 1) Prevention of Significant Deterioration (PSD) for attainment areas/pollutants; and 2) nonattainment New Source Review (NNSR) for nonattainment areas or areas located within the ozone transport region. New York has its own SIP-approved programs for PSD and NNSR codified in 6 NYCRR Part 231. The PSD and NNSR applicability presented in this section rely on definitions from 6 NYCRR 231-4 and tables from 6 NYCRR 231-13.

3.3.9.1 Major NSR Permitting Programs

PSD permitting may apply to facilities located in areas designated as in attainment with the NAAQS. The Proposed Air Permit Project is a new facility and the NYSDEC's PSD permitting program for new major facilities is established in 6 NYCRR 231-7.

NNSR permitting may apply to facilities located in areas that are designated as nonattainment with the NAAQS for a specific criteria pollutant. In addition, even if an area is designated as attainment for ozone, all of New York State is located in the ozone transport region. Areas within the ozone transport region are, at a minimum, treated as a moderate nonattainment area. The Proposed Air Permit Project is a new facility and the New York NNSR program for new major facilities is established in 6 NYCRR 231-5.

3.3.9.2 Attainment Status of Onondaga County, New York

The Proposed Air Permit Project is located in Onondaga County, New York. Onondaga County is part of the Central New York Intrastate Air Quality Control Region (Central NY AQCR) defined in 40 CFR 81.127. Onondaga County and the Central NY AQCR are currently designated as attainment or unclassifiable for all pollutants. However, because New York is in the ozone transport region, all of New York is considered to be in moderate nonattainment for ozone. In addition, the U.S. EPA's Greenbook notes that Onondaga County was formerly considered nonattainment for CO and is currently designated as a maintenance area for CO.[50] Based on guidance received from the NYSDEC, counties that currently achieve the NAAQS for CO but are designated as maintenance for CO are considered to be in attainment.

On February 7, 2024, the U.S. EPA announced a final rule to reduce the annual NAAQS for $PM_{2.5}$ from 12 $\mu g/m^3$ to 9.0 $\mu g/m^3$. Onondaga County is designated as attainment with the 12 $\mu g/m^3$ NAAQS. To understand potential implications from this change in the NAAQS, Trinity evaluated publicly available information on the local air quality. Data collected from a representative monitor in Syracuse[51] and analyzed by Trinity indicates that Onondaga County is likely to be classified as attainment following implementation of the updated NAAQS. This analysis assumes attainment with Annual $PM_{2.5}$ NAAQS is maintained.

Based on the foregoing, all air contaminants will be evaluated under the PSD program, except for NO_X and VOC (as ozone precursors) which will be evaluated under the NNSR program.

3.3.9.3 NSR Applicability Overview and Major Source Thresholds

As a new facility, the Proposed Air Permit Project must be compared to major facility thresholds for the PSD and NNSR programs for attainment and nonattainment contaminants, respectively. If a facility is a new major facility for a regulated NSR contaminant other than GHG and has the potential to emit 75,000 tpy CO_2e (100-yr GWP) or more, GHGs are also subject to regulation under Part 231.

The Proposed Air Permit Project consists of a semiconductor manufacturing facility and associated support operations. Per 6 NYCRR 231-13.5, Table 5, footnote 1, a 100 tpy threshold for PSD major source applies if facility is one of the source categories listed in §201-2.1(b)(21)(iii)(a) through (z). The operations associated with the Proposed Air Permit Project are not included in that list, therefore, the PSD major facility threshold is 250 tpy.

Table 3-3 lists the major facility thresholds relevant to the Proposed Air Permit Project and the Significant Project Thresholds (SPTs) for each PSD and NNSR air contaminant.

[50] https://www3.epa.gov/airquality/greenbook/cbcs.html#NY, Accessed December 3, 2024

[51] Syracuse monitor (AQS Site ID 36-067-1015)

Table 3-3. PSD and NNSR Major Source Thresholds

Air Contaminant	Major Facility Threshold	Facility-wide PTE (tpy)	Regulated Under PSD or NNSR?	6 NYCRR 231-13 Table	Significant Project Threshold (tpy)	6 NYCRR 231-13 Table
Particulate Matter	250	77.7	PSD	Table 5	25	6
PM_{10}	250	67.0	PSD	Table 5	15	6
$PM_{2.5}$	250	56.0	PSD	Table 5	10	6
Volatile Organic Compounds	50	287.7	NNSR	Table 1	40	3
Greenhouse Gases (as CO_2e, 100-yr GWP)	75,000	1,082,596	PSD	6 NYCRR 231-4.1[a]	75,000	6
Nitrogen Oxides	100 250	374.2	NNSR PSD	Table 1	40	3
Sulfur Dioxide	250	21.7	PSD	Table 5	40	6
Fluorides[b]	250	2.48	PSD	Table 5	3	6
Carbon Monoxide	250	1,410	PSD	Table 5	100	6
Lead (elemental)	250	1.79E-03	PSD	Table 5	0.6	6

a. While not subject to a NAAQS, GHG emissions are considered a "regulated NSR contaminant" that is "subject to regulation" under the PSD program if certain thresholds are met.
b. Refer to section 3.3.9.4 related to guidance from the U.S. EPA for fluoride emission calculation.

As demonstrated in Table 3-3, the Proposed Air Permit Project exceeds the major facility thresholds under both the PSD and NNSR programs. Per 6 NYCRR 231-7.1(a)(1), the Proposed Air Permit Project is subject to the requirements of Subpart 231-7 and is PSD Major for certain attainment contaminants. In addition, GHG emissions are subject to regulation under the NSR program per 6 NYCRR 231-4.1(b)(50) because the PTE of GHG for the Proposed Air Permit Project exceeds 75,000. Finally, per 6 NYCRR 231-5.1(a)(1) the Proposed Air Permit Project is subject to the requirements of Subpart 231-5 and is NNSR Major for nonattainment contaminants NO_X and VOC.

Section 4 of this application addresses requirements for new PSD and NNSR major facilities.

3.3.9.4 Fluoride Emissions

As noted throughout this application, the semiconductor manufacturing process requires the use of several fluorinated compounds. Fluorides is a regulated NSR contaminant listed in Table 5 of §231-13.5. However, the term "fluoride" is not defined in §200.1, §201-2.1 or §231-4.1, or in 40 CFR 52.21 related to federal PSD requirements. Clarification on the definition of Fluorides as a regulated NSR pollutant has been given in a letter submitted to the North Carolina Department of Environment and Natural Resources (NCDENR),

Division of Air Quality,[52] and the NCDENR's response. The letter provides the following interpretation of the meaning of "fluorides" with respect to the PSD permitting program:

> *[F]luorides for the purposes of the three (3) tons per year NSR/PSD significant emission increase rate for major sources includes all inorganic fluoride compounds, except hydrogen fluoride (HF) which is a HAP. Therefore the emissions of organic compounds that contain fluorine atoms such as refrigerants, other fluorocarbons and fluoropolymers, which are not measured using EPA Methods 13A or 13B, are excluded from the NSR three (3) ton per year "fluorides" significant emission increase rate threshold.*

The NCDENR agreed with this conclusion. Note that the federal significant emission increase rate threshold aligns with the significant net emission increase (6 NYCRR 231-4.1(b)(47)) threshold. The fluoride emissions presented in Table 3-3 were prepared in alignment with the conclusion of this guidance letter.

3.3.10 6 NYCRR 257: Air Quality Standards

The NYSDEC has established state-specific ambient air quality standards for fluorides in 6 NYCRR Part 257-4. According to the Regulatory Impact Statement published by the NYSDEC to accompany the revisions adopted in 2019, the standards were enacted to address "the deposition of fluoride compounds during the manufacturing of primary aluminum". The Proposed Air Permit Project will not manufacture primary aluminum, but will emit fluorides. Accordingly, Micron will perform air dispersion modeling to demonstrate compliance with the standards for gaseous fluorides in air, as set forth in §257-4.2(b). The fluorides standards in §257-4 apply to "material that tests as fluoride by methods acceptable to the commissioner". Micron proposes U.S. EPA test methods 13A and 13B, excluding HF as outlined in the NCDENR memo referenced in Section 3.3.9.4 above, as methods to quantify fluorides subject to §257-4. Such compounds will be included in the proposed air dispersion modeling under a separate cover letter. Micron believes that compliance with §257-4.2(b) also meets the requirement of §257-4.2(a).

A separate state ambient air quality standard is set for hydrogen sulfide (H_2S) in §257-5. Since the Proposed Air Permit Project will emit H_2S, Micron is performing air dispersion modeling to demonstrate compliance with the standard established in §257-5.3.

3.3.11 6 NYCRR 494: Hydrofluorocarbon Standards and Reporting

On December 23, 2024, the NYSDEC adopted amendments to 6 NYCRR Part 494, Hydrofluorocarbon Standards and Reporting. The amended rule expands the list of regulated hydrofluorocarbons (HFCs) and sets prohibitions for these regulated substances, based on global warming potential and equipment type (subsectors).

In compliance with the prohibition dates stated in §494-1.4(e), no field charged systems may be installed which use a prohibited substance. Additionally, effective one year following the prohibition dates, no person may sell, distribute, or purchase a prohibited substance. The Proposed Air Permit Project includes various regulated subsectors including chillers, HVAC units, and industrial process refrigeration. Fab process chillers using HTFs are not part of a regulated subsector, since the definition of "chiller" in 6 NYCRR 494-1.3(a)(13) covers "equipment that uses a vapor compression or absorption refrigeration cycle". The HTFs used in fab

[52] Letter from Donald R. van der Vaart, P.E. NCDENR to Michael E. Johnson, DuPont Fluoroproducts, July 17, 2008; https://www.deq.nc.gov/water-resources/docs/nsr-fluorides/download, Accessed February 16, 2024.

process chillers do not change phase during operation. For equipment that are part of regulated subsectors, Micron will comply with prohibition dates required per §494-1.4(e).

Micron will further comply with all disclosure and labeling requirements for equipment, product, and packaging as required per §494-1.6. Micron will also register regulated equipment with the NYSDEC and label such equipment in compliance with §494-2.2.

As noted above, the Proposed Air Permit Project will operate various refrigeration and air-conditioning equipment. As part of Micron's refrigerant management program for the Proposed Air Permit Project, Micron will comply with the leak detection and monitoring schedule required per §494-2.3. Detected leaks will be repaired according to the 14-day requirement of §494-2.4 unless an allowance is given according to §494-2.4(c) or §494-2.4(d). Required information will be recorded and reported annually according to §494-2.6 and §494-2.7.

3.3.12 6 NYCRR Part 495: Sulfur Hexafluoride Standards and Reporting

6 NYCRR Part 495, Sulfur Hexafluoride Standards and Reporting sets requirements for the phasedown of sulfur hexafluoride (SF_6) in gas insulated equipment across the electricity sector, an emissions limit for gas insulated equipment owners, limitations on the use of SF_6, and reporting requirements for certain users and suppliers of SF_6 and other fluorinated greenhouse gases. Part 495 applies to gas-insulated equipment (GIE) that utilizes SF_6 or substitutes as an insulating medium and includes annual reporting requirements for owners of GIE with annual GIE emissions of covered insulating gases above 7,500 metric tons of CO_2e.

§495-1.4 sets a periodic phase-out plan for SF_6 gas insulated equipment starting January 1, 2027, for equipment rated less than 38kV and continuing through January 1, 2033, for equipment rated above 245kV. Micron proposes to operate SF_6-containing GIE with voltages of 38 kV and 420 kV, and will comply with the phase-out date for the equipment equal to or above the 38kV threshold. Micron will comply with the applicable phase out requirements.

Micron will additionally comply with all reporting and recordkeeping requirements of Part 495, including the maintenance of a GIE inventory in compliance with §495-1.6. Micron with also maintain emissions in compliance with the limits set in §495-1.5.

3.3.13 6 NYCRR 617: State Environmental Quality Review

New York's State SEQRA requires state and local government agencies to consider environmental impacts, as well as social and economic factors during discretionary decision-making. The NEPA/SEQRA Proposed Project is undergoing a comprehensive evaluation under SEQRA for combined environmental implications. Aspects of air quality impacts will be addressed in the full SEQRA submittal under separate cover.

3.3.14 Climate Leadership and Community Protection Act

The CLCPA was signed into law in July 2019 and became effective January 1, 2020. Pursuant to Section 7(2) of the CLCPA, New York State agencies, such as the NYSDEC, are required to review certain permit applications for inconsistency or interference with the attainment of the statewide GHG emission limits established by the CLCPA. In December 2021, the NYSDEC issued guidance in the form of a proposed DEC Program Policy related to evaluating air emission sources with respect to "DAR-21: The Climate Leadership and Community Protection Act and Air Permit Applications" (DAR-21). DAR-21 outlines guidance for

evaluating when a CLCPA analysis should be submitted and what information should be included in the analysis. The Proposed Air Permit Project is subject to analysis under DAR-21 and a CLCPA analysis will be submitted with the Draft Environmental Impact Statement under a separate cover letter. The CLCPA analysis will be comprehensive of the requirements for all environmental approvals associated with the Proposed Project requiring CLCPA analysis and include an evaluation of the three elements included below:

- Air emissions from stationary sources related to the operation of the production facility once it is constructed and operational;
- Air emissions from mobile equipment used to prepare the land for construction and to construct the production facilities; and
- Wetland-related impacts

Additionally, the NYSDEC issued its final policy DEP 24-1: Permitting and Disadvantaged Communities ("DEP 24-1") on May 8, 2024, outlining the requirements for further analysis of co-pollutants if the Facility is in, or potentially, impacts a Disadvantaged Community (DAC). The NYSDEC finalized the list of DACs in March 2023 and the maps published with that final list were used in determining the applicability of DEP 24-1 to the Proposed Air Permit Project. A preliminary screening analysis of the applicability of DEP 24-1 will be included in the CLCPA analysis under a separate cover letter.

4. MAJOR NSR REQUIREMENTS

As a new major PSD and NNSR facility, the Proposed Air Permit Project will be subject to additional analyses which are described in this section. In addition, within 30 days of commencement of construction, Micron will notify the department in writing that construction has begun as required by 6 NYCRR 231-11.1(b)(1).

4.1 PSD Requirements

The PSD regulations state that facilities subject to PSD review must perform an air quality analysis (which can include atmospheric dispersion modeling and preconstruction ambient air quality monitoring), and a BACT demonstration for those pollutants that exceed the pollutant-specific major facility and/or significant project thresholds for new facilities as well as an additional impacts analysis that examines the impacts of air emissions from the project on visibility, soils, and vegetation.

4.1.1 Best Available Control Technology

Pollutants subject to PSD review may be subject to a BACT analysis. The Proposed Air Permit Project is a new PSD Major stationary source. As described in 6 NYCRR 231-7.1, any proposed facility that has a PTE of attainment contaminants in excess of an applicable major facility threshold in Subpart 231-13 is subject to PSD review. Section 3.3.9 lists the PTE of the Proposed Air Permit Project and illustrates that the major facility threshold is exceeded for CO and NO_X. Therefore, these pollutants are subject to BACT requirements. In addition, 6 NYCRR 231-7.6(a) requires BACT for all regulated NSR contaminants emitted by the Proposed Air Permit Project at a rate that equals or exceeds the applicable significant project threshold (SPT) in Subpart 231-13. This applies to PM, PM_{10}, and $PM_{2.5}$, which are analyzed collectively. In the case of sulfuric acid and fluorides (both regulated NSR contaminants), the PTE from the Proposed Air Permit Project falls below the SPT. Finally, because GHG emissions from the Proposed Air Permit Project are subject to regulation as described in Section 3.3.9.3, GHG emissions are subject to BACT requirements.

The Proposed Air Permit Project will incorporate BACT controls for emissions of NO_X, CO, PM, PM_{10}, $PM_{2.5}$, and GHG for all equipment that emits those contaminants. The requirements for BACT are described in detail in Section 5 and BACT Analyses are presented in Appendices H, J, K, and L. Emissions of NO_X are also subject to more stringent LAER requirements under the ozone nonattainment provisions due to the Project's location in the ozone transport region. Since the LAER requirements are generally at least as stringent as BACT, the LAER analysis included in Appendix H will satisfy the BACT requirements for NO_X. Emission limits and control requirements to achieve BACT are summarized in Section 6.

4.1.2 Air Quality Impact Analysis

The PSD air quality impact analysis requires dispersion modeling that uses emission rates and stack parameters (stack height and flue gas exit temperature and velocity, etc.) coupled with historical meteorology representative of the site to predict the location and magnitude of maximum impacts for various pollutants and averaging periods. Per 6 NYCRR 231-12.3, the Proposed Air Permitting Project is subject to air dispersion modeling for any compound with a PTE that exceeds the SPT and that has been assigned a NAAQS. As illustrated in Section 3.3.9, air dispersion modeling analysis is required for NO_2, CO, PM, PM_{10}, and $PM_{2.5}$. An initial modeling protocol was submitted to the NYSDEC following Permit Application 1, with comments issued by NYSDEC after review. Micron will submit an updated modeling protocol addressing NYSDEC's comments following submittal of this application. In addition, continuous air quality

monitoring data may be required as part of the air quality impact analysis per 6 NYCRR 231-12.3(c). Micron is submitting a request for a waiver for the requirement to conduct air monitoring as a part of the updated modeling protocol.

4.1.2.1 Impacts on Class I Areas

Class I areas, as defined in the Clean Air Act, are the following areas that were in existence as of August 7, 1977: national parks over 6,000 acres, national wilderness areas and national memorial parks over 5,000 acres, and international parks. Proposed major sources greater than 100 kilometers from a Class I area may be eligible for an exemption from the requirement to perform a Class I area modeling analysis. The Class I area closest to the proposed project is Lye Brook Wilderness area in Vermont, approximately 250 kilometers east of the Proposed Air Permit Project. The Federal Land Manager (FLM) is required to be notified as part of this permitting process to determine if assessments of impacts in the Class I areas would be required. A copy of the FLM correspondence will be submitted to the NYSDEC with the air dispersion modeling protocol and report.

4.1.3 PSD Additional Impact Analyses

Certain additional analyses are required as part of the PSD review as described in 6 NYCRR 231-7.3(e)(1). These include modeling to assess potential for impacts to soils and vegetation, visibility, and include emissions from associated industrial, commercial, and residential growth as well as the emissions from the Proposed Air Permit Project. In addition, 6 NYCRR 231-7.3(e)(1) requires an analysis of the air quality impact projected for the area as a result of general commercial, residential, industrial and other growth associated with the proposed new or modified facility. A detailed analysis of these items will be submitted in the modeling report.

4.1.4 Environmental Justice

The Environmental Justice (EJ) program is implemented in accordance with Commissioner's Policy 29 (CP-29): Environmental Justice and Permitting, in the State of New York. The Proposed Air Permit Project is a portion of a larger project (the NEPA/SEQRA Proposed Project). The analysis of requirements under CP-29 is being conducted as a component of the SEQRA review of the NEPA/SEQRA Proposed Project and is not addressed herein.

4.2 Nonattainment New Source Review Requirements

The pre-construction review requirements for major new sources or major modifications located in areas designated as nonattainment pursuant to Section 107 of the Clean Air Act (CAA), as amended in 1990, differ from PSD requirements. Based upon the provisions of 6 NYCRR 231-5, new major facilities located in areas designated by EPA as nonattainment or within the ozone transport region, must demonstrate, as part of the permit application, that several special conditions are met. These include the need to apply LAER and obtain emission offsets, (i.e., emission reduction credits [ERCs]).

4.2.1 Lowest Achievable Emission Rate

Pollutants subject to nonattainment NSR must be limited to LAER levels. LAER is defined as either the most stringent emission limitation contained in a State Implementation Plan (SIP) (unless it is demonstrated to not be achievable) or the most stringent emission limitation which is achieved in practice by the class or category of source taking into consideration each pollutant that must be controlled, whichever is the most

stringent. Nonattainment contaminants are subject to LAER if potential emissions of individual pollutants exceed the SPT listed in 6 NYCRR 231-13. As illustrated in Section 3.3.9, emissions of NO_X and VOC from the Proposed Air Permit Project are subject to LAER requirements. The requirements for LAER are described in detail in Section 5 and a LAER analysis is presented in Appendix H for NO_X and Appendix M for VOC. Emission Limits and control requirements to achieve LAER for NO_X and VOC are summarized in Section 6.

4.2.2 Emission Offset Requirements

A major source or major modification planned in an EPA-designated nonattainment area must obtain ERCs as a condition for permit approval. The emissions reductions, generally obtained from existing sources located in the vicinity of a proposed source, must offset the emissions increase from the new source or modification and satisfy a "contribution test" for VOC and NO_x offsets. These offsets, obtained from existing sources that implement a permanent, enforceable, quantifiable and surplus emissions reduction, must equal the project emission potential from the new source or modification multiplied by the offset ratios established in 6 NYCRR 231-13. For the Proposed Air Permit Project, the offset ratio for both NO_X and VOC is 1.15 to 1 due to the facility's location in the OTR.

The Proposed Air Permit Project is located in the OTR and would be required to purchase ERCs from a source (or sources) from any location within the OTR, including other states within the OTR (such as Pennsylvania) per 6 NYCRR 231-5.5(e)(2). The calculation of required offsets is included in Tables 2-1 and 2-2 of Appendix F and is based on the PTE of the Proposed Air Permit Project (per 6 NYCRR 231-5.5) and the offset ratio.

Micron will surrender the necessary ERCs to satisfy the required offsets calculated. The ERCs selected to offset the emissions from the Proposed Air Permit Project will be included in the public notification and participation process for the air permit. Additional details will be provided in a future submittal.

4.2.3 Compliance Status of Other Micron Owned Major Facilities in New York State

For projects subject to 6 NYCRR 231-5, the applicant must certify that all emission sources which are part of any major facility located in New York State under the applicant's ownership or control are in compliance (or are on a schedule for compliance) with all applicable emission limitations and standards under NYSDEC's regulations. Micron does not own or operate another major source in the State of New York, so this requirement does not apply.

4.2.4 NNSR Analysis of Alternatives

Based upon the NYSDEC requirements at 6 NYCRR 231-5.2(b), the Proposed Air Permit Project is required to conduct an analysis of "alternative sites, sizes, production processes and environmental control techniques for the proposed facility, which demonstrates that the benefits of the proposed facility significantly outweigh the environmental and social costs" imposed as a result of the proposed construction.

4.2.4.1 Alternative Sites Evaluated

The Proposed Air Permit Project is for the construction of a greenfield semiconductor fabrication facility at the White Pine Commerce Park (WPCP) located in Onondaga County, New York. Micron developed a set of site selection criteria that considered minimum parcel size, utility and energy availability, transportation accessibility, workforce development among various other technical and socioeconomic factors. To select the

current location for the facility, Micron completed a review of potential construction and operation sites and analyzed 3 properties before selecting the present location as the most suitable for the Proposed Air Permit Project. Micron's selection of this location is summarized in their public announcement of the project in October 2022.

> *Micron selected the Onondaga County, New York site based on its multiple advantages including leading higher education institutions, access to talent traditionally underrepresented in technology jobs and a significant military population aligned with Micron's commitment to veteran hiring. It also offers availability of water and clean, reliable power to enable a project of this scale while achieving our long-term environmental goals. … New York provides partnership opportunities with local K-12 education programs, community colleges and institutions for top engineering and technical talent. The state has a long history of semiconductor development and manufacturing, providing promising opportunities to collaborate on R&D [Research and Development] initiatives with organizations like the Albany NanoTech Complex and the U.S. Air Force Research Laboratory.*[53]

New York State's Evaluation

New York State has in recent years undertaken an evaluation to identify candidate sites for semiconductor manufacturing. That process identified four (4) sites throughout New York State as "shovel ready" candidate sites for semiconductor manufacturing: Western NY Science, Technology & Advanced Manufacturing Park (STAMP) in Genesee County, WPCP in Onondaga County (where the Proposed Air Permit Project will be located), Marcy Nanocenter in Oneida County, and Luther Forest Technology Campus in Saratoga County.

- Since 2012, GlobalFoundries U.S., Inc. has operated a semiconductor manufacturing facility at the Luther Forest Technology Campus in Saratoga County. The undeveloped 800 acres was not large enough to meet Micron's project requirements and is no longer available. GlobalFoundries purchased the additional acreage in 2023 to develop.
- Marcy Nanocenter Parcel #1 was previously developed into a manufacturing facility for Wolfspeed. The remaining parcel at Marcy Nanocenter is only 438 acres, too small for the Proposed Air Permit Project. The Micron Campus property shown in Figure 1-1 is approximately 1,400 acres.
- Some development has already occurred at STAMP, once covering 1,250 acres. The remaining available acreage at that site (540 acres of non-contiguous parcels) also is too small to accommodate the Proposed Air Permit Project.

In 2018, the New York State Economic Development Council (NYSEDC) prepared a "Competitive Site Location Benchmarking for Semiconductor Manufacturing" study (also known as "Project Rhino"). The purpose of the benchmarking study was to assess and compare four (4) sites in New York State, including WPCP, for their readiness to support semiconductor manufacturing; benchmark those four (4) sites against six (6) other sites located throughout the United States; and identify other industrial sectors that might be attracted to New York State to support semiconductor manufacturing. The study was based upon a hypothetical semiconductor manufacturing facility and evaluated each of the sites against a number of quality, cost, and economic incentive factors.

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[53] Micron Announces Historic Investment of up to $100 Billion to Build Megafab in Central New York, https://investors.micron.com/news-releases/news-release-details/micron-announces-historic-investment-100-billion-build-megafab, Accessed February 18, 2024.

The qualitative assessment evaluated the sites against five categories, each of which had several factors included: site quality and suitability; workforce and community alignment; utilities capacity, quality, and reliability; economic development and regulatory context; and incentive capacity and capability. WPCP ranked second nationally for access to utilities and readiness of those utilities to serve the site. It was noted that all four New York State sites ranked first through fourth for the degree to which tax and non-tax incentives have been made available from the State and local governments. Lastly, three of the New York sites, including WPCP, ranked in the top five for economic development and regulatory support. While all four New York State sites were among the most expensive in terms of construction costs, personnel, water and wastewater, and real estate and personal income taxes, the New York State sites had a competitive advantage on electricity and natural gas costs. On balance, the study concluded that New York State led all competitors in terms of the capacity, capability, and probability of delivering a meaningful incentives package.

Onondaga County's Evaluation

Central New York as well as other regions of New York State have experienced a reduction in manufacturing jobs over several decades. In 1991, OCIDA and the City of Syracuse Chamber of Commerce commissioned an Industrial Park Feasibility Study to identify potential candidate sites for locating industrial businesses in Onondaga County.

As part of its effort to develop a "shovel-ready" industrial park in Onondaga County, OCIDA evaluated a number of potential locations throughout the county. OCIDA ultimately selected WPCP as its preferred site to attract private industrial and commercial development because of its size, potential for industrial zoning, access to transportation, proximity of utilities, as well as a history of Town of Clay efforts to facilitate industrial development at the property. Other sites previously evaluated include Radisson Corporate Park, Hancock Air Park, Collamer Crossings Business Park, and Syracuse Research Park.

- The Radisson Corporate Park was withdrawn from further consideration because it lacked sufficient area and did not offer the location specific advantages such as proximity to Interstate 81.
- The Hancock Air Park and Collamer Crossings Business Park were withdrawn from further consideration because available lots were too small and could not accommodate large industrial uses.
- The Syracuse Research Park was withdrawn from consideration because it could not easily accommodate large-scale industrial uses.

In their 2021 Supplement to Generic Environmental Impact Statement (SGEIS), OCIDA revisited their previous evaluation to address whether WPCP was still the preferred alternative to attract industrial and commercial development to Onondaga County, and compared it to the same alternative candidate sites that were assessed in the 2012 Draft Generic Environmental Impact Statement (DGEIS), concluding that "[n]one of the previously considered alternative locations would be able to accommodate the large-scale industrial use that the [White Pine Commerce] Park is promoting due to size limitations and proximity to services and necessary infrastructure." The 2021 SGEIS further concluded that significant expansion of WPCP was feasible and more likely to attract leading edge manufacturing, such as semiconductor manufacturing. The 2021 SGEIS assessed the additional potential significant adverse impacts from a larger facility (up to 4 million sf of manufacturing space) and increase in size of the development parcel to approximately 1,400 acres. OCIDA indicated in the SEQRA Findings Statement that "consistent with social, economic and other essential considerations from among the reasonable alternatives available, the action is the one that avoids or minimizes adverse impacts to the maximum extent practicable, and that adverse impacts will be avoided

or minimized to the maximum extent practicable by incorporating as conditions to the decision those mitigation measures that were identified as practicable."

4.2.4.2 Alternative Project Technologies, Design and Sizes

In terms of project technologies as they relate to air emissions potential, alternatives that rely exclusively on alternative sources of energy (beyond use of renewable energy for purchased electricity) were considered and ruled out to be infeasible.

To minimize the footprint of the facilities, the support operations (such as gas and chemical distribution systems) that provide process material to the process tools will be beneath the fab floor on the 'subfab level'. This helps to optimize the production capacity within the available footprint for the facility.

The Proposed Air Permit Project includes construction and operation of two 600,000 square foot fab operations and associated support buildings and equipment. The rapid growth of the demand for memory-based semiconductors indeed warrants a four Fab facility. The industry is projected to double in the next 10 years driven by the data economy. The semiconductor industry of today focuses on economies of scale; the need to build fewer, larger Fabs; and the managerial and economic benefits regarding workforce and reducing operational downtimes during expansions. The alternative of building fewer number of fabs at the WPCP location and instead building the remaining fabs at a different site would have significant economic and operational impacts that include:

- Additional infrastructure cost associated with building the other two Fabs needed for the market growth at a different site.
- Loss of operational efficiencies that increase with co-located scale.
- Reduced supplier eco-system.

Pursuing a facility that embodies economies of scale principles reflects an emission minimization approach in that development of similar production capacity across multiple smaller facilities would likely result in a greater overall emission footprint.

4.2.4.3 Alternative Project Layout

Due to the required size of the facility and available property, the physical layout for the facility has undergone extensive engineering design to maximize the utilization of the Micron Campus property. The facility layout is dictated partially by local utilities (such as electrical supply, wastewater treatment plant) as well as easy access to roadways and highways. Micron studied seven different layout options and the selected layout balances the environmental impact with the practical requirements of the operation.

OCIDA's 2021 FSGEIS for the WPCP concluded that development of up to 4 million square feet of manufacturing space would avoid, minimize, or otherwise mitigate adverse environmental impacts to the maximum extent practicable.

4.2.4.4 Environmental Control Technologies

Based upon the Proposed Air Permit Project's site location and nonattainment status, the requirements for the Proposed Air Permit Project are that it must be designed to meet federal BACT and LAER standards to comply with PSD requirements, NNSR requirements, and New York State Part 231 regulations. The BACT

and LAER analyses are included in the Appendix of this application and the emission limits and control requirements are summarized in Section 6 of this permit application.

4.2.4.5 Environmental/Social Costs and Benefits of the Proposed Facility

The purpose of the Proposed Air Permit Project is to further the United States goal to expand domestic memory chip manufacturing capacity and restore U.S. leadership in semiconductor manufacturing as embodied in the "Creating Helpful Incentives to Produce Semiconductors and Science Act of 2022" (the "CHIPS Act"). For Micron, the purpose is to advance its leading-edge position in the development and manufacturing of DRAM memory chips.

The purpose of the CHIPS Act and the need for the Proposed Air Permit Project is to reduce U.S. reliance on foreign production of both leading edge and older generation microelectronics. Semiconductors were invented in the U.S., and the U.S. semiconductor industry has historically dominated many parts of the international semiconductor supply chain, such as research and development, chip design and manufacturing. Yet the U.S. position within the semiconductor industry has been declining. According to the Semiconductor Industry Association, U.S. production of the world's microchips has fallen from 37% in 1990 to 12% in 2020. The Proposed Air Permit Project would reduce economic and national security risks by building domestic capacity, to establish a dynamic and collaborative network for semiconductor research and innovation centers, and to improve competitiveness and strengthen regional supply chain industries. Micron provides a unique and essential role in domestic production of leading-edge memory chips that are essential and high-volume components of the semiconductor industry.

The Proposed Air Permit Project will promote the CHIPS Act objectives by reducing U.S. reliance on foreign production of essential component parts in the semiconductor industry. This addresses a concrete national security concern by minimizing excessive exposure to global supply chain disruptions and additionally provides a secure supply of semiconductors for national security and critical infrastructure, supporting the technology leadership of the United States. Micron has committed to investing up to $50 billion by the end of the decade in connection with its award under the CHIPS Act, including by constructing a new fab complex.[54]

The Proposed Air Permit Project will promote OCIDA's objectives to increase manufacturing employment since Central New York and other regions of New York State have experienced a reduction in manufacturing jobs over several decades. High-tech advanced manufacturing holds the promise of transforming the Onondaga County economy through the following:

- Construction of the Proposed Air Permit Project will result in a substantial economic infusion into the local economy as a result of craft payroll expenditures, local purchases of materials and supplies and local contracted construction services during the construction schedule. Micron has estimated that nearly 50,000 New York jobs will be created.[55]
- The project, once fully operational, will result in the hiring of approximately 9,000 high paying Micron jobs.[56]

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[54] Ibid.

[55] Ibid.

[56] Ibid.

- The project will result in investments in community and workforce development,[57] including the following.
  - As part of the project, Micron and the State of New York announced a historic $500 million investment in community and workforce development with a focus on disadvantaged populations over the duration of the project. Micron will invest $250 million over the next 20-plus years as part of the company's commitment to the Green CHIPS Community Investment Fund.
  - The fund will be aimed at expanding and preparing the workforce in the region and providing additional support for disadvantaged community populations, and will be used for workforce training, education programs, housing and other community investments.
- Micron will be submitting a 'Green CHIPS Community Plan' and a 'Green CHIPS Sustainability Plan' to the Empire State Development Corporation (ESD) as part of the 'Excelsior Jobs Program' application.
- The Proposed Air Permit Project's engineering design will ensure compliance with RACT, BACT, LAER, and both U.S. EPA and New York State regulatory requirements.
- The Project will provide long-term tax stability for local communities by maintaining current tax benefits and increasing the tax base and revenues into the future.

In the October 2022 Micron announcement of the project, Senate Majority Leader Charles Schumer was quoted, stating the following.

> *[I]t's official—Micron is coming to Central New York! With the CHIPS and Science bill, I wrote and championed as the fuse, Micron's $100 billion investment in Upstate New York will fundamentally transform the region into a global hub for manufacturing and bring tens of thousands of good-paying high-tech and construction jobs to Central New York. This project is a dramatic turning point for a region that has faced decades of lost manufacturing jobs, and, in combination with New York's already robust microchip industry from the Hudson Valley, Albany, and the Mohawk Valley to Binghamton, Rochester, and Buffalo, it will put Upstate New York on the map in a way we haven't seen in generations.*[58]

Governor Hochul was also quoted in the October 2022 announcement as stating the following.

> *Micron's $100 billion investment in New York marks the start of something transformative in scale and possibility for our state's economic future. …[T]hanks to our State Green CHIPS legislation, the federal CHIPS and Science Act, and extraordinary partnerships with business, labor, and local and federal leaders, this project will do exactly that. Together, we are leveraging this investment – the largest private-sector investment in state history – to secure our economic future, solidify New York's standing as a global manufacturing hub, and usher the state into another Industrial Revolution.*[59]

4.2.4.6 Alignment with NEPA/SEQRA Process

In addition to the information provided in the sections above, several of these aspects of the project are being evaluated through the NEPA and SEQRA process and the approval by the NYSDEC, U.S. EPA and

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[57] Ibid.

[58] Ibid.

[59] Ibid.

other involved agencies serve to demonstrate the benefit of this location with respect to alternatives locations/sites, production processes, etc.

5. CONTROL TECHNOLOGY REVIEW

This section presents the control technology review process used to evaluate and determine emission pollution control technologies and associated regulatory limits for the Proposed Air Permit Project. Analysis of BACT and LAER for each air contaminant subject to one or both programs is provided in appendices as discussed within this section. Additionally, an analysis of RACT under 6 NYCRR Part 212-3 is included in this section for VOC and NO_X.

5.1 Applicability of Control Technology Requirements

A control technology determination, as discussed in this section, is the process of determining the level of emission control required for each applicable air pollutant. Control technology requirements are generally based upon the potential emissions from an emission source and the attainment status of the area in which the source is to be located. A detailed determination of applicable regulations, including control technology requirements under the PSD and NNSR rules, is provided in Section 3. The following sections discuss the applicability of BACT, LAER and additional NYSDEC requirements for emissions from equipment included in this permit application.

5.1.1 PSD Pollutants Subject to BACT

BACT is defined as an emission limitation based on the maximum degree of reduction, on a case-by-case basis, taking into account energy, environmental and economic considerations.

5.1.2 NNSR Pollutants Subject to LAER

Emissions of pollutants subject to NNSR must be reduced to LAER levels. LAER is defined as the more stringent of: (1) the most stringent emission limitation which is achieved in practice by the class or category of source, or (2) the most stringent emission limitation contained in the applicable State Implementation Plan (unless such emission rate is demonstrated not to be achievable), whichever is the more stringent. LAER will be based upon the lowest permitted emission rates that are verified as being achieved in practice. Pollutants are subject to LAER if potential emissions of individual pollutants exceed area-specific emission thresholds. Based upon these criteria, emissions of NO_X are subject to LAER requirements.

5.1.3 Pollutants Subject to RACT

As the Proposed Air Permit Project will be a major source of both VOC and NO_X, emission sources at the Proposed Air Permit Project will be subject to review of RACT requirements in accordance with 6 NYCRR 212-3.

5.2 Best Available Control Technology

This section discusses the regulatory basis and approach used to determine BACT limits for the Proposed Air Permit Project.

5.2.1 BACT Definition

BACT is defined in the PSD regulations (40 CFR 52.21(b)(12)) as:

> *...an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61.*

Similarly, BACT is defined in the NYSDEC's regulations under 6 NYCRR 231-4.1 as:

> *An emissions limitation based on the maximum degree of reduction for each air pollutant subject to regulation under the act which would be emitted from or which results from any proposed major facility or NSR major modification which the department, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such proposed major facility or NSR major modification through application of production processes or available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of such air pollutant. In no event shall application of BACT result in emissions of any air pollutant which would exceed the emissions allowed by any applicable standard established pursuant to section 7411 or 7412 of the act. Emissions from any source utilizing clean fuels, or any other means, to comply with this paragraph shall not be allowed to increase above levels that would have been required under this paragraph as it existed prior to enactment of the Clean Air Act amendments of 1990.*

Unlike many of the Clean Air Act programs, the PSD program's BACT evaluation is performed on a case-by-case basis. As noted by the EPA:

> *The case-by-case analysis is far more complex than merely pointing to a lower emissions limit or higher control efficiency elsewhere in a permit or a permit application. The BACT determination must take into account all of the factors*

affecting the facility …. The BACT analysis, therefore, involves judgement and balancing.[60]

The components of the BACT definition are discussed below.

5.2.1.1 Defining the Source

BACT provisions in the Clean Air Act and U.S. EPA regulations often use the term "source" but, in some cases, regulations refer to the "emissions unit". Per the October 1990 *New Source Review Workshop Manual,*[61] the BACT must be applied to each individual new or modified affected emissions unit and pollutant emitting activity at which a net emissions increase would occur. Per 40 CFR 52.21(b), BACT should be applied to:

… any part of a stationary source that emits or would have the potential to emit any regulated NSR pollutant ...

A similar definition is found in 6 NYCRR 201-2.1(b)(14).

EPA has supported a logical grouping of emissions units when analyzing what constitutes BACT and considered controls available for individual pollutants when evaluating the merits of grouping.[62]

In some cases, pollution control technology can be considered as an emission unit since it can emit pollutants requiring BACT (such as a thermal oxidizer emitting NO_X). In these instances, Micron has also evaluated BACT for pollution control technology. This evaluation includes weighing the pros and cons of emitting one class of air contaminants compared to another class.

5.2.1.2 Emissions Limitation

When numerical emission limitations are the most appropriate form of BACT, they are often expressed in the form of an emissions limit derived after thorough evaluation of available technologies for control. In general, this limit could be an emission rate limit of a pollutant (e.g., pounds of pollutant per unit throughput).[63] Control device performance-based emission limits expressed on an exit concentration basis for the controlled pollutant (e.g., ppm, gr/dscf, etc.), or destruction and removal efficiencies are also an acceptable form for BACT limits in addition to the primary rate-based and mass-based forms.

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[60] EPA Region 9, *EPA Responses to Public Comments on the Proposed PSD Permit for the Desert Rock Energy Facility*, pp 41-42. EPA-R09-OAR-2007-1110-0120. 31 Jul 2008. https://downloads.regulations.gov/EPA-R09-OAR-2007-1110-0120/content.pdf

[61] EPA, Office of Air Quality Planning and Standards. *New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting, Draft*. Research Triangle Park, NC. Oct 1990. https://www.epa.gov/sites/production/files/2015-07/documents/1990wman.pdf.

[62] EPA, Office of General Counsel, Air and Radiation Law Office, *Defining and Redefining the "Source" for the PSD BACT Analysis*, Presentation by Brian Doster, Feb 2010. https://www.epa.gov/sites/default/files/2015-01/documents/bact_source_definition_questions.pdf

[63] Emission limits can be broadly differentiated as "rate-based" or "mass-based." A rate-based limit would typically be in units of lb/ton or lb/MMBtu (mass emissions per unit material throughput). In contrast, a typical mass-based limit would be in units of lb/hr (mass emissions per unit time).

5.2.1.3 Achievable

A BACT emission limit is to be set at the lowest value that is achievable while also considering energy, environmental and economic impacts. However, there is an important distinction between emission rates achieved at a specific time on a specific unit and an emission limitation that a unit must be able to meet continuously over its operating life. As discussed by the D.C. Circuit Court of Appeals:

> *In National Lime Ass'n v. EPA, 627 F.2d 416, 431 n.46 (D.C. Cir. 1980), we said that where a statute requires that a standard be "achievable," it must be achievable "under most adverse circumstances which can reasonably be expected to recur."*[64]

The EPA has reached similar conclusions in prior determinations for PSD permits.

> *Agency guidance and our prior decisions recognize a distinction between, on the one hand, measured 'emissions rates,' which are necessarily data obtained from a particular facility at a specific time, and on the other hand, the 'emissions limitation' determined to be BACT and set forth in the permit, which the facility is required to continuously meet throughout the facility's life. Stated simply, if there is uncontrollable fluctuation or variability in the measured emission rate, then the lowest measured emission rate will necessarily be more stringent than the "emissions limitation" that is "achievable" for that pollution control method over the life of the facility. Accordingly, because the "emissions limitation" is applicable for the facility's life, it is wholly appropriate for the permit issuer to consider, as part of the BACT analysis, the extent to which the available data demonstrate whether the emissions rate at issue has been achieved by other facilities over a long term.*[65]

Thus, a BACT emission limit must be set at the lowest feasible emission rate recognizing that the emission unit must be in compliance with that limit for the lifetime of the unit on a continuous basis. Thus, while viewing individual unit performance can be instructive in evaluating what BACT might be, any actual performance data must be viewed carefully, as rarely will the data be adequate to truly assess the performance that a unit will achieve during its entire operating life. While statistical variability of actual performance can be used to infer what is "achievable," such testing requires a detailed test plan akin to what EPA uses to develop MACT standards over a several year period, and is far beyond what is reasonable to expect of an individual source. In contrast to limited snapshots of actual performance data, emission limits from similar sources can reasonably be used to infer what is "achievable" for a given unit.[66]

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[64] *Sierra Club, et al v. EPA, et al*. No. 97-1687. 2 Mar 1999. https://www.cadc.uscourts.gov/internet/opinions.nsf/C09711D3E557339385256F15006C1C5C/$file/97-1686a.txt

[65] EPA Environmental Appeals Board. *In Re Newmont Nevada Energy Investment, LLC, TS Power Plant*, p 442. PSD Appeal No. 05-04. Environmental Administrative Decisions, Volume 12. 21 Dec 2005.

[66] Emission limits must be used with care in assessing what is "achievable." Limits established for facilities which were never built must be regarded with skepticism, as they have never been demonstrated and that company never

5.2.1.4 BACT Floor

The least stringent emission rate allowable for BACT is any emission limit to which the facility is subject to including any applicable limit under 40 CFR Parts 60 and 61 (NSPS and NESHAP, respectively). NESHAPs under 40 CFR Part 63 and state SIP limitations must also be considered when determining the emissions floor. As previously noted, the minimum control efficiency to be considered in a BACT assessment must result in an emission rate less than or equal to any applicable NSPS or NESHAP emission rate for the source. Several NSPS and NESHAP regulations are applicable to the site operations as discussed in the supporting documentation to this control technology review. In addition, the BACT floor can be no less stringent than RACT for VOC and NO_X.

5.2.1.5 Alternative to Emission Limitation

In some cases, there may not be an economically reasonable or technologically feasible way to accurately measure the emissions and establish a formal emission limit. Hence, EPA allows facilities to propose an alternative approach. In these instances, sites may utilize alternative methods to establish BACT, including work practices or operational standards, to reduce emissions of the pollutant to the maximum extent.

5.2.2 Top-Down Analysis

In a memorandum dated December 1, 1987, the EPA stated their preference for a "top-down" BACT analysis.[67] The first step in this approach is to determine the most stringent control available for a similar or identical source or source category for each emission unit. If it can be shown that this level of control is technically, environmentally, or economically infeasible for the unit in question, then the next most stringent level of control is determined and similarly evaluated. This process continues until the BACT level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections. Presented below are the five basic steps of a "top-down" BACT analysis procedure as discussed in the October 1990 *New Source Review Workshop Manual* (draft).[68]

5.2.2.1 Step 1 – Identify All Control Technologies

Available control technologies are identified for each emission unit in question. The following methods are typically used to identify potential technologies:

- Research the Reasonably Available Control Technology (RACT)/BACT/Lowest Achievable Emission Reduction (LAER) Clearinghouse (RBLC) database;
- Survey regulatory agencies and issued air permits;
- Draw from previous engineering experience;
- Survey air pollution control equipment vendors; and

took a significant liability in having to meet that limit. Likewise, permitted units which have not yet commenced construction must also be viewed with caution for similar reasons.

[67] Memorandum from J. Craig Potter, Assistant Administrator for Air and Radiation, to Regional Administrator, Regions 1-10, entitled "Improving New Source Review (NSR) Implementation." 1 Dec 1987. https://www.epa.gov/sites/production/files/2015-07/documents/establsh.pdf.

[68] EPA, Office of Air Quality Planning and Standards. *New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting, Draft*. Research Triangle Park, NC. Oct 1990. https://www.epa.gov/sites/production/files/2015-07/documents/1990wman.pdf.

- Survey available literature.

Specific techniques used by Micron to identify control technologies is discussed in Section 5.4.

5.2.2.2 Step 2 – Eliminate Technically Infeasible Options

After the identification of control options, an analysis is conducted to eliminate technically infeasible options. A control option is eliminated from consideration if there are process-specific conditions that prohibit the implementation of the control or if the highest control efficiency of the option would result in an emission level that is higher than any applicable regulatory limits, such as NSPS.

5.2.2.3 Step 3 – Rank Remaining Control Technologies by Control Effectiveness

Once technically infeasible options are removed from consideration, the remaining options are ranked based on their control effectiveness. If there is only one remaining option, or if all of the remaining technologies could achieve equivalent control efficiencies, ranking based on control efficiency is not required.

5.2.2.4 Step 4 – Evaluate the Most Effective Controls and Document the Results

Beginning with the most efficient control option in the ranking, detailed economic, energy, and environmental impact evaluations are performed. If a control option is determined to be economically feasible without adverse energy or environmental impacts, it is not necessary to evaluate the remaining options with lower control efficiencies.

The economic evaluation centers on the cost-effectiveness of the control option. Cost of installing and operating control technologies are estimated an analyzed following the methodologies outlined in the EPA's *Air Pollution Control Cost Manual* (CCM)[69] and other industry resources. Cost-effectiveness is expressed in dollars per ton of pollutant controlled. Analyses of energy and environmental impacts associated with each option are also conducted. Both beneficial and adverse impacts are discussed and quantified.

5.2.2.5 Step 5 – Select BACT

In the final step, one pollutant specific control option is proposed as BACT for each emission unit under review based on evaluations from the previous step.

While the top-down BACT analysis is a procedural approach suggested by EPA policy, this approach is not specifically mandated as a statutory requirement of the BACT determination.[70] As discussed in Section 5.1.1, a BACT limit is an emissions limitation, work practice or operational standard and does not require the installation of any specific control device.

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[69] The EPA is in the process of updating the 6th edition of the cost control manual. Revisions are expected to be complete by January 2022. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20manual

[70] EPA, Office of Air Quality Planning and Standards. *PSD and Title V Permitting Guidance for Greenhouse Gases*, p 19. EPA-457/B-11-001. Mar 2011. https://www.epa.gov/sites/production/files/2015-12/documents/ghgpermittingguidance.pdf.

5.2.3 Alternative to Top-Down BACT Analysis

In lieu of completing a top-down BACT analysis, NYSDEC accepts as BACT the control technology listed for the same industrial category in guidelines and determinations by regulatory agencies in California. If a source opts to select a control technology for the same or similar source category accepted by the air quality management districts in California or other regulatory agencies approved by NYSDEC as a viable alternative, then the source may forgo the top-down analysis methodology. Where relevant and appropriate, these BACT analyses have been considered as reference.

5.3 Lowest Achievable Emission Rate

As discussed within this application, the Proposed Air Permit Project is also expected to exceed major source thresholds under the NNSR program for certain pollutants. For these pollutants, the Proposed Air Permit Project is required to demonstrate compliance with more restrictive LAER limits.

This section discusses LAER applicability, the regulatory basis determining LAER, the approach used in completing the LAER analyses, and the LAER analyses for the Proposed Air Permit Project.

5.3.1 LAER Definition

The definition of LAER, as contained within 40 CFR 51.165(a)(1)(xiii), means, for any source, the more stringent rate of emissions based on the following:

(a) the most stringent emission limitation which is contained in the implementation plan of any State for such class or category of source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable, or

(b) the most stringent emission limitation which is achieved in practice by such class or category of source, whichever is more stringent.

LAER establishes a pollution control standard designed to minimize emissions of air pollutants from major stationary sources for facilities located in areas designated as nonattainment (therefore, subject to NNSR) or within Ozone Transport Region (OTR). The process of determining LAER involves a thorough evaluation of emissions control technologies and practices to identify the most stringent and effective measures that can be applied to a specific emission unit or emission source category.

In New York, pollutants are subject to LAER if potential emissions of individual pollutants exceed significance levels as defined in 6 NYCRR 231-13 and if the area has been designated as nonattainment for that pollutant. LAER aims to reduce emissions of nonattainment pollutants to help improve regional air quality and meet the NAAQS. Since the Proposed Air Permit Project will be located in New York state, which is a part of the OTR, the Proposed Air Permit Project will be required to determine the applicability of LAER for ozone precursors, NO_X and VOC.

5.3.2 LAER Top-Down Analysis

A LAER determination is performed on a case-by-case basis. It considers achievability in practice in a similar source and specific feasibility and effectiveness to control pollutant stream. Unlike BACT,

LAER does not consider economic, energy or other environmental factors, unless the cost of control is so great that no similar source would be built and operated. The following steps shall be documented in a LAER analysis:

- Step 1 – Identify All Control Technologies
- Step 2 – Eliminate Technically Infeasible Options
- Step 3 – Rank Remaining Control Technologies by Control Effectiveness
- Step 4 – LAER Selection

5.3.3 LAER Floor

The least stringent emission rate allowable for LAER is any applicable emission limit to which the facility is subject to, including under 40 CFR Parts 60 and 61 (NSPS and NESHAP, respectively). NESHAPs under 40 CFR Part 63 and state SIP limitations must also be considered when determining the emissions floor. Several NSPS and NESHAP regulations are applicable to the site operations as discussed in the supporting documentation to this control technology review. In addition, the LAER floor can be no less stringent than RACT for VOC and NO_X.

5.4 Control Technology Identification

For both BACT and LAER, the first step of the process is to identify available control technologies for each emission unit. Potentially applicable emission control technologies were identified by researching the EPA control technology database, technical literature, control equipment vendor information, state permitting authority files, and by using process knowledge and engineering experience. Given the complexity of the semiconductor processes, the technologies were identified through multiple resources, and these are outlined in the following sections.

5.4.1 Definition of Control

The primary objective in Step 1 is to identify all control technology applications to the source and pollutant under evaluation. The term "control technology" is clarified in the October 1990 *New Source Review Workshop Manual:*[71]

> *Available control options are those air pollution control technologies or techniques with a practical potential for application to the emissions unit and the regulated pollutant under evaluation. Air pollution control technologies and techniques include the application of production process or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of the affected pollutant. This includes technologies employed outside of the United States. As discussed later, in some circumstances inherently lower-polluting processes are appropriate for consideration as available control alternatives. The control alternatives should include not only existing controls for the source category in question, but also*

[71] EPA, Office of Air Quality Planning and Standards. *New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting, Draft*, p B.13. Research Triangle Park, NC. Oct 1990. https://www.epa.gov/sites/production/files/2015-07/documents/1990wman.pdf.

(through technology transfer) controls applied to similar source categories and gas streams, and innovative control technologies. Technologies required under lowest achievable emission rate (LAER) determinations are available for BACT purposes and must also be included as control alternatives and usually represent the top alternative.

The BACT analysis process and its subsequent determinations are made on the information presented in the analysis, including the degree to which control technologies were identified and evaluated. EPA states that potentially applicable control alternatives can be categorized in three ways:

- Inherently Lower-Emitting Processes/Practices, including the use of materials and production processes and work practices that prevent emissions and result in lower "production-specific" emissions.
- Add-on controls, such as scrubbers, fabric filters, thermal oxidizers and other devices that control and reduce emissions after they are produced.
- Combinations of inherently lower emitting processes and add-on controls. For example, the application of combustion and post-combustion controls to reduce NO_X emissions at a gas-fired turbine.

5.4.2 U.S. EPA RACT/BACT/LAER Clearinghouse Review

The RACT/BACT/LAER Clearinghouse (RBLC), a database made available to the public through the EPA's Office of Air Quality Planning and Standards (OAQPS) Technical Air Pollution Resources[72] lists technologies and corresponding emission limits that have been approved by regulatory agencies in permit actions. These technologies are grouped into categories by industry and can be referenced in determining what emissions levels were proposed and approved for similar types of emission units.

Micron conducted a review of the U.S. EPA's RBLC database to identify current control technologies that have been achieved in practice for similar emissions units and source categories in the semiconductor industry. The review was done for a 10-year lookback period. The goal of this effort was to initially identify the emission control technologies and emission levels that were determined by permitting authorities as BACT for emission sources comparable to the proposed sources.

A complete list of RBLC searches performed for comparison to the proposed operations is provided as follows:

- Boilers:
  - Process Type 12.31 – Industrial-Size Boilers – Natural Gas Combustion
  - Process Type 13.31 – Commercial/Institutional-Size Boilers – Natural Gas Combustion
  - Process Type 19.60 – Miscellaneous Combustion – Misc. Boilers, Heaters & Furnaces
  - All Process Types – Process Name Contains "Boilers"

- Water Bath Vaporizers:

[72] EPA, Office of Air Quality Planning and Standards, *Technical Air Pollution Resources*, https://www.epa.gov/technical-air-pollution-resources, Accessed April 2024

- All Process Types – Process Name Contains "Vaporizer"

Note that in Permit Application 1, boilers and water bath vaporizers were addressed as a combined source type in the BACT and LAER analyses. In this application, boilers and water bath vaporizers are separated into two distinct sources for which BACT and LAER limits are considered.

The term "boiler" is defined in 40 CFR 51.123(cc) as "an enclosed fossil- or other-fuel-fired combustion device used to produce heat and to transfer heat to recirculating water, steam, or other medium". The proposed water bath vaporizers are enclosed fossil fuel-fired combustion devices that will produce heat, but the heat will be transferred to a stationary bath of water that will be maintained at a temperature sufficient to vaporize nitrogen. Neither the water nor the nitrogen will be recirculated. In addition, distinct entries in the RBLC were identified specific to water bath vaporizers, indicating that other facilities have treated them separately from boilers.

- Emergency Generator Engines:
  - Process Type 17.11 – Large Internal Combustion Engines (>500HP) – Fuel Oil
  - All Process Types – Process Name Contains "Engine"

- Emergency Fire Pump Engine:
  - Process Type 17.21 – Small Internal Combustion Engines (<500HP) – Fuel Oil

- Manufacturing Processes:
  - Process Type 99.011 – Semiconductor Manufacturing
  - Process Type 99.006 – Electronics Manufacturing (Except 99.011)
  - Process Type 99.013 – Electroplating/Plating (Except chrome)

- Raw Material Storage:
  - Process Type 42.009 – Volatile Organic Liquid Storage
  - Process Type 49.999 – Other Organic Evaporative Loss Sources
  - All Process Types – Process Name Contains "Silo"

- Roadways:
  - Process Type 99.19 – Other Fugitive Dust Sources
  - All Process Types – Process Name Contains "Road"

- Cooling Towers:
  - Process Type 99.003 – Comfort Cooling Towers
  - Process Type 99.009 – Industrial Process Cooling Towers

- Wastewater Treatment Plant
  - Process Type 22.200 – Industrial Wastewater Treatment
  - Process Type 22.900 – Other Wastewater Treatment Processes
  - All Process Types – Process Name Contains "Wastewater"

- Circuit Breakers
  - Process Type 99.999 – Other Miscellaneous Sources

- All Process Types – Process Name Contains "Circuit Breaker"

Tables summarizing the relevant BACT determinations from the RBLC search are provided within the BACT analyses documentation.

5.4.3 Potentially Applicable State BACT Guidelines

Some local regulatory agencies establish their own BACT guidance and standards. These are often utilized as a resource for guiding permit applicants as well as the regulatory agency during the PSD/NNSR permitting process to understand technologically available emission limits, control devices, and techniques to meet BACT or LAER.

As a part of understanding potential control technologies for emission sources at the Proposed Air Permit Project, Micron reviewed such guidelines from other air permitting jurisdictions where semiconductor manufacturing is known to exist. Of those reviewed, it was determined that the Bay Area Air Quality Management District (BAAQMD) has issued representative BACT guidance specific to the semiconductor industry.[73] BACT designated by BAAQMD for semiconductor manufacturing operations planned for the Proposed Air Permit Project were incorporated into the BACT and LAER analysis. Because the BAAQMD has set BACT limits for non-semiconductor specific sources as well (i.e., boilers), all relevant BACT limits and requirements included in the BAAQMD BACT Workbook were included in the BACT and LAER analysis.

Documentation related to the air quality management district's guidance and standards is provided in each pollutant's respective BACT and LAER analyses.

5.4.4 Air Quality Permit Review of Semiconductor Fabs in United States

The U.S. EPA RBLC database provides search results for facilities that have been subject to PSD permitting requirements and is regularly updated to include recent BACT and LAER determinations for facilities. To further evaluate control technologies that have been implemented for other facilities, Micron reviewed the air permits for a representative selection of semiconductor fabs that manufacture 300-mm wafers within the United States to determine which control technologies are currently being utilized to abate emissions.

It should be noted that permits were reviewed for 300-mm semiconductor fabs only because the Proposed Air Permit Project will manufacture only 300-mm wafers. Smaller capacity semiconductor fabs (i.e., 200-mm fabs) within New York State were also reviewed. This search was not conducted nationwide because fabs making smaller wafers operate with much lower exhaust flow rates and have lower emissions, which are not comparable.

Permit limits identified within this permit search for semiconductor manufacturing process equipment, or supporting operations that may have an emission profile that is specific to

[73] Bay Area Air Quality Management District, BACT / TBACT Workbook, Section 7, Electronics and Semiconductor Industry: Semiconductor Manufacturing Operations. https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook, Accessed February 23, 2024. BACT limits published by the BAAQMD can be interpreted as LAER since the San Francisco Bay Area is classified as nonattainment for ozone.

semiconductor manufacturing facilities (i.e., emissions from WWTPs treating industrial wastewater), have been included in the analysis for consideration when evaluating BACT or LAER. However, limits in the permits reviewed for common emission sources that are not affected by semiconductor manufacturing operations (i.e., boiler emissions) have not been included in the analysis as the results from the RBLC searches are representative of appropriate BACT/LAER limits for such emission sources.

5.4.5 Omitted Control Technologies

In the October 1990 *New Source Review Workshop Manual,*[74] EPA discusses which types of technologies should be evaluated as a part of the BACT and LAER analyses, clarifying that technologies that redefine the source or those that have not been demonstrated in practice need not be considered. Additional details regarding these exemptions are provided in the following sections.

5.4.5.1 Technologies That Redefine the Source

To assist in meeting the BACT and LAER limits, the source must consider production processes or available methods, systems or techniques, as long as those considerations do not redefine the source. As stated in the *New Source Review Workshop Manual*, "EPA has not considered the BACT requirement as a means to redefine the design of the source when considering available control alternatives."[75] As such, a different fuel or raw material that would redefine the Proposed Air Permit Project or emission unit are out of the scope of a BACT or LAER analysis. Therefore, these options have not been included as potential control technologies.

5.4.5.2 Technologies That Have Not Been Demonstrated in Practice

EPA has clarified which technologies should be included in the BACT and LAER control technology evaluation, limiting the scope to those that have been demonstrated in practice. As stated in the *New Source Review Workshop Manual:*

> *Technologies which have not yet been applied to (or permitted for) full scale operations need not be considered available; an applicant should be able to purchase or construct a process or control device that has already been demonstrated in practice.*

EPA also clarifies that a control technology is considered "available" if it "has reached the licensing and commercial sales stage of development".[76] While there are control technology developments being researched for semiconductor manufacturing, many of these have not been demonstrated in practice nor reached the stage of commercial sales. Consequently, technologies in the pilot scale

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[74] EPA, Office of Air Quality Planning and Standards. *New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting, Draft*, p B.13. Research Triangle Park, NC. Oct 1990. https://www.epa.gov/sites/production/files/2015-07/documents/1990wman.pdf.
[75] EPA, Office of Air Quality Planning and Standards. *New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting, Draft*, p B.13. Research Triangle Park, NC. Oct 1990. https://www.epa.gov/sites/production/files/2015-07/documents/1990wman.pdf.
[76] EPA, Office of Air Quality Planning and Standards. *New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting, Draft*. Research Triangle Park, NC. Oct 1990. https://www.epa.gov/sites/production/files/2015-07/documents/1990wman.pdf.

testing stages of development would not be considered "available" and were not considered in the BACT and LAER analyses.

6. CONTROL TECHNOLOGY LIMIT SUMMARY

Because the Proposed Air Permit Project is considered to be a major source under the PSD/NNSR programs, the emission sources proposed are subject to BACT- and/or LAER-based limits as described in per 6 NYCRR 231-7.5 and 231-5.3(a). Micron has identified BACT and LAER limitations, including associated numerical limits, as detailed in Section 4 of this application and Appendices H through N.

This Section summarizes the proposed BACT and LAER requirements for each PSD/NNSR pollutant, broken down by emission source groups. The Emission Unit ID, Title V Process ID, and initial Emission Source/Control IDs are provided to clarify the emission sources and equipment to which each limit applies. The Emission Unit Matrix in Appendix Q provides additional details on each source. Only emission sources that emit the specific pollutant are included in each section.

6.1 Nitrogen Oxides

As described in Section 4.1.1 and 4.2.1, the Proposed Air Permit Project is subject to the requirements of both BACT and LAER for emissions of NO_X. The proposed BACT/LAER limitations are summarized in Table 6-1.

Table 6-1. Proposed NO_X Limitations

Source Description	Emission Unit	Title V Process	Emission Source/Control	NO_X BACT/LAER
Natural Gas-fired Boilers	1-CMBOP	BLR	BLR01 – BLR03	9 ppmvd at 3% O_2 Good Combustion and Maintenance Practices Limited to 6,000 hours per year for each boiler
	2-CMBOP	BLR	BLR04 – BLR06	
Natural Gas-fired Water Bath Vaporizers	1-CMBOP	WBV	WBV01 - WBV04	50 lb/MMscf Good Combustion and Maintenance Practices Limited to 8,000 hours per year for all water bath vaporizers combined
	2-CMBOP	WBV	WBV05 – WBV08	

Source Description	Emission Unit	Title V Process	Emission Source/Control	NO_X BACT/LAER
Diesel-fired Emergency Generators	1-CMBOP	EMD	DG001 – DG060	Procure engines that meet Tier 4 Final Emission Standards Good Combustion and Maintenance Practices Limited to 100 hours per year for each engine
	2-CMBOP	EMD	DG061 – DG118	
Diesel-fired Emergency Fire Pump	1-CMBOP	DFP	FP001	Procure engines that meet NSPS IIII/Tier 3 Emission Standards Good Combustion and Maintenance Practices Limited to 500 hours per year
Semiconductor Process Tools and PEECs	1-FABOP	FC1	TFD01	Good Combustion and Maintenance Practices Wet scrubbing of NO_2
	2-FABOP	FC2	TFD02	
	1-FABOP	FA1	PLE01	Good Combustion and Maintenance Practices
		FS1	PHO01	
			WET01	
	2-FABOP	FA2	PLE02	
		FC2	TFD02	
		FS2	PHO02	
			WET02	

As required by 6 NYCRR 231-5.3(a) and 231-7.5(a), all sources of NO_X emissions at the Proposed Air Permit Project will be subject to a combined limit of 374.2 tons per year NO_X emissions, based on

current emissions estimates. Additional details and proposed permit condition language will be included in a forthcoming submission.

6.2 Carbon Monoxide

As described in Section 4.1.1, the Proposed Air Permit Project is subject to BACT for emissions of CO. The proposed CO BACT limitations are summarized in Table 6-2.

Table 6-2. Proposed CO Limitations

Source Description	Emission Unit	Title V Process	Emission Source/Control	CO BACT
Natural Gas-fired Boilers	1-CMBOP	BLR	BLR01 – BLR03	50 ppmvd at 3% O_2 Good Combustion and Maintenance Practices Limited to 6,000 hours per year for each boiler
	2-CMBOP	BLR	BLR04 – BLR06	
Natural Gas-fired Water Bath Vaporizers	1-CMBOP	WBV	WBV01 - WBV04	84 lb/MMscf Good Combustion and Maintenance Practices Limited to 8,000 hours per year for all water bath vaporizers combined
	2-CMBOP	WBV	WBV05 – WBV08	

Source Description	Emission Unit	Title V Process	Emission Source/Control	CO BACT
Diesel-fired Emergency Generators	1-CMBOP	EMD	DG001 – DG060	Procure engines that meet Tier 4 Final Emission Standards Good Combustion and Maintenance Practices Use of ULSD fuel Limited to 100 hours per year for each engine
	2-CMBOP	EMD	DG061 – DG118	
Diesel-fired Emergency Fire Pump	1-CMBOP	DFP	FP001	Procure engines that meet NSPS IIII/Tier 3 Emission Standards Good Combustion and Maintenance Practices Use of ULSD fuel Limited to 500 hours per year
Semiconductor Process Tools and PEECs	1-FABOP	FA1	PLE01	Good Combustion and Maintenance Practices
	2-FABOP	FA2	PLE02	

As required by 6 NYCRR 231-7.5(a), all sources of CO emissions at the Proposed Air Permit Project will be subject to a combined limit of 1,410 tons per year CO emissions, based on current emissions estimates. Additional details and a proposed permit condition language will be included in a forthcoming submission.

6.3 Particulate Matter

As described in Section 4.1.1, the Proposed Air Permit Project is subject to BACT for emissions of PM. The proposed PM LAER limitations are summarized in Table 6-3.

Table 6-3. Proposed PM Limitations

Source Description	Emission Unit	Title V Process	Emission Source/Control	PM BACT
Natural Gas-fired Boilers	1-CMBOP	BLR	BLR01 – BLR03	7.6 lb/MMscf Good Combustion and Maintenance Practices Limited to 6,000 hours per year for each boiler
	2-CMBOP	BLR	BLR04 – BLR06	
Natural Gas-fired Water Bath Vaporizers	1-CMBOP	WBV	WBV01 - WBV04	7.6 lb/MMscf Good Combustion and Maintenance Practices Limited to 8,000 hours per year for all water bath vaporizers combined
	2-CMBOP	WBV	WBV05 – WBV08	
Diesel-fired Emergency Generators	1-CMBOP	EMD	DG001 – DG060	Procure engines that meet Tier 4 Final Emission Standards Good Combustion and Maintenance Practices Use of ULSD fuel Limited to 100 hours per year for each engine
	2-CMBOP	EMD	DG061 – DG118	
Diesel-fired Emergency Fire Pump	1-CMBOP	DFP	FP001	Procure engines that meet NSPS IIII/Tier 3 Emission Standards

Source Description	Emission Unit	Title V Process	Emission Source/Control	PM BACT
				Good Combustion and Maintenance Practices Use of ULSD fuel Limited to 500 hours per year
Semiconductor Process Tools and PEECs	1-FABOP	FC1	TFD01	Use of Ionizing Wet Scrubber for 99% Total PM Reduction
		FA1	PLE01	Use of Mist Eliminators on Acid Scrubbers Good Combustion and Maintenance Practices
			IMP01	
			WET01	
		FB1	PHO01	Use of Mist Eliminators on Ammonia Scrubbers Good Combustion and Maintenance Practices
			CMP01	
		FS1	PHO01	Good Combustion and Maintenance Practices
	2-FABOP	FC2	TFD02	Use of Ionizing Wet Scrubber for 99% Total PM Reduction

Source Description	Emission Unit	Title V Process	Emission Source/Control	PM BACT
		FA2	PLE02	Use of Mist Eliminators on Acid Scrubbers Good Combustion and Maintenance Practices
			IMP02	
			WET02	
		FB2	PHO02	Use of Mist Eliminators on Ammonia Scrubbers Good Combustion and Maintenance Practices
			CMP02	
		FS2	PHO02	Good Combustion and Maintenance Practices
Cooling towers	1-HPMCU	CT1	CT001 – CT105	Drift/Mist eliminators certified to < 0.0005% drift rate Total Dissolved Solids < 1,200 mg/L
		CT1	CT106 – CT111	
	2-HPMCU	CT2	CT112 – CT216	
		CT2	CT217 – CT222	
Bulk Material Storage Silos	1-WWBIO	SL1	SIL001 - SIL02	Fabric Filters certified to 0.005 gr/dscf Good Operating and Maintenance Practices.
	2-WWBIO	SL2	SIL03 – SIL04	

Source Description	Emission Unit	Title V Process	Emission Source/Control	PM BACT
Vehicle Traffic Dust Emissions	--	--	--	Surface Improvements (e.g., Paving) and implementation of Speed Limit(s) Periodic Surface Treatments (i.e., watering) where paving is not feasible.
Wastewater Treatment Process	1-WWBIO	WS1	WWT01	Waste Minimization and Efficient Design
		BG1	BIO01	
	2-WWBIO	WS2	WWT02	
		BG2	BIO02	

As required by 6 NYCRR 231-7.5(a), all sources of particulate matter emissions at the Proposed Air Permit Project will be subject to the following PM limits, based on current emissions estimates. Additional details and proposed permit condition language will be included in a forthcoming submission.

- PM: 77.7 tons per year
- PM_{10}: 67.0 tons per year
- $PM_{2.5}$: 56.0 tons per year

6.4 Volatile Organic Compounds

As described in Section 4.2.1, the Proposed Air Permit Project is subject to LAER for emissions of VOC. The proposed VOC LAER limitations are summarized in Table 6-4.

Table 6-3. Proposed VOC Emission Limits

Source Description	Emission Unit	Title V Process	Emission Source/Control	VOC LAER
Natural Gas-fired Boilers	1-CMBOP	BLR	BLR01 – BLR03	0.0017 lb/MMBtu Good Combustion and Maintenance Practices

Source Description	Emission Unit	Title V Process	Emission Source/Control	VOC LAER
	2-CMBOP	BLR	BLR04 – BLR06	Limited to 6,000 hours per year for each boiler
Natural Gas-fired Water Bath Vaporizers	1-CMBOP	WBV	WBV01 - WBV04	0.0054 lb/MMBtu Good Combustion and Maintenance Practices Limited to 8,000 hours per year for all water bath vaporizers combined
	2-CMBOP	WBV	WBV05 – WBV08	
Diesel-fired Emergency Generators	1-CMBOP	EMD	DG001 – DG060	Procure engines that meet Tier 4 Final Emission Standards Good Combustion and Maintenance Practices Use of ULSD fuel Limited to 100 hours per year for each engine
	2-CMBOP	EMD	DG061 – DG118	
Diesel-fired Emergency Fire Pump	1-CMBOP	DFP	FP001	Procure engines that meet NSPS IIII/Tier 3 Emission Standards Good Combustion and Maintenance Practices Use of ULSD fuel Limited to 500 hours per year
Semiconductor Process Tools, PEECs, and Cleaning Operations	1-FABOP	FA1	PLE01	Compliance with the following DREs and/or concentration-based limits: ► ≥98.5% destruction/recovery
			WET01	
		FC1	TFD01	

Source Description	Emission Unit	Title V Process	Emission Source/Control	VOC LAER
		FB1	PHO01	efficiency if inlet VOC ≥2,000 ppmv; ► ≥97% efficiency if inlet VOC ≥200 to <2,000 ppmv; ► ≥90% efficiency if inlet VOC <200 ppmv; or ► ≤10 parts per ppmv at outlet. ppmv measured as methane.
			CMP01	
		FS1	PHO01	
			WET01	
		FG1	GN001 - GN040	
	2-FABOP	FA2	PLE02	
			WET02	
		FC2	TFD02	
		FB2	PHO02	
			CMP02	
		FS2	PHO02	
			WET02	
		FG2	GN041 - GN080	
	1-HPMCU	HS1	SOD01	
	2-HPMCU	HS2	SOD02	

Source Description	Emission Unit	Title V Process	Emission Source/Control	VOC LAER
Volatile Organic Liquid Storage Tanks	1-HPMCU	HB1	ST054 – ST065	Good Operating and Maintenance Practices Procurement of efficiently designed tanks. Equip tanks with submerged fill device and conservation vent; and apply light colored paint or locate tanks indoors. Achieve ≥95% overall reduction of VOC emissions. Ammonia Scrubber to control TMAH emissions (Process FB1, HB1, FB2, and HB2). RCTO for all other tanks
		HS1	ST066 – ST077	
	2-HPMCU	HB2	ST123 – ST134	
		HS2	ST135 – ST146	
Waste Volatile Organic Liquid Storage Tanks	1-FABOP	FS1	WS001 – WS030	Good Operating and Maintenance Practices Procurement of efficiently designed tanks Nitrogen blanketing, conservation vents, and adequately sized pressure relief valves for organic concentrations of at least 10 percent. Achieve ≥95% overall reduction of VOC emissions.
	2-FABOP	FS2	WS031 – WS030	
	1-WWBIO	WS1	WWT01	

Source Description	Emission Unit	Title V Process	Emission Source/Control	VOC LAER
Wastewater Treatment Process		WA1	WLB01	Waste Minimization and Efficient Design
		BG1	BIO01	
	2-WWBIO	WS2	WWT02	
		WA2	WLB02	
		BG2	BIO02	

As required by 6 NYCRR 231-5.3(a), all sources of VOC emissions at the Proposed Air Permit Project will be subject to the combined limit of 287.7 tons per year VOC emissions, based on current emissions estimates. Additional details and proposed permit condition language will be included in a forthcoming submission.

6.5 Greenhouse Gases

As described in Section 4.1.1, GHG emissions are subject to BACT requirements. The proposed GHG BACT limitations are summarized in Table 6-5.

Table 6-5. Proposed GHG Limitations

Source Description	Emission Unit	Title V Process	Emission Source/ Control	GHG BACT
Natural Gas-fired Boilers	1-CMBOP	BLR	BLR01 – BLR03	Efficient design and combustion practices Limited to 6,000 hours per year for each boiler
	2-CMBOP	BLR	BLR04 – BLR06	
Natural Gas-fired Water Bath Vaporizers	1-CMBOP	WBV	WBV01 - WBV04	Efficient design and combustion practices Limited to 8,000 hours per year for all water bath vaporizers combined
	2-CMBOP	WBV	WBV05 – WBV08	
	1-CMBOP	EMD	DG001 – DG060	Efficient Design and Combustion Practices

Source Description	Emission Unit	Title V Process	Emission Source/ Control	GHG BACT
Diesel-fired Emergency Generators	2-CMBOP	EMD	DG061 – DG118	Limited to 100 hours per year for each engine
Diesel-fired Emergency Fire Pump	1-CMBOP	DFP	FP001	Efficient Design and Combustion Practices Limited to 500 hours per year
Semiconductor Process Tools and PEECs	1-FABOP	FA1	PLE01	Use of thermal oxidation systems that are used to oxidize F-GHGs Meet the default DREs listed in the IPCC's 2019 Revision Table 6.17[77] plasma etch processes by executing the following work-practice standards: ► Obtain POU control device and RCS supplier DRE certification that states each can at a minimum meet default DREs or higher. ► Maintain a site maintenance plan that meets the POU control device and RCS supplier's installation, operation, and maintenance requirements. ► Track uptime of POU control devices and RCS when fab processes are running. DRE is assumed 0% (unless demonstrated otherwise) when POU control device is not running per site maintenance plan while process is running. ► Certify annually that each POU control device and RCS claiming default DRE followed the site maintenance plan.

[77] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6 – Electronics Industry Emissions.

Source Description	Emission Unit	Title V Process	Emission Source/ Control	GHG BACT
			WET01	Good Combustion and Maintenance Practices Utilize GHG raw materials as efficiently as possible, including optimizing tool operating cycles and efficient utilization of process chemicals.
		FC1	TFD01	Good Combustion and Maintenance Practices Use of thermal oxidation systems that are used to oxidize F-GHGs. For cleaning CVD chambers between production cycles, NF_3 will replace the use of carbon-based F-GHGs. Utilize GHG raw materials as efficiently as possible, including optimizing tool operating cycles and efficient utilization of process chemicals.
		FB1	CMP01	Good Combustion and Maintenance Practices
		FS1	WET01	
			PHO01	
		FG1	GN001 – GN040	
	2-FABOP	FA2	PLE02	Use of thermal oxidation systems that are used to oxidize F-GHGs Meet the default DREs listed in the IPCC's 2019 Revision Table 6.17[78] plasma etch processes by executing the following work-practice standards: ► Obtain POU control device and RCS supplier DRE certification that states each

[78] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6 – Electronics Industry Emissions.

Source Description	Emission Unit	Title V Process	Emission Source/ Control	GHG BACT
				can at a minimum meet default DREs or higher. ► Maintain a site maintenance plan that meets the POU control device and RCS supplier's installation, operation, and maintenance requirements. ► Track uptime of POU control devices and RCS when fab processes are running. DRE is assumed 0% (unless demonstrated otherwise) when POU control device is not running per site maintenance plan while process is running. ► Certify annually that each POU control device and RCS claiming default DRE followed the site maintenance plan.
			WET02	Good Combustion and Maintenance Practices Utilize GHG raw materials as efficiently as possible, including optimizing tool operating cycles and efficient utilization of process chemicals.
		FC2	TFD02	Good Combustion and Maintenance Practices Use of thermal oxidation systems that are used to oxidize F-GHGs. For cleaning CVD chambers between production cycles, NF_3 will replace the use of carbon-based F-GHGs.

Source Description	Emission Unit	Title V Process	Emission Source/ Control	GHG BACT
				Utilize GHG raw materials as efficiently as possible, including optimizing tool operating cycles and efficient utilization of process chemicals.
		FB2	CMP02	Good Combustion and Maintenance Practices
		FS2	WET02	
			PHO02	
		FG2	GN041 – GN080	
Use of Heat Transfer Fluids	--	--	--	Good Design and Maintenance Practices, including regular evaluation of consumption records to confirm efficient usage, evaluation of transfer lines and equipment to identify areas of potential inefficient use, and maintenance and repair of those areas.
Circuit Breakers	--	--	--	Leak rate < 0.5% Leak detection system

As required by 6 NYCRR 231-7.5(a), all sources of GHG emissions at the Proposed Air Permit Project will be subject to the combined limit of 1,082,596 tons per year of CO_2e (100-yr GWP), based on current emissions estimates. Additional details and proposed permit condition language will be included in a forthcoming submission.

APPENDIX A. NYSDEC APPLICATION FORMS

New York State Department of Environmental Conservation
Air Permit Application

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

DEC ID	Application ID	Application Type
- -	- - /	☐ State Facility ☑ Title V

Section I - Certification

Certification

I certify under penalty of law that this document and all the attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information required to complete this application, I believe the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Responsible Official Scott Gatzemeier	Title CVP, Front End US Expansion
Signature	Date 10.1.2025

Professional Engineer Certification

I certify under penalty of law that I have personally examined, and am familiar with, the statements and information submitted in this document and all its attachments as they pertain to the practice of engineering. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Professional Engineer Thomas M. Muscenti	NYS License No. 110857
Signature	Date 10/1/25

Section II - Identification Information

Type of Permit Action Requested

☑ New ☐ Renewal ☐ Significant Modification ☐ Administrative Amendment ☐ Minor Modification
☑ Application for the construction of a new facility ☐ Application involves the construction of new emission unit(s)

Facility Information

Name Micron New York Semiconductor Manufacturing LLC
Location Address 5171 RTE 31
☐ City / ☑ Town / ☐ Village Clay — Zip 13041

Owner/Firm Information

Business Taxpayer ID: 9 2 0 6 9 2 5 0 7

Name Micron New York Semiconductor Manufacturing LLC
Street Address 5171 RTE 31

City	State/Province	Country	Zip
Clay	NY	USA	13041

Owner Classification: ☐ Federal ☐ State ☐ Municipal ☑ Corporation/Partnership ☐ Individual

Owner/Firm Contact Information

Name Scott Gatzmeier	Phone (203) 363-4026
E-mail Address sngatzemeier@micron.com	Fax
Affiliation Micron New York Semiconductor Manufacturing LLC	Title CVP, Front End US Expansion
Street Address 5171 RTE 31	

City	State/Province	Country	Zip
Clay	NY	USA	13041

Facility Contact Information

Name Scott Gatzmeier	Phone (203) 363-4026
E-mail Address sngatzemeier@micron.com	Fax
Affiliation Micron New York Semiconductor Manufacturing LLC	Title CVP, Front End US Expansion
Street Address 5171 RTE 31	

City	State/Province	Country	Zip
Clay	NY	USA	13041

New York State Department of Environmental Conservation
Air Permit Application Form

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

DEC ID
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Project Description ☑ Continuation Sheet(s)

SEE CONTINUATION SHEET

Section III - Facility Information

Facility Classification

☐ Hospital ☐ Residential ☐ Educational/Institutional ☐ Commercial ☑ Industrial ☐ Utility

Affected States (Title V Applications Only)

☐ Vermont ☐ Massachusetts ☐ Rhode Island ☐ Pennsylvania ☑ Tribal Land: Cayuga, Oneida
☐ New Hampshire ☐ Connecticut ☐ New Jersey ☐ Ohio ☑ Tribal Land: Onondaga

SIC Code(s)			NAICS Code(s)			
3674			334413			

Facility Description ☑ Continuation Sheet(s)

SEE CONTINUATION SHEET

Compliance Statements (Title V Applications Only)

I certify that as of the date of this application the facility is in compliance with all applicable requirements ☑ Yes ☐ No
If one or more emission units at the facility are not in compliance with all applicable requirements at the time of signing this application (the 'NO' box must be checked), the noncomplying units must be identified in the "Compliance Plan" block on page 8 of this form along with the compliance plan information required. For all emission units at the facility that are operating in compliance with all applicable requirements, complete the following:

☑ This facility will continue to be operated and maintained in such a manner as to assure compliance for the duration of the permit, except those emission units referenced in the compliance plan portion of this application.

☑ For all emission units subject to any applicable requirements that will become effective during the term of the permit, this facility will meet such requirements on a timely basis.

☑ Compliance certification reports will be submitted at least once per year. Each report will certify compliance status with respect to each applicable requirement, and the method used to determine the status.

Facility Applicable Federal Requirements ☑ Continuation Sheet(s)

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause
SEE CONTINUATION SHEET									

Facility State Only Requirements ☑ Continuation Sheet(s)

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause
SEE CONTINUATION SHEET									

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Section II - Identification Information

Project Description (continuation)

Micron New York Semiconductor Manufacturing LLC (Micron), a Delaware limited liability company (LLC) and wholly owned subsidiary of Micron Technology, Inc., is proposing to construct a semiconductor manufacturing campus in the Town of Clay, New York, at the White Pine Commerce Park (WPCP), an approximately 1,400-acre industrial park.

The proposed project will be a major facility under the Title V air permitting Program, a major source of hazardous air pollutants (HAP), and a major new facility under both the Prevention of Significant Deterioration (PSD) and the Non-attainment New Source Review (NNSR) programs. The emission sources at the facility will meet Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) levels of control and emission limits as required. The emission sources at the facility will meet all federal and New York State air emission control regulations.

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Section III - Facility Information

Facility Description (continuation)

The facility will consist of two semiconductor fabrication facilities (referred to as Fab 1 and Fab 2) and associated supporting facilities.

Fab 1 and Fab 2 will manufacture semiconductors and other devices on silicon-based wafers. To remain competitive and meet market demands, Micron will constantly adapt to changing product mix, architecture, and functionality. Both Fab 1 and Fab 2 will generally consist of the following operations which allow independent operation of either fab:

- A main production cleanroom space of approximately 600,000 square feet (sq. ft.) that includes a mix of process tools;
- A sub-fab area that prepares and stores raw materials (e.g., process gases, chemical mixtures/slurries in the liquid state, etc.) used in the fab buildings;
- Support buildings storing bulk raw materials and waste materials and preparing raw materials that are transferred to the fab or sub-fab;
- A central utilities building;
- Bulk gas storage yards;
- An administrative (Admin/Probe) building that includes a quality control laboratory;
- Ancillary support equipment including cooling towers and emergency generators; and,
- Wastewater treatment plant (WWTP) operations, including high fluoride waste treatment and general industrial waste treatment housed in one building (WWT), and biological wastewater treatment housed in its own building (BIO).

This permit is dedicated to the memory of Brian S. Noel, P.E.

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Section III - Facility Information

Facility Applicable Federal Requirements (continuation)

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause
40	CFR	60	A						
40	CFR	63	A						
6	NYCRR	201	6						
6	NYCRR	211	2						
6	NYCRR	212	3.1						
6	NYCRR	257	4						
6	NYCRR	494							
6	NYCRR	495							

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Facility Compliance Certification ☐ Continuation Sheet(s)

Rule Citation

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause

☐ Applicable Federal Requirement
☐ State Only Requirement

☐ Capping

CAS Number	Contaminant Name

Monitoring Information

☐ Work Practice Involving Specific Operations ☐ Ambient Air Monitoring ☐ Record Keeping/Maintenance Procedures

Compliance Activity Description

Work Practice Type Code	Process Material		Reference Test Method
	Code	Description	

Monitored Parameter		Manufacturer's Name/Model Number
Code	Description	

Limit		Limit Units	
Upper	Lower	Code	Description

Averaging Method		Monitoring Frequency		Reporting Requirements	
Code	Description	Code	Description	Code	Description

Facility Emissions Summary ☐ Continuation Sheet(s)

CAS Number	Contaminant Name	Potential to Emit (tons/yr)	Actual Emissions (pounds/yr)
0NY075 - 00 - 5	PM-10	REFER TO APPENDIX F	
0NY750 - 02 - 5	PM-2.5		
007446 - 09 - 5	Sulfur Dioxide		
0NY210 - 00 - 0	Oxides of Nitrogen		
000630 - 08 - 0	Carbon Monoxide		
007439 - 92 - 1	Lead (elemental)		
0NY998 - 00 - 0	Total Volatile Organic Compounds		
0NY100 - 00 - 0	Total Hazardous Air Pollutants		
0NY750 - 00 - 0	Carbon Dioxide Equivalents		

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Section IV - Emission Unit Information

Emission Unit Description ☑ Continuation Sheet(s)

Emission Unit: 1 - F A B O P

Process operations associated with semiconductor manufacturing in Fab 1. Includes process tools, process equipment exhaust conditioners (PEECs), point-of-use (POU) control devices, general fab exhaust, and centralized control devices - acid gas scrubbers, regenerative catalytic systems for greenhouse gas abatement, ionizing wet scrubbers capable of scrubbing nitrogen dioxide, caustic gas scrubbers, and rotor-concentrator thermal oxidizers.

Building Information ☑ Continuation Sheet(s)

Building ID	Building Name	Length (ft)	Width (ft)	Orientation
	Refer to Continuation Sheet			

Emission Unit: -

Emission Unit Emissions Summary ☐ Continuation Sheet(s)

CAS Number	Contaminant Name			
ERP (lbs/yr)	Potential to Emit		Actual Emissions	
	(lbs/hr)	(lbs/yr)	(lbs/hr)	(lbs/yr)
CAS Number	Contaminant Name			
ERP (lbs/yr)	Potential to Emit		Actual Emissions	
	(lbs/hr)	(lbs/yr)	(lbs/hr)	(lbs/yr)
CAS Number	Contaminant Name			
ERP (lbs/yr)	Potential to Emit		Actual Emissions	
	(lbs/hr)	(lbs/yr)	(lbs/hr)	(lbs/yr)
CAS Number	Contaminant Name			
ERP (lbs/yr)	Potential to Emit		Actual Emissions	
	(lbs/hr)	(lbs/yr)	(lbs/hr)	(lbs/yr)

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Section IV - Emission Unit Information

Emission Unit Description (continuation)

Emission Unit: 2-FABOP

Process operations associated with semiconductor manufacturing in Fab 2. Includes process tools, process equipment exhaust conditioners (PEECs), point-of-use (POU) control devices, general fab exhaust, and centralized control devices - acid gas scrubbers, regenerative catalytic systems for greenhouse gas abatement, ionizing wet scrubbers capable of scrubbing nitrogen dioxide, caustic gas scrubbers, and rotor-concentrator thermal oxidizers.

Continuation Sheet 4-1 of 4-10

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	1-CMBOP

Natural gas-fired boilers, natural gas-fired water bath vaporizers, diesel-fired emergency generators, and diesel-fired backup fire pump associated with Fab 1.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	2-CMBOP

Natural gas-fired boilers, natural gas-fired water bath vaporizers, and diesel-fired emergency generators associated with Fab 2.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	1-HPMCU

Storage, waste treatment, and cooling towers in the hazardous process material (HPM) buildings and central utilities building (CUB) supporting Fab 1.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	2-HPMCU

Storage, waste treatment, and cooling towers in the hazardous process material (HPM) buildings and central utilities building (CUB) supporting Fab 2.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	1-WWBIO

Wastewater treatment processes and material storage in the WWT and BIO buildings supporting Fab 1.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	2-WWBIO

Wastewater treatment processes and material storage in the WWT and BIO buildings supporting Fab 2.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	1-ADMPR

Quality assurance laboratories in the administrative and "probe" buildings supporting Fab 1.

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Section IV - Emission Unit Information

Emission Unit Description (continuation)	
Emission Unit	2-ADMPR

Quality assurance laboratories in the administrative and "probe" buildings supporting Fab 2.

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Section IV - Emission Unit Information

Building (continuation)					
Emission Unit	Building ID	Building Name	Length (ft)	Width (ft)	Orientation
	FAB1	Fab1	1913	719	36
	FAB2	Fab2	1913	719	36
	WWT1	WWT1	756	584	126
	WWT2	WWT2	756	584	126
	BIO1	BIO1	245	553	87
	BIO2	BIO2	245	553	87
	ADMIN1	Admin 1	806	223	126
	PROBE1	Probe 1	189	960	126
	PROBE2	Probe 2	189	960	126
	CUB1	CUB 1	1394	327	126
	CUB2	CUB 2	1394	327	126
	ADMIN2	Admin 2	806	223	126
	HPM1-N	HPM 1 North	898	247	36
	HPM1-S	HPM 1 South	898	247	36
	HPM2-N	HPM 2 North	898	247	36
	HPM2-S	HPM 2 South	898	247	36
	MPH1	Mechanical Pump House 1	195	65	35

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Emission Point Information ☐ Continuation Sheet(s)

Emission Point						
Ground Elevation (ft)	Height (ft)	Height Above Structure (ft)	Inside Diameter (in)	Exit Temp. (°F)	Cross Section Length (in)	Cross Section Width (in)
SEE APPENDIX A, TABLE A-1						
Exit Velocity (FPS)	Exit Flow (ACFM)	NYTM (E) (KM)	NYTM (N) (KM)	Building	Distance to Property Line (ft)	Date of Removal

Emission Point						
Ground Elevation (ft)	Height (ft)	Height Above Structure (ft)	Inside Diameter (in)	Exit Temp. (°F)	Cross Section Length (in)	Cross Section Width (in)
Exit Velocity (FPS)	Exit Flow (ACFM)	NYTM (E) (KM)	NYTM (N) (KM)	Building	Distance to Property Line (ft)	Date of Removal

Emission Point						
Ground Elevation (ft)	Height (ft)	Height Above Structure (ft)	Inside Diameter (in)	Exit Temp. (°F)	Cross Section Length (in)	Cross Section Width (in)
Exit Velocity (FPS)	Exit Flow (ACFM)	NYTM (E) (KM)	NYTM (N) (KM)	Building	Distance to Property Line (ft)	Date of Removal

Emission Source/Control Information ☐ Continuation Sheet(s)

Emission Source ID	Emission Source Type	Date of Construction	Date of Operation	Date of Removal	Control Type Code	Control Type Description	Manufacturer's Name/Model Number
SEE APPENDIX A, TABLE A-2							
Design Capacity	Design Capacity Units Code	Design Capacity Units Description			Waste Feed Code	Waste Feed Description	Waste Type Code / Description

Emission Source ID	Emission Source Type	Date of Construction	Date of Operation	Date of Removal	Control Type Code	Control Type Description	Manufacturer's Name/Model Number
Design Capacity	Design Capacity Units Code	Design Capacity Units Description			Waste Feed Code	Waste Feed Description	Waste Type Code / Description

Emission Source ID	Emission Source Type	Date of Construction	Date of Operation	Date of Removal	Control Type Code	Control Type Description	Manufacturer's Name/Model Number
Design Capacity	Design Capacity Units Code	Design Capacity Units Description			Waste Feed Code	Waste Feed Description	Waste Type Code / Description

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Process Information ☐Continuation Sheet(s)

Emission Unit		Process	

Process Description

SEE APPENDIX A, TABLE A-3

Source Classification Code (SCC)	Total Throughput		Throughput Quantity Units	
	Quantity/Hr	Quantity/Yr	Code	Description

☐ Confidential ☐ Operating at Maximum Capacity	Operating Schedule		Building	Floor/Location
	Hours/Day	Days/Year		

Emission Point Identifier(s)

Emission Source/Control Identifier(s)

Emission Unit		Process	

Process Description

Source Classification Code (SCC)	Total Throughput		Throughput Quantity Units	
	Quantity/Hr	Quantity/Yr	Code	Description

☐ Confidential ☐ Operating at Maximum Capacity	Operating Schedule		Building	Floor/Location
	Hours/Day	Days/Year		

Emission Point Identifier(s)

Emission Source/Control Identifier(s)

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Emission Unit	Emission Point	Process	Emission Source	Emission Unit Applicable Federal Requirements							☑ Continuation Sheet(s)		
				Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Cl.	Subcl.
SEE CONTINUATION SHEET													

Emission Unit	Emission Point	Process	Emission Source	Emission Unit State Only Requirements							☑ Continuation Sheet(s)		
				Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Cl.	Subcl.
SEE CONTINUATION SHEET													

Emission Unit Compliance Certification ☐ Continuation Sheet(s)

Rule Citation

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause

☐ Applicable Federal Requirement ☐ State Only Requirement ☐ Capping

Emission Unit	Emission Point	Process	Emission Source	CAS Number	Contaminant Name

Monitoring Information

☐ Continuous Emission Monitoring
☐ Intermittent Emission Testing
☐ Ambient Air Monitoring
☐ Monitoring of a Process or Control Device Parameters as a Surrogate
☐ Work Practice Involving Specific Operations
☐ Record Keeping/Maintenance Procedures

Compliance Activity Description

Detailed condition language will be proposed as an addendum to this Permit Application 2 at a later date.

Work Practice Type Code	Process Material		Reference Test Method
	Code	Description	

Monitored Parameter		Manufacturer's Name/Model Number
Code	Description	

Limit		Limit Units	
Upper	Lower	Code	Description

Averaging Method		Monitoring Frequency		Reporting Requirements	
Code	Description	Code	Description	Code	Description

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Section IV - Emission Unit Information

Emission Unit	Emission Point	Process	Emission Source	Emission Unit Applicable Federal Requirements (continuation)									
				Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Clause	Subcl.
1-CMBOP		BLR, WBV		40	CFR	60	Dc	48	c	a			
1-CMBOP		BLR, WBV		40	CFR	60	Dc	48	c	g			
1-CMBOP		BLR, WBV		40	CFR	60	Dc	48	c	i			
2-CMBOP		BLR, WBV		40	CFR	60	Dc	48	c	a			
2-CMBOP		BLR, WBV		40	CFR	60	Dc	48	c	g			
2-CMBOP		BLR, WBV		40	CFR	60	Dc	48	c	i			
1-CMBOP		EMD, DFP		40	CFR	60	IIII						
2-CMBOP		EMD		40	CFR	60	IIII						
1-CMBOP		EMD, DFP		40	CFR	63	ZZZZ						
2-CMBOP		EMD		40	CFR	63	ZZZZ						
1-FABOP		FA1, FC1, FB1		40	CFR	63	BBBBB	7184	c				
1-FABOP				40	CFR	63	BBBBB	7187					
1-FABOP				40	CFR	63	BBBBB	7188					
1-FABOP				40	CFR	63	BBBBB	7189					
1-FABOP				40	CFR	63	BBBBB	7190					
2-FABOP		FA2, FC2, FB2		40	CFR	63	BBBBB	7184	c				
2-FABOP				40	CFR	63	BBBBB	7187					
2-FABOP				40	CFR	63	BBBBB	7188					
2-FABOP				40	CFR	63	BBBBB	7189					
2-FABOP				40	CFR	63	BBBBB	7190					
1-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7500	e				
1-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7545					
1-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7550					
1-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7555					
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7545					
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7550					
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7555					
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7500	e				
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7545					
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7550					
2-CMBOP		BLR, WBV		40	CFR	63	DDDDD	7555					
1-FABOP		FS1, FG1		40	CFR	63	BBBBB	7184	b				

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Section IV - Emission Unit Information

Emission Unit	Emission Point	Process	Emission Source	Emission Unit Applicable Federal Requirements (continuation)									
				Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Clause	Subcl.
2-FABOP		FS2, FG2		40	CFR	63	BBBBB	7184	b				
1-HPMCU		HA1, HB1, HS1		40	CFR	63	BBBBB	7184	d				
2-HPMCU		HA2, HB2, HS2		40	CFR	63	BBBBB	7184	d				
1-WWBIO		WA1, WB1		40	CFR	63	BBBBB	7184	d				
1-WWBIO	1W008 - 1W010	WS1		40	CFR	63	BBBBB	7184	d				
2-WWBIO		WA2, WB2		40	CFR	63	BBBBB	7184	d				
2-WWBIO	2W008 - 2W010	WS2		40	CFR	63	BBBBB	7184	d				
1-HPMCU		HA1, HB1, HS1		40	CFR	63	BBBBB	7187					
1-HPMCU		HA1, HB1, HS1		40	CFR	63	BBBBB	7188					
1-HPMCU		HA1, HB1, HS1		40	CFR	63	BBBBB	7189					
1-HPMCU		HA1, HB1, HS1		40	CFR	63	BBBBB	7190					
2-HPMCU		HA2, HB2, HS2		40	CFR	63	BBBBB	7187					
2-HPMCU		HA2, HB2, HS2		40	CFR	63	BBBBB	7188					
2-HPMCU		HA2, HB2, HS2		40	CFR	63	BBBBB	7189					
2-HPMCU		HA2, HB2, HS2		40	CFR	63	BBBBB	7190					
1-WWBIO		WA1, WB1		40	CFR	63	BBBBB	7187					
1-WWBIO	1W008 - 1W010	WS1		40	CFR	63	BBBBB	7187					
1-WWBIO		WA1, WB1		40	CFR	63	BBBBB	7188					
1-WWBIO	1W008 - 1W010	WS1		40	CFR	63	BBBBB	7188					
1-WWBIO		WA1, WB1		40	CFR	63	BBBBB	7189					
1-WWBIO	1W008 - 1W010	WS1		40	CFR	63	BBBBB	7189					
1-WWBIO		WA1, WB1		40	CFR	63	BBBBB	7190					
1-WWBIO	1W008 - 1W010	WS1		40	CFR	63	BBBBB	7190					
2-WWBIO		WA2, WB2		40	CFR	63	BBBBB	7187					
2-WWBIO	2W008 - 2W010	WS2		40	CFR	63	BBBBB	7187					
2-WWBIO		WA2, WB2		40	CFR	63	BBBBB	7188					
2-WWBIO	2W008 - 2W010	WS2		40	CFR	63	BBBBB	7188					
2-WWBIO		WA2, WB2		40	CFR	63	BBBBB	7189					
2-WWBIO	2W008 - 2W010	WS2		40	CFR	63	BBBBB	7189					
2-WWBIO		WA2, WB2		40	CFR	63	BBBBB	7190					
2-WWBIO	2W008 - 2W010	WS2		40	CFR	63	BBBBB	7190					

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Section IV - Emission Unit Information

Emission Unit	Emission Point	Process	Emission Source	Emission Unit Applicable Federal Requirements (continuation)									
				Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Clause	Subcl.
1-CMBOP		EMD, DFP		6	NYCRR	225	1.2	d					
1-CMBOP				6	NYCRR	227	1.4						
1-CMBOP				6	NYCRR	227	2						
2-CMBOP		EMD		6	NYCRR	225	1.2	d					
2-CMBOP				6	NYCRR	227	1.4						
2-CMBOP				6	NYCRR	227	2						
1-FABOP			WS001-WS024	6	NYCRR	229	3	e	2	iv			
1-FABOP			WS025-WS030	6	NYCRR	229	3	e	2	v			
2-FABOP			WS031-WS054	6	NYCRR	229	3	e	2	iv			
2-FABOP			WS055-WS060	6	NYCRR	229	3	e	2	v			
1-HPMCU			ST066-ST073	6	NYCRR	229	3	e	2	iv			
1-HPMCU			ST054-ST065; ST074-ST077	6	NYCRR	229	3	e	2	v			
2-HPMCU			ST135-ST142	6	NYCRR	229	3	e	2	iv			
2-HPMCU			ST123-ST134 ST143-ST146	6	NYCRR	229	3	e	2	v			
1-WWBIO			ST080; ST163; ST164; ST182	6	NYCRR	229	3	e	2	v			
2-WWBIO			ST149; ST196; ST197; ST215	6	NYCRR	229	3	e	2	v			
ALL*				6	NYCRR	231	4.1	b	50				
ALL*				6	NYCRR	231	5.1	a	1				
ALL*				6	NYCRR	231	7.1	a	1				
1-FABOP		FA1, FC1, FS1,		6	NYCRR	212	1.4	a					
2-FABOP		FA2, FC2, FS2,		6	NYCRR	212	1.4	a					
1-HPMCU		HS1		6	NYCRR	212	1.4	a					
2-HPMCU		HS2		6	NYCRR	212	1.4	a					
1-WWBIO		BG1		6	NYCRR	212	1.4	a					
2-WWBIO		BG2		6	NYCRR	212	1.4	a					
1-FABOP		FA1, FC1, FB1, FG1		6	NYCRR	212	1.5	e	2				
2-FABOP		FA2, FC2, FB2, FG2		6	NYCRR	212	1.5	e	2				
1-HPMCU		HA1		6	NYCRR	212	1.5	e	2				
2-HPMCU		HA2		6	NYCRR	212	1.5	e	2				
1-WWBIO		WA1, WS1, BG1		6	NYCRR	212	1.5	e	2				
2-WWBIO		WA2, WS2, BG2		6	NYCRR	212	1.5	e	2				
1-FABOP		FA1, FC1, FB1, FC1, FG1		6	NYCRR	212	1.5	f					

Continuation Sheet 8-3 of 8-4

**These citations apply to all EUs that are part of the Proposed Air Permit Project, but do not necessarily apply to all future EUs at the facility.*

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Section IV - Emission Unit Information

Emission Unit	Emission Point	Process	Emission Source	Emission Unit Applicable Federal Requirements (continuation)									
				Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Clause	Subcl.
2-FABOP		FA2, FC2, FB2, FC2, FG2		6	NYCRR	212	1.5	f					
1-HPMCU		HS1		6	NYCRR	212	1.5	f					
2-HPMCU		HS2		6	NYCRR	212	1.5	f					
1-WWBIO		WS1, BG1		6	NYCRR	212	1.5	f					
2-WWBIO		WS2, BG2		6	NYCRR	212	1.5	f					
1-FABOP		FA1, FC1, FB1, FC1		6	NYCRR	212	1.5	g					
2-FABOP		FA2, FC2, FB2, FC2		6	NYCRR	212	1.5	g					
1-HPMCU		HS1		6	NYCRR	212	1.5	g					
2-HPMCU		HS2		6	NYCRR	212	1.5	g					
1-WWBIO		WS1, BG1		6	NYCRR	212	1.5	g					
2-WWBIO		WS2, BG2		6	NYCRR	212	1.5	g					
1-WWBIO		FU1		6	NYCRR	212	1.5	g					
2-WWBIO		FU2		6	NYCRR	212	1.5	g					
1-FABOP		FA1, FS1		6	NYCRR	212	2.3	a					
2-FABOP		FA2, FS2		6	NYCRR	212	2.3	a					
1-WWBIO		BG1		6	NYCRR	212	2.3	a					
2-WWBIO		BG2		6	NYCRR	212	2.3	a					
1-FABOP		FA1, FC1		6	NYCRR	212	2.3	b					
2-FABOP		FA2, FC2		6	NYCRR	212	2.3	b					
1-HPMCU		HA1		6	NYCRR	212	2.3	b					
2-HPMCU		HA2		6	NYCRR	212	2.3	b					
1-WWBIO		WA1		6	NYCRR	212	2.3	b					
2-WWBIO		WA2		6	NYCRR	212	2.3	b					
1-FABOP		FA1, FC1, FS1		6	NYCRR	212	2.4	b	1				
2-FABOP		FA2, FC2, FS2		6	NYCRR	212	2.4	b	1				
1-HPMCU		HS1		6	NYCRR	212	2.4	b	1				
2-HPMCU		HS2		6	NYCRR	212	2.4	b	1				
1-WWBIO		WA1		6	NYCRR	212	2.4	b	1				
2-WWBIO		WA2		6	NYCRR	212	2.4	b	1				
1-WWBIO		FU1		6	NYCRR	212	2.4	b	1				
2-WWBIO		FU2		6	NYCRR	212	2.4	b	1				

Continuation Sheet 8-4 of 8-4

**These citations apply to all EUs that are part of the Proposed Air Permit Project, but do not necessarily apply to all future EUs at the facility.*

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Determination of Non-Applicability (Title V Applications Only) ☐ Continuation Sheet(s)

Rule Citation

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause
6	NYCRR	226	2						

Emission Unit	Emission Point	Process	Emission Source	☑ Applicable Federal Requirement ☐ State Only Requirement
1-FABOP, 2-FABOP				

Non-Applicability Description

Per 6 NYCRR 226-2.1(c)(6), the use of cleaning solvents that are already subject to RACT under Part 212 are exempt from the requirements of Subpart 226-2. The facility is subject to VOC RACT requirements under Part 212, and as such, Micron will comply with RACT through Part 212 rather than Subpart 226-2.

Rule Citation

Title	Type	Part	Subpart	Section	Subdivision	Paragraph	Subparagraph	Clause	Subclause

Emission Unit	Emission Point	Process	Emission Source	☐ Applicable Federal Requirement ☐ State Only Requirement

Non-Applicability Description

Compliance Plan ☐ Continuation Sheet(s)

For any emission units which are <u>not in compliance</u> at the time of permit application, the applicant shall complete the following:

Consent Order		Certified progress reports are to be submitted every 6 months beginning / /

Emission Unit	Process	Emission Source	Applicable Federal Requirements									
			Title	Type	Part	Subpart	Section	Subdiv.	Parag.	Subparag.	Clause	Subcl.

Remedial Measures and Intermediate Milestones	R/I	Date Scheduled

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Request for Emission Reduction Credits ☐ Continuation Sheet(s)

Emission Source

Emission Reduction Description

Contaminant Emission Reduction Data

Baseline Period ____/____/_____ to ____/____/_____

CAS Number	Contaminant Name	Reduction Date	Reduction Method	ERC (lbs/yr) Netting	ERC (lbs/yr) Offset

Facility to Use Future Reduction

Name — Application ID - - /

Location Address

☐ City / ☐ Town/ ☐ Village — State — Zip

Use of Emission Reduction Credits ☐ Continuation Sheet(s)

Emission Source

Proposed Project Description

Emission Reduction Credits will be retired prior to public comment

Contaminant Emissions Increase Data

CAS Number	Contaminant Name	Project Emission Potential (lbs/yr)

Statement of Compliance

☐ All facilities under the ownership of this "owner/firm" are operating in compliance with all applicable requirements and state regulations including any compliance certification requirements under Section 114(a)(3) of the Clean Air Act Amendments of 1990, or are meeting the schedule of a consent order.

Source of Emission Reduction Credit-Facility

Name — Permit ID - - /

Location Address

☐ City / ☐ Town/ ☐ Village — State — Zip

Emission Source	CAS Number	Contaminant Name	ERC (lbs/yr) Netting	ERC (lbs/yr) Offset

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Supporting Documentation and Attachments	
Required Supporting Documentation	**Date of Document**
☑ List of Exempt Activities (attach form)	March 2025
☑ Plot Plan	March 2025
☑ Process Flow Diagram	March 2025
☐ Methods Used to Determine Compliance (attach form)	
☑ Emissions Calculations	March 2025
Optional Supporting Documentation	**Date of Document**
☑ Air Quality Model	March 2025
☑ Confidentiality Justification	March 2025
☐ Ambient Air Quality Monitoring Plan or Reports	
☐ Stack Test Protocol	
☐ Stack Test Report	
☐ Continuous Emissions Monitoring Plan	
☑ Lowest Achievable Emission Rate (LAER) Demonstration	March 2025
☑ Best Available Control Technology (BACT) Demonstration	March 2025
☑ Reasonably Available Control Technology (RACT) Demonstration	March 2025
☐ Toxic Impact Assessment (TIA)	
☐ Environmental Rating Demonstration	
☑ Operational Flexibility Protocol/Description of Alternate Operating Scenarios	March 2025
☐ Title IV Permit Application	
☐ Emission Reduction Credit (ERC) Quantification (attach form)	
☐ Baseline Period Demonstration	
☑ Use of Emission Reduction Credits (attach form)	March 2025
☐ Analysis of Contemporaneous Emissions Increase/Decrease	
Other Supporting Documentation	**Date of Document**
Appendix Q - Emission Unit Matrix	March 2025
Appendix R - Response to Comment	March 2025
Appendix V - Internal Specification Sheets	March 2025
Climate Leadership and Community Protection Act Analysis (w/ DEIS)	March 2025

Table A-1 - Section IV Pg. 5 Emission Point Information

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1F001	AE_1	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6504	4782.844	FAB1	1519
1F002	AE_2	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6394	4782.8292	FAB1	1480
1F003	AE_3	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.633	4782.819	FAB1	1457
1F004	AE_4	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6241	4782.8073	FAB1	1426
1F005	AE_5	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6156	4782.7955	FAB1	1396
1F006	AE_6	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.5558	4782.7124	FAB1	1184
1F007	AE_7	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.543	4782.6944	FAB1	1138
1F008	AE_8	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.5386	4782.6886	FAB1	1122
1F009	AE_9	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.5298	4782.6767	FAB1	1091
1F010	AE_10	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.5174	4782.659	FAB1	1045
1F011	AE_11	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7592	4782.7663	FAB1	1860
1F012	AE_12	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7483	4782.7512	FAB1	1822
1F013	AE_13	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.741	4782.7414	FAB1	1796
1F014	AE_14	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7326	4782.7299	FAB1	1766
1F015	AE_15	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7241	4782.7176	FAB1	1736
1F016	AE_16	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6641	4782.6345	FAB1	1519
1F017	AE_17	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6515	4782.6166	FAB1	1474
1F018	AE_18	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6473	4782.6108	FAB1	1459
1F019	AE_19	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6385	4782.5987	FAB1	1427
1F020	AE_20	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.6257	4782.581	FAB1	1381
1F021	AE_21	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8429	4783.112382	FAB1	2201
1F022	AE_22	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.829939	4783.095056	FAB1	2155
1F023	AE_23	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8221	4783.0824	FAB1	2127
1F024	AE_24	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8177	4783.0765	FAB1	2111
1F025	AE_25	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8046	4783.059	FAB1	2065
1F026	AE_26	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7458	4782.9755	FAB1	1856
1F027	AE_27	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7411	4782.9697	FAB1	1826
1F028	AE_28	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7283	4782.952	FAB1	1795
1F029	AE_29	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7188	4782.9394	FAB1	1761
1F030	AE_30	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.7062	4782.9214	FAB1	1716
1F031	AE_31	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9522	4783.0341	FAB1	2543
1F032	AE_32	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9392	4783.0167	FAB1	2498
1F033	AE_33	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9305	4783.0051	FAB1	2467
1F034	AE_34	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9262	4782.9993	FAB1	2452
1F035	AE_35	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9137	4782.9811	FAB1	2407
1F036	AE_36	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8536	4782.898	FAB1	2195
1F037	AE_37	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.849	4782.8919	FAB1	2164
1F038	AE_38	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.836	4782.8745	FAB1	2133
1F039	AE_39	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8272	4782.8613	FAB1	2101
1F040	AE_40	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.8143	4782.8435	FAB1	2056
1F041	CVD_1	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.5477	4782.7067	FAB1	1163
1F042	CVD_2	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.5465	4782.7053	FAB1	1146
1F043	CVD_3	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.522	4782.671	FAB1	1069
1F044	CVD_4	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.5209	4782.6695	FAB1	1054
1F045	CVD_5	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.6614	4782.6255	FAB1	1512
1F046	CVD_6	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.6603	4782.6238	FAB1	1496
1F047	CVD_7	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.6356	4782.5895	FAB1	1419
1F048	CVD_8	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.6346	4782.5878	FAB1	1404
1F049	CVD_9	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.733	4782.9642	FAB1	1831
1F050	CVD_10	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.7319	4782.9627	FAB1	1800
1F051	CVD_11	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.7107	4782.934	FAB1	1739
1F052	CVD_12	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.7096	4782.932	FAB1	1723
1F053	CVD_13	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.8464	4782.8826	FAB1	2186

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1F054	CVD_14	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.8454	4782.8809	FAB1	2157
1F055	CVD_15	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.8247	4782.852	FAB1	2096
1F056	CVD_16	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.8236	4782.8507	FAB1	2080
1F057	AME_1	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.6445	4782.8407	FAB1	1499
1F058	AME_2	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.64	4782.8348	FAB1	1483
1F059	AME_3	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.6254	4782.8157	FAB1	1432
1F060	AME_4	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.617	4782.803	FAB1	1402
1F061	AME_5	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.7575	4782.7588	FAB1	1854
1F062	AME_6	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.7535	4782.7527	FAB1	1839
1F063	AME_7	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.7396	4782.7336	FAB1	1790
1F064	AME_8	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.7305	4782.721	FAB1	1758
1F065	AME_9	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.8361	4783.1081	FAB1	2177
1F066	AME_10	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.8321	4783.1027	FAB1	2163
1F067	AME_11	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.813	4783.0749	FAB1	2095
1F068	AME_12	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.8063	4783.066	FAB1	2072
1F069	AME_13	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.9499	4783.0264	FAB1	2535
1F070	AME_14	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.9459	4783.0209	FAB1	2521
1F071	AME_15	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.9263	4782.9941	FAB1	2451
1F072	AME_16	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	405.9198	4782.9849	FAB1	2428
1F073	SE_1	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.59	4782.7915	FAB1	1311
1F074	SEA_1	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.6008	4782.7759	FAB1	1345
1F075	SE_2	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5853	4782.7851	FAB1	1295
1F076	SEA_2	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.5963	4782.7695	FAB1	1327
1F077	SE_3	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5805	4782.7788	FAB1	1278
1F078	SEA_3	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.5917	4782.7631	FAB1	1311
1F079	SE_4	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5758	4782.7724	FAB1	1261
1F080	SEA_4	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.587	4782.7565	FAB1	1294
1F081	SE_5	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.571	4782.7661	FAB1	1244
1F082	SEA_5	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.5824	4782.7502	FAB1	1279
1F083	SE_6	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5667	4782.7592	FAB1	1229
1F084	SEA_6	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.5777	4782.7437	FAB1	1262
1F085	SE_7	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5619	4782.7529	FAB1	1212
1F086	SEA_7	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.573	4782.7372	FAB1	1245
1F087	SE_8	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5572	4782.7465	FAB1	1196
1F088	SEA_8	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.5685	4782.7308	FAB1	1228
1F089	SE_9	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.5525	4782.7402	FAB1	1179
1F090	SEA_9	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.5639	4782.7244	FAB1	1212
1F091	SE_10	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7291	4782.6911	FAB1	1746
1F092	SEA_10	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.71	4782.6975	FAB1	1686
1F093	SE_11	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7244	4782.6848	FAB1	1729
1F094	SEA_11	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7053	4782.6911	FAB1	1668
1F095	SE_12	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7196	4782.6784	FAB1	1711
1F096	SEA_12	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7007	4782.6846	FAB1	1651
1F097	SE_13	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7149	4782.6721	FAB1	1695
1F098	SEA_13	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.6959	4782.678	FAB1	1634
1F099	SE_14	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7101	4782.6658	FAB1	1678
1F100	SEA_14	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.6912	4782.6717	FAB1	1617
1F101	SE_15	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7054	4782.6594	FAB1	1661
1F102	SEA_15	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.6869	4782.6653	FAB1	1602
1F103	SE_16	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7006	4782.6531	FAB1	1643
1F104	SEA_16	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.6822	4782.6588	FAB1	1585
1F105	SE_17	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.6963	4782.6463	FAB1	1628
1F106	SEA_17	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.6776	4782.6524	FAB1	1568
1F107	SE_18	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.6921	4782.64	FAB1	1613
1F108	SEA_18	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.673	4782.646	FAB1	1551

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1F109	SE_19	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7808	4783.0554	FAB1	1986
1F110	SEA_19	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7918	4783.0467	FAB1	2021
1F111	SE_20	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7761	4783.0491	FAB1	1970
1F112	SEA_20	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7872	4783.0403	FAB1	2005
1F113	SE_21	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7714	4783.0428	FAB1	1953
1F114	SEA_21	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7827	4783.034	FAB1	1988
1F115	SE_22	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7668	4783.0366	FAB1	1937
1F116	SEA_22	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7781	4783.0277	FAB1	1972
1F117	SE_23	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.762	4783.0303	FAB1	1920
1F118	SEA_23	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7735	4783.0212	FAB1	1955
1F119	SE_24	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7573	4783.024	FAB1	1903
1F120	SEA_24	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7689	4783.0148	FAB1	1939
1F121	SE_25	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7525	4783.0175	FAB1	1886
1F122	SEA_25	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7642	4783.0084	FAB1	1922
1F123	SE_26	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.7477	4783.0112	FAB1	1870
1F124	SEA_26	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.7596	4783.0018	FAB1	1905
1F125	SE_27	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.743	4783.0048	FAB1	1853
1F126	SEA_27	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.755	4782.9954	FAB1	1888
1F127	SE_28	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9182	4782.9568	FAB1	2418
1F128	SEA_28	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.9057	4782.9646	FAB1	2378
1F129	SE_29	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9135	4782.9505	FAB1	2401
1F130	SEA_29	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.901	4782.9584	FAB1	2362
1F131	SE_30	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9088	4782.9442	FAB1	2384
1F132	SEA_30	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.8963	4782.9521	FAB1	2345
1F133	SE_31	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9042	4782.938	FAB1	2368
1F134	SEA_31	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.892	4782.9458	FAB1	2331
1F135	SE_32	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.8998	4782.9311	FAB1	2352
1F136	SEA_32	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.8876	4782.9392	FAB1	2314
1F137	SE_33	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.8951	4782.9248	FAB1	2336
1F138	SEA_33	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.8829	4782.9329	FAB1	2297
1F139	SE_34	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.8903	4782.9183	FAB1	2319
1F140	SEA_34	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.8781	4782.9265	FAB1	2280
1F141	SE_35	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.8856	4782.912	FAB1	2302
1F142	SEA_35	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.8735	4782.92	FAB1	2265
1F143	SE_36	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.8808	4782.9056	FAB1	2285
1F144	SEA_36	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.869	4782.9134	FAB1	2248
1F145	GE_1	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6599	4782.846	FAB1	1550
1F146	GE_2	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6519	4782.8341	FAB1	1522
1F147	GE_3	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6422	4782.8212	FAB1	1488
1F148	GE_4	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6336	4782.8096	FAB1	1457
1F149	GE_5	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6247	4782.7975	FAB1	1426
1F150	GE_6	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6166	4782.7854	FAB1	1397
1F151	GE_7	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.5654	4782.7144	FAB1	1216
1F152	GE_8	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.5565	4782.702	FAB1	1184
1F153	GE_9	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.5397	4782.6785	FAB1	1124
1F154	GE_10	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.5311	4782.6667	FAB1	1092
1F155	GE_11	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7575	4782.7756	FAB1	1857
1F156	GE_12	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.749	4782.764	FAB1	1827
1F157	GE_13	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.74	4782.7509	FAB1	1795
1F158	GE_14	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7314	4782.7391	FAB1	1764
1F159	GE_15	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7226	4782.7269	FAB1	1733
1F160	GE_16	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7143	4782.715	FAB1	1703
1F161	GE_17	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6632	4782.644	FAB1	1519
1F162	GE_18	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6544	4782.6323	FAB1	1487
1F163	GE_19	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6374	4782.6081	FAB1	1426

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1F164	GE_20	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.6291	4782.5966	FAB1	1396
1F165	GE_21	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8396	4783.0964	FAB1	2187
1F166	GE_22	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8313	4783.0843	FAB1	2157
1F167	GE_23	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8141	4783.0607	FAB1	2098
1F168	GE_24	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.806	4783.0485	FAB1	2068
1F169	GE_25	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7459	4782.9649	FAB1	1855
1F170	GE_26	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7375	4782.9533	FAB1	1825
1F171	GE_27	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7278	4782.9407	FAB1	1791
1F172	GE_28	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7198	4782.9287	FAB1	1762
1F173	GE_29	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7151	4782.9224	FAB1	1746
1F174	GE_30	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.7093	4782.9147	FAB1	1725
1F175	GE_31	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.9379	4783.0257	FAB1	2495
1F176	GE_32	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.929	4783.0138	FAB1	2464
1F177	GE_33	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.912	4782.9903	FAB1	2404
1F178	GE_34	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.9031	4782.9785	FAB1	2372
1F179	GE_35	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8435	4782.8947	FAB1	2161
1F180	GE_36	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8357	4782.8833	FAB1	2133
1F181	GE_37	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8254	4782.8709	FAB1	2097
1F182	GE_38	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8172	4782.8585	FAB1	2068
1F183	GE_39	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8127	4782.8525	FAB1	2052
1F184	GE_40	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.8069	4782.8448	FAB1	2032
2F001	AE_1	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1656	4782.4746	FAB2	2003
2F002	AE_2	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1544	4782.4597	FAB2	1942
2F003	AE_3	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1471	4782.449	FAB2	1900
2F004	AE_4	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1392	4782.4373	FAB2	1854
2F005	AE_5	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1304	4782.4258	FAB2	1806
2F006	AE_6	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0709	4782.3425	FAB2	1470
2F007	AE_7	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.058	4782.325	FAB2	1399
2F008	AE_8	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0535	4782.3188	FAB2	1374
2F009	AE_9	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0452	4782.3064	FAB2	1325
2F010	AE_10	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0322	4782.2887	FAB2	1253
2F011	AE_11	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0576	4782.5525	FAB2	2017
2F012	AE_12	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0461	4782.5371	FAB2	1955
2F013	AE_13	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0391	4782.5268	FAB2	1914
2F014	AE_14	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0307	4782.5154	FAB2	1868
2F015	AE_15	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.0221	4782.5033	FAB2	1820
2F016	AE_16	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9623	4782.42	FAB2	1487
2F017	AE_17	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9496	4782.403	FAB2	1419
2F018	AE_18	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.945	4782.3968	FAB2	1394
2F019	AE_19	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.937	4782.3846	FAB2	1346
2F020	AE_20	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	405.9236	4782.3668	FAB2	1275
2F021	AE_21	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.3583	4782.7422	FAB2	2872
2F022	AE_22	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.3453	4782.7248	FAB2	2943
2F023	AE_23	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.3366	4782.7132	FAB2	2967
2F024	AE_24	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.3327	4782.7069	FAB2	2942
2F025	AE_25	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.3202	4782.6889	FAB2	2870
2F026	AE_26	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2597	4782.6061	FAB2	2534
2F027	AE_27	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2555	4782.6001	FAB2	2486
2F028	AE_28	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2426	4782.5823	FAB2	2438
2F029	AE_29	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2337	4782.5692	FAB2	2386
2F030	AE_30	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2205	4782.5516	FAB2	2314
2F031	AE_31	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2493	4782.8202	FAB2	2935
2F032	AE_32	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2363	4782.8028	FAB2	3004
2F033	AE_33	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2277	4782.7913	FAB2	2975
2F034	AE_34	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2241	4782.7849	FAB2	2951

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2F035	AE_35	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.2115	4782.7671	FAB2	2880
2F036	AE_36	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1522	4782.6836	FAB2	2545
2F037	AE_37	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1476	4782.6777	FAB2	2497
2F038	AE_38	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1346	4782.6601	FAB2	2449
2F039	AE_39	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1251	4782.6474	FAB2	2397
2F040	AE_40	400	154.0	6.2	4.2	50.0	72.0	N/A	97.8	80000	406.1125	4782.6295	FAB2	2326
2F041	CVD_1	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.0681	4782.3332	FAB2	1446
2F042	CVD_2	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.067	4782.3315	FAB2	1423
2F043	CVD_3	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.0424	4782.2978	FAB2	1301
2F044	CVD_4	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.0415	4782.2962	FAB2	1279
2F045	CVD_5	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.9543	4782.4145	FAB2	1468
2F046	CVD_6	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.9533	4782.4133	FAB2	1442
2F047	CVD_7	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.9288	4782.379	FAB2	1325
2F048	CVD_8	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	405.9275	4782.3775	FAB2	1300
2F049	CVD_9	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.2529	4782.5907	FAB2	2510
2F050	CVD_10	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.2521	4782.5892	FAB2	2462
2F051	CVD_11	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.2311	4782.5603	FAB2	2361
2F052	CVD_12	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.2301	4782.5589	FAB2	2338
2F053	CVD_13	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.139	4782.6725	FAB2	2521
2F054	CVD_14	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.1379	4782.6709	FAB2	2474
2F055	CVD_15	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.1168	4782.642	FAB2	2374
2F056	CVD_16	400	170.4	22.6	3.1	36.8	72.0	N/A	119.8	53000	406.1161	4782.6406	FAB2	2351
2F057	AME_1	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.1639	4782.467	FAB2	1980
2F058	AME_2	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.1595	4782.4612	FAB2	1956
2F059	AME_3	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.1459	4782.4415	FAB2	1878
2F060	AME_4	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.1373	4782.4293	FAB2	1829
2F061	AME_5	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.0502	4782.5485	FAB2	1994
2F062	AME_6	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.0457	4782.5428	FAB2	1971
2F063	AME_7	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.0322	4782.5235	FAB2	1894
2F064	AME_8	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.0231	4782.511	FAB2	1844
2F065	AME_9	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.3563	4782.7342	FAB2	2896
2F066	AME_10	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.352	4782.729	FAB2	2918
2F067	AME_11	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.3328	4782.7017	FAB2	2929
2F068	AME_12	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.3264	4782.6927	FAB2	2892
2F069	AME_13	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.2426	4782.8155	FAB2	2961
2F070	AME_14	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.2388	4782.8103	FAB2	2982
2F071	AME_15	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.2192	4782.7831	FAB2	2938
2F072	AME_16	400	154.0	6.2	3.0	36.0	72.0	N/A	94.3	40000	406.2127	4782.7746	FAB2	2903
2F073	SE_1	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1354	4782.3993	FAB2	1746
2F074	SEA_1	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1164	4782.4054	FAB2	1725
2F075	SE_2	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1307	4782.393	FAB2	1720
2F076	SEA_2	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1117	4782.399	FAB2	1700
2F077	SE_3	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1259	4782.3866	FAB2	1694
2F078	SEA_3	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1073	4782.3926	FAB2	1673
2F079	SE_4	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1212	4782.3803	FAB2	1668
2F080	SEA_4	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1025	4782.3861	FAB2	1646
2F081	SE_5	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1169	4782.3734	FAB2	1641
2F082	SEA_5	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.0978	4782.3796	FAB2	1620
2F083	SE_6	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1122	4782.3671	FAB2	1615
2F084	SEA_6	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.0932	4782.3728	FAB2	1594
2F085	SE_7	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1074	4782.3607	FAB2	1589
2F086	SEA_7	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.0886	4782.3668	FAB2	1568
2F087	SE_8	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1027	4782.3544	FAB2	1563
2F088	SEA_8	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.084	4782.3604	FAB2	1542
2F089	SE_9	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.0979	4782.348	FAB2	1537

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2F090	SEA_9	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.0792	4782.3537	FAB2	1516
2F091	SE_10	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.996	4782.4996	FAB2	1770
2F092	SEA_10	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.0073	4782.4839	FAB2	1740
2F093	SE_11	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9913	4782.4932	FAB2	1745
2F094	SEA_11	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.0027	4782.4774	FAB2	1714
2F095	SE_12	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9865	4782.4869	FAB2	1719
2F096	SEA_12	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.9978	4782.4708	FAB2	1689
2F097	SE_13	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9818	4782.4805	FAB2	1694
2F098	SEA_13	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.9934	4782.4646	FAB2	1663
2F099	SE_14	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.977	4782.4742	FAB2	1668
2F100	SEA_14	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.9888	4782.4582	FAB2	1638
2F101	SE_15	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.973	4782.4672	FAB2	1642
2F102	SEA_15	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.984	4782.4518	FAB2	1612
2F103	SE_16	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9682	4782.4609	FAB2	1617
2F104	SEA_16	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.9796	4782.4451	FAB2	1586
2F105	SE_17	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9635	4782.4545	FAB2	1591
2F106	SEA_17	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.975	4782.4386	FAB2	1560
2F107	SE_18	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	405.9587	4782.4482	FAB2	1565
2F108	SEA_18	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	405.9703	4782.4323	FAB2	1535
2F109	SE_19	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.3247	4782.6646	FAB2	2815
2F110	SEA_19	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.3121	4782.6728	FAB2	2811
2F111	SE_20	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.32	4782.6584	FAB2	2789
2F112	SEA_20	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.3075	4782.6665	FAB2	2786
2F113	SE_21	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.3153	4782.652	FAB2	2763
2F114	SEA_21	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.3029	4782.6598	FAB2	2760
2F115	SE_22	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.3107	4782.6458	FAB2	2738
2F116	SEA_22	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.2983	4782.6536	FAB2	2734
2F117	SE_23	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.3065	4782.639	FAB2	2712
2F118	SEA_23	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.2938	4782.6474	FAB2	2708
2F119	SE_24	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.3018	4782.6327	FAB2	2686
2F120	SEA_24	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.2893	4782.641	FAB2	2683
2F121	SE_25	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.297	4782.6263	FAB2	2660
2F122	SEA_25	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.2845	4782.6344	FAB2	2656
2F123	SE_26	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.2922	4782.6199	FAB2	2634
2F124	SEA_26	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.2798	4782.6278	FAB2	2630
2F125	SE_27	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.2875	4782.6136	FAB2	2608
2F126	SEA_27	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.2751	4782.6214	FAB2	2604
2F127	SE_28	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.187	4782.7636	FAB2	2829
2F128	SEA_28	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1984	4782.7545	FAB2	2822
2F129	SE_29	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1823	4782.7573	FAB2	2804
2F130	SEA_29	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1937	4782.7482	FAB2	2796
2F131	SE_30	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1776	4782.7506	FAB2	2777
2F132	SEA_30	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1889	4782.7419	FAB2	2771
2F133	SE_31	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1733	4782.7443	FAB2	2752
2F134	SEA_31	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1845	4782.7354	FAB2	2745
2F135	SE_32	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1686	4782.738	FAB2	2726
2F136	SEA_32	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1798	4782.729	FAB2	2719
2F137	SE_33	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1639	4782.7317	FAB2	2701
2F138	SEA_33	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1751	4782.7228	FAB2	2694
2F139	SE_34	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1596	4782.7251	FAB2	2675
2F140	SEA_34	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1706	4782.7162	FAB2	2667
2F141	SE_35	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1548	4782.7187	FAB2	2649
2F142	SEA_35	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1659	4782.7096	FAB2	2641
2F143	SE_36	400	154.0	6.2	3.3	40.0	72.0	N/A	95.5	50000	406.1501	4782.7124	FAB2	2623
2F144	SEA_36	400	154.0	6.2	0.8	10.0	600.0	N/A	76.4	2500	406.1612	4782.7032	FAB2	2615

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2F145	GE_1	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1642	4782.4837	FAB2	2025
2F146	GE_2	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1556	4782.4723	FAB2	1978
2F147	GE_3	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1468	4782.4587	FAB2	1925
2F148	GE_4	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1375	4782.4471	FAB2	1876
2F149	GE_5	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1289	4782.4352	FAB2	1828
2F150	GE_6	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.121	4782.423	FAB2	1780
2F151	GE_7	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0699	4782.3516	FAB2	1492
2F152	GE_8	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0611	4782.3397	FAB2	1444
2F153	GE_9	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0438	4782.3165	FAB2	1346
2F154	GE_10	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0348	4782.3045	FAB2	1300
2F155	GE_11	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0663	4782.5536	FAB2	2035
2F156	GE_12	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0578	4782.542	FAB2	1988
2F157	GE_13	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.048	4782.5292	FAB2	1935
2F158	GE_14	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0396	4782.518	FAB2	1890
2F159	GE_15	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0312	4782.5055	FAB2	1841
2F160	GE_16	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.0225	4782.4932	FAB2	1791
2F161	GE_17	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.9719	4782.4221	FAB2	1508
2F162	GE_18	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.9631	4782.4104	FAB2	1460
2F163	GE_19	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.9461	4782.3861	FAB2	1364
2F164	GE_20	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	405.9377	4782.3748	FAB2	1319
2F165	GE_21	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.3442	4782.7334	FAB2	2923
2F166	GE_22	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.3353	4782.7216	FAB2	2972
2F167	GE_23	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.3184	4782.6988	FAB2	2893
2F168	GE_24	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.3096	4782.6863	FAB2	2843
2F169	GE_25	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2497	4782.6031	FAB2	2507
2F170	GE_26	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2415	4782.591	FAB2	2459
2F171	GE_27	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2323	4782.5783	FAB2	2407
2F172	GE_28	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2235	4782.5669	FAB2	2360
2F173	GE_29	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2187	4782.5605	FAB2	2334
2F174	GE_30	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2138	4782.5526	FAB2	2303
2F175	GE_31	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2458	4782.8039	FAB2	2979
2F176	GE_32	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2378	4782.7923	FAB2	2995
2F177	GE_33	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.2205	4782.7691	FAB2	2900
2F178	GE_34	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.212	4782.7564	FAB2	2850
2F179	GE_35	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1517	4782.673	FAB2	2514
2F180	GE_36	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1437	4782.6614	FAB2	2468
2F181	GE_37	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1341	4782.6488	FAB2	2416
2F182	GE_38	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1261	4782.637	FAB2	2370
2F183	GE_39	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1212	4782.6304	FAB2	2343
2F184	GE_40	400	154.0	6.2	3.5	42.0	72.0	N/A	95.3	55000	406.1159	4782.6232	FAB2	2314
1U001	BEX1	400	71.0	2.0	2.0	24.0	400.0	N/A	119.4	22507	405.5478	4782.8401	CUB1	1183
1U002	BEX2	400	71.0	2.0	2.0	24.0	400.0	N/A	119.4	22507	405.5414	4782.8311	CUB1	1160
1U003	BEX3	400	71.0	2.0	2.0	24.0	400.0	N/A	119.4	22507	405.5364	4782.8242	CUB1	1140
1U004	WBV_1	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.1291	4783.2778	N/A-Outside	2066
1U005	WBV_2	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.1365	4783.2725	N/A-Outside	2084
1U006	WBV_3	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.1759	4783.2442	N/A-Outside	2184
1U007	WBV_4	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.1795	4783.2412	N/A-Outside	2195
1U008	GEN_1	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.509	4782.9512	CUB1	1080
1U009	GEN_2	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5079	4782.9498	CUB1	1072
1U010	GEN_3	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5069	4782.9483	CUB1	1058
1U011	GEN_4	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5025	4782.9423	CUB1	1048
1U012	GEN_5	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5015	4782.9409	CUB1	1034
1U013	GEN_6	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5005	4782.9395	CUB1	1026
1U014	GEN_7	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4897	4782.9245	CUB1	1012
1U015	GEN_8	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4886	4782.923	CUB1	1004

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1U016	GEN_9	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4876	4782.9216	CUB1	988
1U017	GEN_10	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4789	4782.9096	CUB1	979
1U018	GEN_11	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4781	4782.9082	CUB1	965
1U019	GEN_12	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4769	4782.9068	CUB1	956
1U020	GEN_13	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4701	4782.8972	CUB1	944
1U021	GEN_14	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4692	4782.8957	CUB1	935
1U022	GEN_15	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4681	4782.8944	CUB1	921
1U023	GEN_16	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.4588	4782.8813	CUB1	912
1U024	GEN_17	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.4577	4782.88	CUB1	894
1U025	GEN_18	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.4501	4782.8695	CUB1	868
1U026	GEN_19	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.4492	4782.8681	CUB1	864
1U027	GEN_20	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.4438	4782.8606	CUB1	1444
1U028	GEN_21	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.4428	4782.8593	CUB1	1435
1U029	GEN_22	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4373	4782.8518	CUB1	1421
1U030	GEN_23	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4364	4782.8503	CUB1	1413
1U031	GEN_24	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.4355	4782.849	CUB1	1400
1U032	GEN_25	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.6266	4783.115	CUB1	1392
1U033	GEN_26	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.6256	4783.1136	CUB1	1376
1U034	GEN_27	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.6214	4783.1076	CUB1	1367
1U035	GEN_28	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.6204	4783.1063	CUB1	1353
1U036	GEN_29	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.6117	4783.0944	CUB1	1345
1U037	GEN_30	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.6107	4783.0929	CUB1	1331
1U038	GEN_31	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.6098	4783.0915	CUB1	1322
1U039	GEN_32	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.6014	4783.08	CUB1	1308
1U040	GEN_33	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.6005	4783.0785	CUB1	1299
1U041	GEN_34	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5994	4783.0771	CUB1	1284
1U042	GEN_35	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5925	4783.0676	CUB1	1276
1U043	GEN_36	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5915	4783.0662	CUB1	1262
1U044	GEN_37	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5905	4783.0648	CUB1	1253
1U045	GEN_38	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5821	4783.0532	CUB1	1238
1U046	GEN_39	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5811	4783.0519	CUB1	850
1U047	GEN_40	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5803	4783.0503	CUB1	841
1U048	GEN_41	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5733	4783.0408	CUB1	827
1U049	GEN_42	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5723	4783.0394	CUB1	818
1U050	GEN_43	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5713	4783.038	CUB1	805
1U051	GEN_44	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5627	4783.026	CUB1	1512
1U052	GEN_45	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5616	4783.0245	CUB1	1503
1U053	GEN_46	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	405.5606	4783.0231	CUB1	1489
1U054	GEN_47	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.5552	4783.0156	CUB1	1474
1U055	GEN_48	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	405.5542	4783.0142	CUB1	1449
1U056	GEN_49	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.8506	4782.6906	N/A-Outside	2127
1U057	GEN_50	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.8555	4782.687	N/A-Outside	2123
1U058	GEN_51	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.9178	4782.7843	N/A-Outside	2383
1U059	GEN_52	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.9228	4782.7811	N/A-Outside	2399
1U060	GEN_53	400	27.5	N/A	1.7	20.0	877.0	N/A	150.2	19662	405.4435	4783.688	N/A-Outside	539
1U061	GEN_54	400	11.3	N/A	0.7	8.0	873.0	N/A	331.8	6950	406.049	4783.1277	N/A-Outside	2543
1U062	GEN_55	400	11.3	N/A	0.7	8.0	873.0	N/A	331.8	6950	406.1066	4783.2109	N/A-Outside	2283
1U063	GEN_56	400	124.0	24.0	2.0	24.0	973.3	N/A	42.8	8065.3	405.643	4782.5324	PROBE1	1423
1U064	GEN_57	400	124.0	24.0	2.0	24.0	973.3	N/A	42.8	8065.3	405.6343	4782.5388	PROBE1	1400
1U065	GEN_58	400	124.0	24.0	2.0	24.0	973.3	N/A	42.8	8065.3	405.6254	4782.5452	PROBE1	1372
1U066	GEN_59	400	27.5	N/A	1.7	20.0	877.0	N/A	150.2	19662	405.5169	4783.7233	N/A-Outside	499
1U067	GEN_60	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.5142	4783.7785	N/A-Outside	317
1FP01	FWP_01	400	26.0	10.0	0.7	8.0	865.0	N/A	56.6	1186	405.7561	4783.3377	MPH1	1803
2U001	BEX1	400	71.0	2.0	2.0	24.0	400.0	N/A	119.4	22507	406.1945	4782.3753	CUB2	1795
2U002	BEX2	400	71.0	2.0	2.0	24.0	400.0	N/A	119.4	22507	406.1881	4782.3663	CUB2	1758

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2U003	BEX3	400	71.0	2.0	2.0	24.0	400.0	N/A	119.4	22507	406.183	4782.3594	CUB2	1729
2U004	WBV_1	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.8117	4783.1144	N/A-Outside	1051
2U005	WBV_2	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.8192	4783.1095	N/A-Outside	1059
2U006	WBV_3	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.8583	4783.0811	N/A-Outside	1120
2U007	WBV_4	400	17.0	N/A	3.2	38.0	750.0	N/A	47.6	22507	406.862	4783.0781	N/A-Outside	1127
2U008	GEN_1	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3122	4782.3739	CUB2	2026
2U009	GEN_2	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3111	4782.3725	CUB2	2013
2U010	GEN_3	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3102	4782.3711	CUB2	1990
2U011	GEN_4	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3058	4782.365	CUB2	1977
2U012	GEN_5	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3048	4782.3637	CUB2	1954
2U013	GEN_6	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3038	4782.3623	CUB2	1941
2U014	GEN_7	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.293	4782.3472	CUB2	1918
2U015	GEN_8	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.292	4782.3458	CUB2	1904
2U016	GEN_9	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2909	4782.3444	CUB2	1881
2U017	GEN_10	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2823	4782.3325	CUB2	1866
2U018	GEN_11	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2813	4782.331	CUB2	1844
2U019	GEN_12	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2803	4782.3295	CUB2	1831
2U020	GEN_13	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2734	4782.32	CUB2	1808
2U021	GEN_14	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2723	4782.3186	CUB2	1795
2U022	GEN_15	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2714	4782.3172	CUB2	1772
2U023	GEN_16	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2621	4782.3042	CUB2	1758
2U024	GEN_17	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.261	4782.3028	CUB2	1731
2U025	GEN_18	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.26	4782.3013	CUB2	1706
2U026	GEN_19	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2496	4782.2868	CUB2	1666
2U027	GEN_20	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2486	4782.2854	CUB2	2604
2U028	GEN_21	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2475	4782.284	CUB2	2590
2U029	GEN_22	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2407	4782.2744	CUB2	2568
2U030	GEN_23	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2397	4782.2731	CUB2	2554
2U031	GEN_24	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.2386	4782.2717	CUB2	2534
2U032	GEN_25	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	406.4299	4782.5378	CUB2	2520
2U033	GEN_26	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	406.429	4782.5365	CUB2	2496
2U034	GEN_27	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	406.4214	4782.5259	CUB2	2482
2U035	GEN_28	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	406.4204	4782.5246	CUB2	2461
2U036	GEN_29	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	406.4164	4782.519	CUB2	2447
2U037	GEN_30	400	69.0	0.0	2.4	28.3	973.3	N/A	150.2	39324	406.4154	4782.5177	CUB2	2424
2U038	GEN_31	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.4086	4782.5081	CUB2	2411
2U039	GEN_32	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.4075	4782.5067	CUB2	2388
2U040	GEN_33	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.4065	4782.5054	CUB2	2374
2U041	GEN_34	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3982	4782.4937	CUB2	2350
2U042	GEN_35	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3972	4782.4924	CUB2	2336
2U043	GEN_36	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3963	4782.4908	CUB2	2314
2U044	GEN_37	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3894	4782.4813	CUB2	2300
2U045	GEN_38	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3883	4782.4799	CUB2	2279
2U046	GEN_39	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3874	4782.4785	CUB2	1660
2U047	GEN_40	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3791	4782.467	CUB2	1647
2U048	GEN_41	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3781	4782.4656	CUB2	1624
2U049	GEN_42	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.377	4782.4642	CUB2	1611
2U050	GEN_43	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3699	4782.4541	CUB2	1588
2U051	GEN_44	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3688	4782.4527	CUB2	2712
2U052	GEN_45	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3678	4782.4514	CUB2	2699
2U053	GEN_46	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3595	4782.4398	CUB2	2676
2U054	GEN_47	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3585	4782.4383	CUB2	2634
2U055	GEN_48	400	69.0	0.0	2.9	34.6	973.3	N/A	150.2	58986	406.3575	4782.437	CUB2	2628
2U056	GEN_49	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.9561	4782.6145	N/A-Outside	2052
2U057	GEN_50	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	405.9512	4782.6181	N/A-Outside	2056

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2U058	GEN_51	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	406.0237	4782.7082	N/A-Outside	2426
2U059	GEN_52	400	27.5	N/A	1.7	20.0	973.3	N/A	150.2	19662	406.0189	4782.7118	N/A-Outside	2429
2U060	GEN_53	400	27.5	N/A	1.7	20.0	877.0	N/A	150.2	19662	405.6741	4783.69	N/A-Outside	596
2U061	GEN_54	400	11.3	N/A	0.7	8.0	873.0	N/A	331.8	6950	406.7309	4782.9648	N/A-Outside	1604
2U062	GEN_55	400	11.3	N/A	0.7	8.0	873.0	N/A	331.8	6950	406.7893	4783.0474	N/A-Outside	1283
2U063	GEN_56	400	124.0	24.0	2.0	24.0	973.3	N/A	42.8	8065.3	405.8646	4782.3734	PROBE1	1209
2U064	GEN_57	400	124.0	24.0	2.0	24.0	973.3	N/A	42.8	8065.3	405.8733	4782.367	PROBE1	1204
2U065	GEN_58	400	124.0	24.0	2.0	24.0	973.3	N/A	42.8	8065.3	405.8819	4782.3604	PROBE1	1196
1H001	AE_41	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.7836	4782.672	HPM1	1920
1H002	AE_42	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.7808	4782.6682	HPM1	1910
1H003	AE_43	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.7777	4782.6642	HPM1	1898
1H004	AE_44	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.7749	4782.6604	HPM1	1888
1H005	AE_45	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9225	4782.8657	HPM1	2414
1H006	AE_46	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9199	4782.862	HPM1	2405
1H007	AE_47	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9165	4782.8574	HPM1	2393
1H008	AE_48	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9137	4782.8537	HPM1	2383
1C001	AE_49	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	405.5658	4783.0224	CUB1	1279
1C002	AE_50	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	405.562	4783.017	CUB1	1264
1C003	AE_57	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	405.5343	4782.9784	CUB1	1163
1C004	AE_58	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	405.5304	4782.9729	CUB1	1152
1H009	AME_17	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.7411	4782.6177	HPM1	1768
1H010	AME_18	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.7383	4782.6139	HPM1	1757
1H011	AME_19	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.7355	4782.6101	HPM1	1747
1H012	AME_20	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.7328	4782.6063	HPM1	1733
1H013	AME_21	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9601	4782.9229	HPM1	2548
1H014	AME_22	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9575	4782.919	HPM1	2539
1H015	AME_23	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9547	4782.9152	HPM1	2529
1H016	AME_24	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9519	4782.9114	HPM1	2519
1H017	SE_37	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.8391	4782.6956	HPM1	2107
1H018	SEA_37	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.8092	4782.7081	HPM1	2013
1H019	SE_38	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.8378	4782.6933	HPM1	2102
1H020	SEA_38	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.8041	4782.7007	HPM1	1994
1H021	SE_39	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.8274	4782.68	HPM1	2065
1H022	SEA_39	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.7989	4782.6937	HPM1	1975
1H023	SE_40	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.8267	4782.6777	HPM1	2057
1H024	SEA_40	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.7937	4782.6864	HPM1	1955
1H025	SE_41	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.9221	4782.8114	HPM1	2403
1H026	SEA_41	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.9039	4782.8398	HPM1	2349
1H027	SE_42	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.9207	4782.8096	HPM1	2398
1H028	SEA_42	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.8987	4782.8325	HPM1	2330
1H029	SE_43	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.911	4782.7954	HPM1	2363
1H030	SEA_43	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.8935	4782.8252	HPM1	2312
1H031	SE_44	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.9097	4782.7936	HPM1	2359
1H032	SEA_44	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.8881	4782.8181	HPM1	2293
1D001	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
1D002	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
1D003	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
1D004	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
1C005	CT_1	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.4823	4782.8592	CUB1	971
1C006	CT_2	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.4876	4782.8663	CUB1	990
1C007	CT_3	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.4918	4782.8718	CUB1	1005
1C008	CT_4	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.496	4782.8775	CUB1	1020
1C009	CT_5	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5012	4782.8846	CUB1	1038
1C010	CT_6	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5055	4782.8901	CUB1	1053
1C011	CT_7	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5097	4782.8972	CUB1	1069

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1C012	CT_8	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5274	4782.9212	CUB1	1131
1C013	CT_9	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5314	4782.9276	CUB1	1145
1C014	CT_10	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5356	4782.9332	CUB1	1160
1C015	CT_11	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5409	4782.9402	CUB1	1179
1C016	CT_12	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.545	4782.9459	CUB1	1194
1C017	CT_13	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5492	4782.9517	CUB1	1208
1C018	CT_14	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5529	4782.9597	CUB1	1221
1C019	CT_15	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5572	4782.9649	CUB1	1237
1C020	CT_16	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.4969	4782.8482	CUB1	1017
1C021	CT_17	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5022	4782.8552	CUB1	1036
1C022	CT_18	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5065	4782.8608	CUB1	1051
1C023	CT_19	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5107	4782.8663	CUB1	1066
1C024	CT_20	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5159	4782.8736	CUB1	1085
1C025	CT_21	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5201	4782.8792	CUB1	1099
1C026	CT_22	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5243	4782.8848	CUB1	1114
1C027	CT_23	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5219	4782.9142	CUB1	1111
1C028	CT_24	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5338	4782.8974	CUB1	1148
1C029	CT_25	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.538	4782.9032	CUB1	1162
1C030	CT_26	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5418	4782.9111	CUB1	1176
1C031	CT_27	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.546	4782.9168	CUB1	1191
1C032	CT_28	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5502	4782.9222	CUB1	1206
1C033	CT_29	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5547	4782.9295	CUB1	1222
1C034	CT_30	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5597	4782.935	CUB1	1239
1C035	CT_31	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5638	4782.9407	CUB1	1254
1C036	CT_32	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5675	4782.9486	CUB1	1268
1C037	CT_33	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5717	4782.9545	CUB1	1282
1C038	CT_34	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5116	4782.8372	CUB1	1063
1C039	CT_35	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5169	4782.8443	CUB1	1082
1C040	CT_36	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.521	4782.8502	CUB1	1097
1C041	CT_37	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5253	4782.8555	CUB1	1111
1C042	CT_38	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5306	4782.8625	CUB1	1130
1C043	CT_39	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5348	4782.8682	CUB1	1145
1C044	CT_40	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.539	4782.8736	CUB1	1160
1C045	CT_41	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5178	4782.9081	CUB1	1097
1C046	CT_42	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5484	4782.8866	CUB1	1193
1C047	CT_43	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5526	4782.8922	CUB1	1208
1C048	CT_44	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5564	4782.9001	CUB1	1222
1C049	CT_45	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5606	4782.9058	CUB1	1237
1C050	CT_46	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5648	4782.9113	CUB1	1251
1C051	CT_47	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5701	4782.9185	CUB1	1270
1C052	CT_48	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5743	4782.924	CUB1	1285
1C053	CT_49	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5785	4782.9297	CUB1	1300
1C054	CT_50	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5822	4782.9377	CUB1	1313
1C055	CT_51	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5864	4782.9432	CUB1	1328
1C056	CT_52	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5613	4782.9708	CUB1	1251
1C057	CT_53	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5665	4782.9781	CUB1	1270
1C058	CT_54	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5709	4782.9833	CUB1	1285
1C059	CT_55	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.575	4782.9891	CUB1	1300
1C060	CT_56	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5941	4783.014	CUB1	1367
1C061	CT_57	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5983	4783.0196	CUB1	1382
1C062	CT_58	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6024	4783.0257	CUB1	1397
1C063	CT_59	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6077	4783.0327	CUB1	1415
1C064	CT_60	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6118	4783.0385	CUB1	1430
1C065	CT_61	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.616	4783.0442	CUB1	1444
1C066	CT_62	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6214	4783.0507	CUB1	1464

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
1C067	CT_63	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6256	4783.0565	CUB1	1478
1C068	CT_64	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6297	4783.0623	CUB1	1493
1C069	CT_65	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.635	4783.0693	CUB1	1511
1C070	CT_66	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6392	4783.075	CUB1	1526
1C071	CT_67	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6434	4783.0805	CUB1	1541
1C072	CT_68	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5759	4782.96	CUB1	1297
1C073	CT_69	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5813	4782.9669	CUB1	1316
1C074	CT_70	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5854	4782.9728	CUB1	1331
1C075	CT_71	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5895	4782.9785	CUB1	1346
1C076	CT_72	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5949	4782.9853	CUB1	1364
1C077	CT_73	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5991	4782.991	CUB1	1379
1C078	CT_74	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5809	4782.9952	CUB1	1320
1C079	CT_75	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6085	4783.0037	CUB1	1412
1C080	CT_76	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6129	4783.0089	CUB1	1427
1C081	CT_77	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.617	4783.0147	CUB1	1442
1C082	CT_78	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6222	4783.022	CUB1	1460
1C083	CT_79	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6265	4783.0276	CUB1	1476
1C084	CT_80	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6306	4783.0332	CUB1	1490
1C085	CT_81	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.636	4783.0401	CUB1	1509
1C086	CT_82	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6402	4783.0456	CUB1	1524
1C087	CT_83	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6444	4783.0512	CUB1	1539
1C088	CT_84	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6496	4783.0586	CUB1	1557
1C089	CT_85	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6539	4783.0637	CUB1	1572
1C090	CT_86	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.658	4783.0697	CUB1	1587
1C091	CT_87	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5906	4782.9488	CUB1	1343
1C092	CT_88	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5975	4782.9558	CUB1	1367
1C093	CT_89	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6001	4782.9615	CUB1	1376
1C094	CT_90	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6041	4782.9678	CUB1	1391
1C095	CT_91	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6096	4782.974	CUB1	1410
1C096	CT_92	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6137	4782.9801	CUB1	1425
1C097	CT_93	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.5848	4783.0008	CUB1	1334
1C098	CT_94	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6231	4782.9933	CUB1	1458
1C099	CT_95	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6275	4782.9979	CUB1	1473
1C100	CT_96	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6316	4783.0039	CUB1	1488
1C101	CT_97	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6369	4783.0109	CUB1	1506
1C102	CT_98	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6411	4783.0165	CUB1	1521
1C103	CT_99	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6454	4783.022	CUB1	1536
1C104	CT_100	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6507	4783.029	CUB1	1555
1C105	CT_101	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6548	4783.0347	CUB1	1570
1C106	CT_102	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.659	4783.0403	CUB1	1584
1C107	CT_103	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6643	4783.0474	CUB1	1603
1C108	CT_104	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6684	4783.0531	CUB1	1618
1C109	CT_105	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	405.6726	4783.0588	CUB1	1633
1G001	CT_106	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.1256	4783.2562	N/A-Outside	2136
1G002	CT_107	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.1179	4783.2461	N/A-Outside	2168
1G003	CT_108	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.1102	4783.236	N/A-Outside	2199
1G004	CT_109	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.0694	4783.1809	N/A-Outside	2373
1G005	CT_110	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.0617	4783.1708	N/A-Outside	2404
1G006	CT_111	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.0555	4783.1607	N/A-Outside	2437
2H001	AE_41	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9603	4782.5448	HPM2	1853
2H002	AE_42	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9575	4782.5411	HPM2	1838
2H003	AE_43	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9544	4782.537	HPM2	1821
2H004	AE_44	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	405.9516	4782.5332	HPM2	1806
2H005	AE_45	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	406.0991	4782.7386	HPM2	2624
2H006	AE_46	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	406.0963	4782.7349	HPM2	2609

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2H007	AE_47	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	406.0933	4782.7307	HPM2	2592
2H008	AE_48	400	101.3	45.3	3.5	42.0	72.0	N/A	63.2	36500	406.0904	4782.727	HPM2	2577
2C001	AE_49	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	406.3601	4782.4488	CUB2	2316
2C002	AE_50	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	406.3562	4782.4435	CUB2	2296
2C003	AE_57	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	406.3285	4782.4048	CUB2	2138
2C004	AE_58	400	81.0	12.0	1.7	20.0	75.0	N/A	91.7	12000	406.3247	4782.3996	CUB2	2120
2H009	AME_17	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9223	4782.4875	HPM2	1629
2H010	AME_18	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9195	4782.4837	HPM2	1614
2H011	AME_19	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.9166	4782.4799	HPM2	1598
2H012	AME_20	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	405.914	4782.4761	HPM2	1583
2H013	AME_21	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	406.1412	4782.7925	HPM2	2843
2H014	AME_22	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	406.1385	4782.7888	HPM2	2828
2H015	AME_23	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	406.1357	4782.785	HPM2	2813
2H016	AME_24	400	101.3	45.3	2.5	30.0	72.0	N/A	61.1	18000	406.1329	4782.7812	HPM2	2798
2H017	SE_37	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.964	4782.6058	HPM2	2038
2H018	SEA_37	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.9857	4782.5813	HPM2	1996
2H019	SE_38	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.9632	4782.6041	HPM2	2032
2H020	SEA_38	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.9804	4782.5741	HPM2	1967
2H021	SE_39	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.9534	4782.5897	HPM2	1975
2H022	SEA_39	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.9752	4782.5669	HPM2	1938
2H023	SE_40	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	405.952	4782.5878	HPM2	1968
2H024	SEA_40	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	405.97	4782.5597	HPM2	1910
2H025	SE_41	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	406.0478	4782.7211	HPM2	2498
2H026	SEA_41	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	406.0803	4782.713	HPM2	2520
2H027	SE_42	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	406.0464	4782.7193	HPM2	2491
2H028	SEA_42	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	406.0751	4782.7058	HPM2	2491
2H029	SE_43	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	406.0361	4782.7055	HPM2	2436
2H030	SEA_43	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	406.0699	4782.6986	HPM2	2463
2H031	SE_44	400	101.3	45.3	2.8	34.0	72.0	N/A	60.8	23000	406.0347	4782.7037	HPM2	2428
2H032	SEA_44	400	101.3	45.3	0.5	6.0	600.0	N/A	97.6	1150	406.0647	4782.6913	HPM2	2434
2D001	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
2D002	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
2D003	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
2D004	N/A	400	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A-Outside	TBD
2C005	CT_1	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2331	4782.3191	CUB2	1721
2C006	CT_2	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2384	4782.3262	CUB2	1750
2C007	CT_3	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2425	4782.3318	CUB2	1773
2C008	CT_4	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2469	4782.3374	CUB2	1796
2C009	CT_5	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2519	4782.3445	CUB2	1825
2C010	CT_6	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2561	4782.3501	CUB2	1848
2C011	CT_7	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2604	4782.3557	CUB2	1871
2C012	CT_8	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2785	4782.3809	CUB2	1972
2C013	CT_9	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2825	4782.3879	CUB2	1999
2C014	CT_10	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2869	4782.3935	CUB2	2022
2C015	CT_11	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2921	4782.4006	CUB2	2051
2C016	CT_12	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2962	4782.4062	CUB2	2074
2C017	CT_13	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3002	4782.4118	CUB2	2096
2C018	CT_14	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3059	4782.4189	CUB2	2126
2C019	CT_15	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3099	4782.4245	CUB2	2149
2C020	CT_16	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2186	4782.3301	CUB2	1722
2C021	CT_17	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2237	4782.3371	CUB2	1750
2C022	CT_18	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2278	4782.3427	CUB2	1773
2C023	CT_19	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.232	4782.3484	CUB2	1796
2C024	CT_20	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2374	4782.3554	CUB2	1825
2C025	CT_21	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2415	4782.3611	CUB2	1848

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2C026	CT_22	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2459	4782.3667	CUB2	1872
2C027	CT_23	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2735	4782.3736	CUB2	1943
2C028	CT_24	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2554	4782.3794	CUB2	1924
2C029	CT_25	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2594	4782.385	CUB2	1946
2C030	CT_26	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2639	4782.3932	CUB2	1977
2C031	CT_27	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2679	4782.3988	CUB2	1999
2C032	CT_28	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2722	4782.4044	CUB2	2023
2C033	CT_29	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2776	4782.4115	CUB2	2052
2C034	CT_30	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2818	4782.4171	CUB2	2075
2C035	CT_31	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2858	4782.4228	CUB2	2098
2C036	CT_32	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.291	4782.4298	CUB2	2126
2C037	CT_33	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2954	4782.4354	CUB2	2150
2C038	CT_34	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2039	4782.341	CUB2	1723
2C039	CT_35	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2089	4782.3481	CUB2	1751
2C040	CT_36	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2132	4782.3537	CUB2	1774
2C041	CT_37	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2177	4782.3593	CUB2	1798
2C042	CT_38	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2228	4782.3664	CUB2	1827
2C043	CT_39	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2268	4782.372	CUB2	1849
2C044	CT_40	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2312	4782.3776	CUB2	1873
2C045	CT_41	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2696	4782.3679	CUB2	1921
2C046	CT_42	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2404	4782.3903	CUB2	1924
2C047	CT_43	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2448	4782.3959	CUB2	1947
2C048	CT_44	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.249	4782.4042	CUB2	1977
2C049	CT_45	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2532	4782.4098	CUB2	2000
2C050	CT_46	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2577	4782.4154	CUB2	2024
2C051	CT_47	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2627	4782.4225	CUB2	2052
2C052	CT_48	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.267	4782.4281	CUB2	2076
2C053	CT_49	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2713	4782.4337	CUB2	2099
2C054	CT_50	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2765	4782.4408	CUB2	2128
2C055	CT_51	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2807	4782.4464	CUB2	2151
2C056	CT_52	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3142	4782.4301	CUB2	2172
2C057	CT_53	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3182	4782.4377	CUB2	2200
2C058	CT_54	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3222	4782.4433	CUB2	2222
2C059	CT_55	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3265	4782.4489	CUB2	2246
2C060	CT_56	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3453	4782.4743	CUB2	2349
2C061	CT_57	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3495	4782.4799	CUB2	2372
2C062	CT_58	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3539	4782.4855	CUB2	2396
2C063	CT_59	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3582	4782.4934	CUB2	2425
2C064	CT_60	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3628	4782.499	CUB2	2449
2C065	CT_61	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.367	4782.5046	CUB2	2471
2C066	CT_62	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.372	4782.5117	CUB2	2500
2C067	CT_63	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3764	4782.5173	CUB2	2523
2C068	CT_64	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3806	4782.5229	CUB2	2546
2C069	CT_65	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3858	4782.5299	CUB2	2575
2C070	CT_66	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3901	4782.5355	CUB2	2598
2C071	CT_67	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3942	4782.5412	CUB2	2621
2C072	CT_68	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2994	4782.4411	CUB2	2172
2C073	CT_69	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3035	4782.4486	CUB2	2200
2C074	CT_70	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3078	4782.4542	CUB2	2223
2C075	CT_71	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3116	4782.4598	CUB2	2246
2C076	CT_72	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.317	4782.4669	CUB2	2275
2C077	CT_73	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3214	4782.4725	CUB2	2298
2C078	CT_74	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3319	4782.4552	CUB2	2273
2C079	CT_75	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3309	4782.4852	CUB2	2350
2C080	CT_76	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3345	4782.4908	CUB2	2372

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2C081	CT_77	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3393	4782.4964	CUB2	2396
2C082	CT_78	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3439	4782.5043	CUB2	2426
2C083	CT_79	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.348	4782.5099	CUB2	2449
2C084	CT_80	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3523	4782.5155	CUB2	2472
2C085	CT_81	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3576	4782.5226	CUB2	2501
2C086	CT_82	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3616	4782.5282	CUB2	2524
2C087	CT_83	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3658	4782.5338	CUB2	2547
2C088	CT_84	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3711	4782.5409	CUB2	2576
2C089	CT_85	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3752	4782.5465	CUB2	2598
2C090	CT_86	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3795	4782.5521	CUB2	2622
2C091	CT_87	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2849	4782.452	CUB2	2173
2C092	CT_88	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.289	4782.4595	CUB2	2201
2C093	CT_89	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2929	4782.4652	CUB2	2224
2C094	CT_90	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.2973	4782.4708	CUB2	2247
2C095	CT_91	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3025	4782.4779	CUB2	2276
2C096	CT_92	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3069	4782.4835	CUB2	2299
2C097	CT_93	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3357	4782.4607	CUB2	2295
2C098	CT_94	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3161	4782.4962	CUB2	2351
2C099	CT_95	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3196	4782.5016	CUB2	2372
2C100	CT_96	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.324	4782.5082	CUB2	2398
2C101	CT_97	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3293	4782.5153	CUB2	2427
2C102	CT_98	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3333	4782.5209	CUB2	2450
2C103	CT_99	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3376	4782.5265	CUB2	2473
2C104	CT_100	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3429	4782.5336	CUB2	2502
2C105	CT_101	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3471	4782.5392	CUB2	2525
2C106	CT_102	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3513	4782.5448	CUB2	2548
2C107	CT_103	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3565	4782.5518	CUB2	2576
2C108	CT_104	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3608	4782.5574	CUB2	2600
2C109	CT_105	400	100.9	31.9	19.2	230.0	-459.7	N/A	33.8	585800	406.3649	4782.5631	CUB2	2623
2G001	CT_106	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.8079	4783.0926	N/A-Outside	1123
2G002	CT_107	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.8001	4783.0825	N/A-Outside	1162
2G003	CT_108	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.7924	4783.0723	N/A-Outside	1202
2G004	CT_109	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.7516	4783.0174	N/A-Outside	1418
2G005	CT_110	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.7439	4783.0073	N/A-Outside	1458
2G006	CT_111	400	42.0	N/A	24.0	288.0	-459.7	N/A	27.6	750000	406.7362	4782.9971	N/A-Outside	1499
1W001	AE_51	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	405.3736	4783.0698	WWT1	656
1W002	AE_52	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	405.3777	4783.067	WWT1	669
1W003	AE_53	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	405.3869	4783.0603	WWT1	697
1W004	AE_54	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	405.3913	4783.0572	WWT1	713
1W005	AME_25	400	144.0	10.0	0.8	10.0	70.0	N/A	76.4	2500	405.3558	4783.0833	WWT1	599
1W006	AME_26	400	144.0	10.0	0.8	10.0	70.0	N/A	76.4	2500	405.3607	4783.0798	WWT1	616
1W007	AME_27	400	144.0	10.0	0.8	10.0	70.0	N/A	76.4	2500	405.3661	4783.0759	WWT1	634
1W008	SE_45	400	144.0	10.0	0.5	6.0	70.0	N/A	169.8	2000	405.339	4783.0956	WWT1	550
1W009	SE_46	400	144.0	10.0	0.5	6.0	70.0	N/A	169.8	2000	405.3437	4783.0923	WWT1	565
1W010	SE_47	400	144.0	10.0	0.5	6.0	70.0	N/A	169.8	2000	405.3483	4783.0891	WWT1	577
1W011	SILO1	400	46.0	N/A	75.5	905.5	N/A	N/A	N/A	N/A	405.4379	4782.946	N/A-Outside	843
1W012	SILO2	400	46.0	N/A	75.5	905.5	N/A	N/A	N/A	N/A	406.2251	4783.1254	N/A-Outside	2458
1B001	GE_59	400	70.6	9.8	4.3	52.0	80.0	N/A	74.9	66234	405.4082	4783.683	BIO1	436
1B002	GE_60	400	70.6	9.8	4.3	52.0	80.0	N/A	74.9	66234	405.3977	4783.6822	BIO1	404
2W001	AE_51	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	406.2942	4783.009	WWT2	2439
2W002	AE_52	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	406.2902	4783.0118	WWT2	2445
2W003	AE_53	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	406.2807	4783.0185	WWT2	2459
2W004	AE_54	400	144.0	10.0	2.2	26.0	70.0	N/A	67.8	15000	406.2763	4783.0216	WWT2	2466
2W005	AME_25	400	144.0	10.0	0.8	10.0	70.0	N/A	76.4	2500	406.3124	4782.9963	WWT2	2413
2W006	AME_26	400	144.0	10.0	0.8	10.0	70.0	N/A	76.4	2500	406.3074	4782.9998	WWT2	2419

Emission Point	Plot Plan ID	Ground Elevation	Height	Height Above Structure	Inside Diameter	Inside Diameter	Exit Temp	Cross Section	Exit Velocity	Exit Flow	UTM X Coordinate	UTM Y Coordinate	Building	Distance to Property Line
		(ft)	(ft)	(ft)	(ft)	(in)	(F)	(in)	(FPS)	(ACFM)	(km)	(km)		(ft)
2W007	AME_27	400	144.0	10.0	0.8	10.0	70.0	N/A	76.4	2500	406.302	4783.0037	WWT2	2427
2W008	SE_45	400	144.0	10.0	0.5	6.0	70.0	N/A	169.8	2000	406.3294	4782.9843	WWT2	2391
2W009	SE_46	400	144.0	10.0	0.5	6.0	70.0	N/A	169.8	2000	406.3248	4782.9874	WWT2	2396
2W010	SE_47	400	144.0	10.0	0.5	6.0	70.0	N/A	169.8	2000	406.3203	4782.9907	WWT2	2402
2W011	SILO3	400	46.0	N/A	75.5	905.5	N/A	N/A	N/A	N/A	407.045	4782.5367	N/A-Outside	1548
2W012	SILO4	400	46.0	N/A	75.5	905.5	N/A	N/A	N/A	N/A	407.0824	4782.5099	N/A-Outside	1430
2B001	GE_59	400	70.6	9.8	4.3	52.0	80.0	N/A	74.9	66234	405.7099	4783.6894	BIO2	603
2B002	GE_60	400	70.6	9.8	4.3	52.0	80.0	N/A	74.9	66234	405.7203	4783.69	BIO2	604
1A001	AE_55	400	114.0	14.0	1.7	20.0	70.0	N/A	76.4	10000	405.5218	4782.5898	PROBE1	1043
1A002	AE_56	400	114.0	14.0	1.7	20.0	70.0	N/A	76.4	10000	405.5192	4782.5863	PROBE1	1034
1A003	SE_48	400	114.0	14.0	1.0	12.0	70.0	N/A	84.9	4000	405.5151	4782.5814	PROBE1	1019
1A004	SE_49	400	114.0	14.0	1.0	12.0	70.0	N/A	84.9	4000	405.5137	4782.5795	PROBE1	1014
2A001	AE_55	400	114.0	14.0	1.7	20.0	70.0	N/A	76.4	10000	405.9577	4782.2767	PROBE2	1077
2A002	AE_56	400	114.0	14.0	1.7	20.0	70.0	N/A	76.4	10000	405.9551	4782.2732	PROBE2	1063
2A003	SE_48	400	114.0	14.0	1.0	12.0	70.0	N/A	84.9	4000	405.9517	4782.268	PROBE2	1042
2A004	SE_49	400	114.0	14.0	1.0	12.0	70.0	N/A	84.9	4000	405.9502	4782.2661	PROBE2	1034

Table A-2 - Section IV Pg. 5 Emission Source/Control

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
AS001	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS002	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS003	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS004	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS005	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS006	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS007	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS008	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS009	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS010	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS011	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS012	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS013	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS014	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS015	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS016	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS017	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS018	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS019	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS020	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS021	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS022	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS023	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS024	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS025	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS026	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS027	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS028	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS029	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS030	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS031	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS032	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS033	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS034	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS035	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS036	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS037	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS038	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS039	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
AS040	K	Q4 2025	Q1 2029	001	wet scrubber		80,000	39	cubic feet per minute
PLE01	I	Q4 2025	Q1 2029	--	--		--	--	--
POU01	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				127	thermal oxidation				
RCS01	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS02	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS03	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS04	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS05	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
RCS06	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS07	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS08	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS09	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS10	K	Q4 2025	Q1 2029	001	wet scrubber		--	--	--
				110	catalytic oxidation				
IMP01	I	Q4 2025	Q1 2029	--	--		--	--	--
WET01	I	Q4 2025	Q1 2029	--	--		--	--	--
TFD01	I	Q4 2025	Q1 2029	--	--		--	--	--
CS001	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS002	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS003	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS004	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS005	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS006	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS007	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS008	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS009	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS010	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS011	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS012	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS013	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS014	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
CS015	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS016	K	Q4 2025	Q1 2029	080	chemical oxidation		26,500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
BS001	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS002	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS003	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS004	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS005	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS006	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS007	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS008	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS009	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS010	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS011	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS012	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS013	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS014	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS015	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
BS016	K	Q4 2025	Q1 2029	001	wet scrubber		40,000	39	cubic feet per minute
PHO01	I	Q4 2025	Q1 2029	--	--		--	--	--
CMP01	I	Q4 2025	Q1 2029	--	--		--	--	--
ST001	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide Tank 1	5,400	15	gallons
ST002	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide Tank 2	5,400	15	gallons
ST003	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide Tank 3	5,400	15	gallons
ST004	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide Tank 4	5,400	15	gallons
ST005	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide Tank 5	5,400	15	gallons
ST006	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide Tank 6	5,400	15	gallons
TO001	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO002	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO003	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO004	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO005	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO006	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO007	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO008	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO009	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO010	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO011	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO012	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO013	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
TO014	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO015	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO016	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO017	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO018	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO019	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO020	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO021	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO022	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO023	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO024	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO025	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO026	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO027	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO028	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO029	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO030	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO031	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO032	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO033	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO034	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO035	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO036	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
WS001	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 1	12,000	15	gallons
WS002	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 2	12,000	15	gallons
WS003	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 3	12,000	15	gallons
WS004	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 4	12,000	15	gallons
WS005	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 5	12,000	15	gallons
WS006	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 6	12,000	15	gallons
WS007	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 7	12,000	15	gallons
WS008	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 8	12,000	15	gallons
WS009	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 9	12,000	15	gallons
WS010	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 10	12,000	15	gallons

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
WS011	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 11	12,000	15	gallons
WS012	I	Q4 2025	Q1 2029	--	--	Waste IPA Tank 12	12,000	15	gallons
WS013	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 1	12,000	15	gallons
WS014	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 2	12,000	15	gallons
WS015	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 3	12,000	15	gallons
WS016	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 4	12,000	15	gallons
WS017	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 5	12,000	15	gallons
WS018	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 6	12,000	15	gallons
WS019	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 7	12,000	15	gallons
WS020	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 8	12,000	15	gallons
WS021	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 9	12,000	15	gallons
WS022	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 10	12,000	15	gallons
WS023	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 11	12,000	15	gallons
WS024	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 1/PGMEA Tank 12	12,000	15	gallons
WS025	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 2/PGMEA Tank 1	7,000	15	gallons
WS026	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 2/PGMEA Tank 2	7,000	15	gallons
WS027	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 2/PGMEA Tank 3	7,000	15	gallons
WS028	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 2/PGMEA Tank 4	7,000	15	gallons
WS029	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 2/PGMEA Tank 5	7,000	15	gallons
WS030	I	Q4 2025	Q1 2029	--	--	Waste Photosolvent 2/PGMEA Tank 6	7,000	15	gallons
GN001	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN002	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN003	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN004	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN005	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN006	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN007	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN008	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN009	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN010	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN011	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN012	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN013	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN014	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN015	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN016	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN017	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN018	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN019	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN020	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN021	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN022	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN023	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN024	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN025	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN026	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN027	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN028	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN029	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN030	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN031	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN032	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN033	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN034	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN035	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN036	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
GN037	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN038	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN039	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
GN040	I	Q4 2025	Q1 2029	--	--		55,000	39	cubic feet per minute
AS041	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS042	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS043	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS044	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS045	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS046	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS047	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS048	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS049	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS050	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS051	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS052	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS053	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS054	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS055	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS056	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS057	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS058	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS059	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS060	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS061	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS062	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS063	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS064	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS065	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS066	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS067	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS068	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS069	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS070	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS071	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS072	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS073	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS074	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS075	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS076	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS077	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS078	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS079	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
AS080	K	Q3 2028	Q4 2030	001	wet scrubber		80,000	39	cubic feet per minute
PLE02	I	Q3 2028	Q4 2030	--	--		--	--	--
POU02	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				127	thermal oxidation				
RCS11	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS12	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS13	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS14	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
RCS15	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS16	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS17	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS18	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS19	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
RCS20	K	Q3 2028	Q4 2030	001	wet scrubber		--	--	--
				110	catalytic oxidation				
IMP02	I	Q3 2028	Q4 2030	--	--		--	--	--
WET02	I	Q3 2028	Q4 2030	--	--		--	--	--
TFD02	I	Q3 2028	Q4 2030	--	--		--	--	--
CS017	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS018	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS019	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS020	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS021	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS022	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS023	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS024	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS025	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS026	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS027	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS028	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS029	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
CS030	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS031	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
CS032	K	Q3 2028	Q4 2030	080	chemical oxidation		26500	39	cubic feet per minute
				001	wet scrubber				
				010	electrostatic precipitator				
BS017	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS018	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS019	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS020	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS021	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS022	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS023	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS024	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS025	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS026	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS027	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS028	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS029	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS030	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS031	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
BS032	K	Q3 2028	Q4 2030	001	wet scrubber		40,000	39	cubic feet per minute
PHO02	I	Q3 2028	Q4 2030	--	--		--	--	--
CMP02	I	Q3 2028	Q4 2030	--	--		--	--	--
ST007	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide Tank 7	5,400	15	gallons
ST008	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide Tank 8	5,400	15	gallons
ST009	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide Tank 9	5,400	15	gallons
ST010	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide Tank 10	5,400	15	gallons
ST011	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide Tank 11	5,400	15	gallons
ST012	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide Tank 12	5,400	15	gallons
TO037	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO038	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO039	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO040	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO041	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO042	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO043	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO044	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO045	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO046	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO047	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
TO048	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO049	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO050	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO051	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO052	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO053	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO054	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO055	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO056	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO057	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO058	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO059	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO060	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO061	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO062	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO063	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO064	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO065	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO066	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO067	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO068	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO069	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO070	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO071	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				
TO072	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		52,500	39	cubic feet per minute
				127	thermal oxidation				

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
WS031	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 13	12,000	15	gallons
WS032	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 14	12,000	15	gallons
WS033	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 15	12,000	15	gallons
WS034	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 16	12,000	15	gallons
WS035	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 17	12,000	15	gallons
WS036	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 18	12,000	15	gallons
WS037	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 19	12,000	15	gallons
WS038	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 20	12,000	15	gallons
WS039	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 21	12,000	15	gallons
WS040	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 22	12,000	15	gallons
WS041	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 23	12,000	15	gallons
WS042	I	Q3 2028	Q4 2030	--	--	Waste IPA Tank 24	12,000	15	gallons
WS043	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 13	12,000	15	gallons
WS044	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 14	12,000	15	gallons
WS045	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 15	12,000	15	gallons
WS046	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 16	12,000	15	gallons
WS047	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 17	12,000	15	gallons
WS048	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 18	12,000	15	gallons
WS049	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 19	12,000	15	gallons
WS050	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 20	12,000	15	gallons
WS051	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 21	12,000	15	gallons
WS052	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 22	12,000	15	gallons
WS053	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 23	12,000	15	gallons
WS054	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 1/PGMEA Tank 24	12,000	15	gallons
WS055	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 2/PGMEA Tank 7	7,000	15	gallons
WS056	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 2/PGMEA Tank 8	7,000	15	gallons
WS057	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 2/PGMEA Tank 9	7,000	15	gallons
WS058	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 2/PGMEA Tank 10	7,000	15	gallons
WS059	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 2/PGMEA Tank 11	7,000	15	gallons
WS060	I	Q3 2028	Q4 2030	--	--	Waste Photosolvent 2/PGMEA Tank 12	7,000	15	gallons
GN041	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN042	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN043	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN044	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN045	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN046	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN047	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN048	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN049	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN050	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN051	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN052	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN053	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN054	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN055	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN056	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN057	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN058	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN059	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN060	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN061	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN062	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN063	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN064	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN065	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN066	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
GN067	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN068	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN069	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN070	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN071	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN072	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN073	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN074	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN075	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN076	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN077	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN078	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN079	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
GN080	I	Q3 2028	Q4 2030	--	--		55,000	39	cubic feet per minute
BLR01	C	Q4 2025	Q1 2029	--	--		32.7	25	million Btu per hour
BLR02	C	Q4 2025	Q1 2029	--	--		32.7	25	million Btu per hour
BLR03	C	Q4 2025	Q1 2029	--	--		32.7	25	million Btu per hour
WBV01	C	Q4 2025	Q1 2029	--	--		42.8	25	million Btu per hour
WBV02	C	Q4 2025	Q1 2029	--	--		42.8	25	million Btu per hour
WBV03	C	Q4 2025	Q1 2029	--	--		42.8	25	million Btu per hour
WBV04	C	Q4 2025	Q1 2029	--	--		42.8	25	million Btu per hour
DG001	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG002	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG003	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG004	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG005	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG006	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG007	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG008	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG009	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG010	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG011	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG012	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG013	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG014	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG015	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG016	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG017	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG018	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG019	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG020	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG021	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG022	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG023	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG024	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG025	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG026	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG027	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG028	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG029	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG030	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG031	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG032	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG033	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG034	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG035	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
DG036	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG037	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG038	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG039	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG040	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG041	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG042	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG043	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG044	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG045	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG046	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG047	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG048	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG049	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG050	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG051	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG052	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG053	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG054	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG055	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG056	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG057	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG058	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG059	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
DG060	C	Q4 2025	Q1 2029	--	--		3,350	219	horsepower (mechanical)
FP001	C	Q4 2025	Q1 2029	--	--		250	219	horsepower (mechanical)
BLR04	C	Q3 2028	Q4 2030	--	--		32.7	25	million Btu per hour
BLR05	C	Q3 2028	Q4 2030	--	--		32.7	25	million Btu per hour
BLR06	C	Q3 2028	Q4 2030	--	--		32.7	25	million Btu per hour
WBV05	C	Q3 2028	Q4 2030	--	--		42.8	25	million Btu per hour
WBV06	C	Q3 2028	Q4 2030	--	--		42.8	25	million Btu per hour
WBV07	C	Q3 2028	Q4 2030	--	--		42.8	25	million Btu per hour
WBV08	C	Q3 2028	Q4 2030	--	--		42.8	25	million Btu per hour
DG061	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG062	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG063	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG064	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG065	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG066	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG067	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG068	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG069	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG070	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG071	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG072	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG073	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG074	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG075	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG076	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG077	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG078	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG079	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG080	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG081	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG082	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG083	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
DG084	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG085	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG086	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG087	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG088	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG089	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG090	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG091	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG092	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG093	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG094	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG095	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG096	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG097	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG098	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG099	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG100	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG101	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG102	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG103	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG104	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG105	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG106	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG107	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG108	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG109	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG110	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG111	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG112	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG113	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG114	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG115	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG116	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG117	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
DG118	C	Q3 2028	Q4 2030	--	--		3,350	219	horsepower (mechanical)
AS081	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS082	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS083	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS084	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS085	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS086	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS087	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
AS088	K	Q4 2025	Q1 2029	001	wet scrubber		36,500	39	cubic feet per minute
ST013	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 1	10,000	15	gallons
ST014	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 2	10,000	15	gallons
ST015	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 3	10,000	15	gallons
ST016	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 4	10,000	15	gallons
ST017	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 5	10,000	15	gallons
ST018	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 6	10,000	15	gallons
ST019	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 7	10,000	15	gallons
ST020	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 8	10,000	15	gallons
ST021	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 9	10,000	15	gallons
ST022	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 10	10,000	15	gallons
ST023	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 11	10,000	15	gallons
ST024	I	Q4 2025	Q1 2029	--	--	Hydrogen Peroxide 31% Tank 12	10,000	15	gallons
ST025	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 1	10,000	15	gallons

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
ST026	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 2	10,000	15	gallons
ST027	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 3	10,000	15	gallons
ST028	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 4	10,000	15	gallons
ST029	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 5	10,000	15	gallons
ST030	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 6	10,000	15	gallons
ST031	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 7	10,000	15	gallons
ST032	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 96% Tank 8	10,000	15	gallons
ST033	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 49% Tank 1	10,000	15	gallons
ST034	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 49% Tank 2	10,000	15	gallons
ST035	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 49% Tank 3	10,000	15	gallons
ST036	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 49% Tank 4	10,000	15	gallons
ST037	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 100:1 Tank 1	6,500	15	gallons
ST038	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 100:1 Tank 2	6,500	15	gallons
ST039	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 100:1 Tank 3	6,500	15	gallons
ST040	I	Q4 2025	Q1 2029	--	--	Hydrofluoric Acid 100:1 Tank 4	6,500	15	gallons
ST041	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 93% Tank 1	7,600	15	gallons
ST042	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 93% Tank 2	7,600	15	gallons
ST043	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 93% Tank 3	7,600	15	gallons
ST044	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 93% Tank 4	7,600	15	gallons
WS061	I	Q4 2025	Q1 2029	--	--	Waste Sulfuric Acid Tank 1	13,209	15	gallons
WS062	I	Q4 2025	Q1 2029	--	--	Waste Sulfuric Acid Tank 2	13,209	15	gallons
WS063	I	Q4 2025	Q1 2029	--	--	Waste Sulfuric Acid Tank 3	13,209	15	gallons
WS064	I	Q4 2025	Q1 2029	--	--	Waste Sulfuric Acid Tank 4	13,209	15	gallons
WS065	I	Q4 2025	Q1 2029	--	--	Waste Sulfuric Acid Tank 5	13,209	15	gallons
WS066	I	Q4 2025	Q1 2029	--	--	Waste Sulfuric Acid Tank 6	13,209	15	gallons
AS089	K	Q4 2025	Q1 2029	001	wet scrubber		12,000	39	cubic feet per minute
AS090	K	Q4 2025	Q1 2029	001	wet scrubber		12,000	39	cubic feet per minute
AS091	K	Q4 2025	Q1 2029	001	wet scrubber		12,000	39	cubic feet per minute
AS092	K	Q4 2025	Q1 2029	001	wet scrubber		12,000	39	cubic feet per minute
ST045	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 70% Tank 1	4,000	15	gallons
BS033	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS034	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS035	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS036	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS037	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS038	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS039	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
BS040	K	Q4 2025	Q1 2029	001	wet scrubber		18,000	39	cubic feet per minute
ST046	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 1	6,500	15	gallons
ST047	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 2	6,500	15	gallons
ST048	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 3	6,500	15	gallons
ST049	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 4	6,500	15	gallons
ST050	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 5	6,500	15	gallons
ST051	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 6	6,500	15	gallons
ST052	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 7	6,500	15	gallons
ST053	I	Q4 2025	Q1 2029	--	--	Aqueous Ammonia 29% Tank 8	6,500	15	gallons
ST054	I	Q4 2025	Q1 2029	--	--	TMAH 25% Tank 1	5,000	15	gallons
ST055	I	Q4 2025	Q1 2029	--	--	TMAH 25% Tank 2	5,000	15	gallons
ST056	I	Q4 2025	Q1 2029	--	--	TMAH 25% Tank 3	5,000	15	gallons
ST057	I	Q4 2025	Q1 2029	--	--	TMAH 25% Tank 4	5,000	15	gallons
ST058	I	Q4 2025	Q1 2029	--	--	Dilute TMAH with Surfactant Tank 1	6,500	15	gallons
ST059	I	Q4 2025	Q1 2029	--	--	Dilute TMAH with Surfactant Tank 2	6,500	15	gallons
ST060	I	Q4 2025	Q1 2029	--	--	Dilute TMAH with Surfactant Tank 3	6,500	15	gallons
ST061	I	Q4 2025	Q1 2029	--	--	Dilute TMAH with Surfactant Tank 4	6,500	15	gallons
ST062	I	Q4 2025	Q1 2029	--	--	Dilute TMAH Tank 1	6,500	15	gallons
ST063	I	Q4 2025	Q1 2029	--	--	Dilute TMAH Tank 2	6,500	15	gallons

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
ST064	I	Q4 2025	Q1 2029	--	--	Dilute TMAH Tank 3	6,500	15	gallons
ST065	I	Q4 2025	Q1 2029	--	--	Dilute TMAH Tank 4	6,500	15	gallons
TO073	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO074	K	Q4 2026	Q1 2030	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO075	K	Q4 2027	Q1 2031	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO076	K	Q4 2028	Q1 2032	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO077	K	Q4 2029	Q1 2033	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO078	K	Q4 2030	Q1 2034	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO079	K	Q4 2031	Q1 2035	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO080	K	Q4 2032	Q1 2036	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
ST066	I	Q4 2025	Q1 2029	--	--	IPA Tank 1	10,000	15	gallons
ST067	I	Q4 2025	Q1 2029	--	--	IPA Tank 2	10,000	15	gallons
ST068	I	Q4 2025	Q1 2029	--	--	IPA Tank 3	10,000	15	gallons
ST069	I	Q4 2025	Q1 2029	--	--	IPA Tank 4	10,000	15	gallons
ST070	I	Q4 2025	Q1 2029	--	--	IPA Tank 5	10,000	15	gallons
ST071	I	Q4 2025	Q1 2029	--	--	IPA Tank 6	10,000	15	gallons
ST072	I	Q4 2025	Q1 2029	--	--	IPA Tank 7	10,000	15	gallons
ST073	I	Q4 2025	Q1 2029	--	--	IPA Tank 8	10,000	15	gallons
ST074	I	Q4 2025	Q1 2029	--	--	PGMEA Tank 1	6,500	15	gallons
ST075	I	Q4 2025	Q1 2029	--	--	PGMEA Tank 2	6,500	15	gallons
ST076	I	Q4 2025	Q1 2029	--	--	PGMEA Tank 3	6,500	15	gallons
ST077	I	Q4 2025	Q1 2029	--	--	PGMEA Tank 4	6,500	15	gallons
SOD01	I	Q4 2025	Q1 2029	--	--		--	--	--
DT001	I	Q4 2025	Q1 2029	--	--	Diesel Tank 1	25,000	15	gallons
DT002	I	Q4 2025	Q1 2029	--	--	Diesel Tank 2	25,000	15	gallons
DT003	I	Q4 2025	Q1 2029	--	--	Diesel Tank 3	25,000	15	gallons
DT004	I	Q4 2025	Q1 2029	--	--	Diesel Tank 4	25,000	15	gallons
ST078	I	Q4 2025	Q1 2029	--	--	Sodium Hypochlorite 12% Tank 1	7,000	15	gallons
ST079	I	Q4 2025	Q1 2029	--	--	Biocide Tank 1	2,000	15	gallons
ST080	I	Q4 2025	Q1 2029	--	--	Corrosion Inhibitor Tank 1	2,000	15	gallons
ST081	I	Q4 2025	Q1 2029	--	--	Antiscalant and Biocide Tank 1	2,000	15	gallons
CT001	I	Q4 2025	Q1 2029	--	--	Cooling Tower 1	2,500	115	gallons per minute
CT002	I	Q4 2025	Q1 2029	--	--	Cooling Tower 2	2,500	115	gallons per minute
CT003	I	Q4 2025	Q1 2029	--	--	Cooling Tower 3	2,500	115	gallons per minute
CT004	I	Q4 2025	Q1 2029	--	--	Cooling Tower 4	2,500	115	gallons per minute
CT005	I	Q4 2025	Q1 2029	--	--	Cooling Tower 5	2,500	115	gallons per minute
CT006	I	Q4 2025	Q1 2029	--	--	Cooling Tower 6	2,500	115	gallons per minute
CT007	I	Q4 2025	Q1 2029	--	--	Cooling Tower 7	2,500	115	gallons per minute
CT008	I	Q4 2025	Q1 2029	--	--	Cooling Tower 8	2,500	115	gallons per minute
CT009	I	Q4 2025	Q1 2029	--	--	Cooling Tower 9	2,500	115	gallons per minute
CT010	I	Q4 2025	Q1 2029	--	--	Cooling Tower 10	2,500	115	gallons per minute
CT011	I	Q4 2025	Q1 2029	--	--	Cooling Tower 11	2,500	115	gallons per minute
CT012	I	Q4 2025	Q1 2029	--	--	Cooling Tower 12	2,500	115	gallons per minute
CT013	I	Q4 2025	Q1 2029	--	--	Cooling Tower 13	2,500	115	gallons per minute
CT014	I	Q4 2025	Q1 2029	--	--	Cooling Tower 14	2,500	115	gallons per minute
CT015	I	Q4 2025	Q1 2029	--	--	Cooling Tower 15	2,500	115	gallons per minute
CT016	I	Q4 2025	Q1 2029	--	--	Cooling Tower 16	2,500	115	gallons per minute
CT017	I	Q4 2025	Q1 2029	--	--	Cooling Tower 17	2,500	115	gallons per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
CT018	I	Q4 2025	Q1 2029	--	--	Cooling Tower 18	2,500	115	gallons per minute
CT019	I	Q4 2025	Q1 2029	--	--	Cooling Tower 19	2,500	115	gallons per minute
CT020	I	Q4 2025	Q1 2029	--	--	Cooling Tower 20	2,500	115	gallons per minute
CT021	I	Q4 2025	Q1 2029	--	--	Cooling Tower 21	2,500	115	gallons per minute
CT022	I	Q4 2025	Q1 2029	--	--	Cooling Tower 22	2,500	115	gallons per minute
CT023	I	Q4 2025	Q1 2029	--	--	Cooling Tower 23	2,500	115	gallons per minute
CT024	I	Q4 2025	Q1 2029	--	--	Cooling Tower 24	2,500	115	gallons per minute
CT025	I	Q4 2025	Q1 2029	--	--	Cooling Tower 25	2,500	115	gallons per minute
CT026	I	Q4 2025	Q1 2029	--	--	Cooling Tower 26	2,500	115	gallons per minute
CT027	I	Q4 2025	Q1 2029	--	--	Cooling Tower 27	2,500	115	gallons per minute
CT028	I	Q4 2025	Q1 2029	--	--	Cooling Tower 28	2,500	115	gallons per minute
CT029	I	Q4 2025	Q1 2029	--	--	Cooling Tower 29	2,500	115	gallons per minute
CT030	I	Q4 2025	Q1 2029	--	--	Cooling Tower 30	2,500	115	gallons per minute
CT031	I	Q4 2025	Q1 2029	--	--	Cooling Tower 31	2,500	115	gallons per minute
CT032	I	Q4 2025	Q1 2029	--	--	Cooling Tower 32	2,500	115	gallons per minute
CT033	I	Q4 2025	Q1 2029	--	--	Cooling Tower 33	2,500	115	gallons per minute
CT034	I	Q4 2025	Q1 2029	--	--	Cooling Tower 34	2,500	115	gallons per minute
CT035	I	Q4 2025	Q1 2029	--	--	Cooling Tower 35	2,500	115	gallons per minute
CT036	I	Q4 2025	Q1 2029	--	--	Cooling Tower 36	2,500	115	gallons per minute
CT037	I	Q4 2025	Q1 2029	--	--	Cooling Tower 37	2,500	115	gallons per minute
CT038	I	Q4 2025	Q1 2029	--	--	Cooling Tower 38	2,500	115	gallons per minute
CT039	I	Q4 2025	Q1 2029	--	--	Cooling Tower 39	2,500	115	gallons per minute
CT040	I	Q4 2025	Q1 2029	--	--	Cooling Tower 40	2,500	115	gallons per minute
CT041	I	Q4 2025	Q1 2029	--	--	Cooling Tower 41	2,500	115	gallons per minute
CT042	I	Q4 2025	Q1 2029	--	--	Cooling Tower 42	2,500	115	gallons per minute
CT043	I	Q4 2025	Q1 2029	--	--	Cooling Tower 43	2,500	115	gallons per minute
CT044	I	Q4 2025	Q1 2029	--	--	Cooling Tower 44	2,500	115	gallons per minute
CT045	I	Q4 2025	Q1 2029	--	--	Cooling Tower 45	2,500	115	gallons per minute
CT046	I	Q4 2025	Q1 2029	--	--	Cooling Tower 46	2,500	115	gallons per minute
CT047	I	Q4 2025	Q1 2029	--	--	Cooling Tower 47	2,500	115	gallons per minute
CT048	I	Q4 2025	Q1 2029	--	--	Cooling Tower 48	2,500	115	gallons per minute
CT049	I	Q4 2025	Q1 2029	--	--	Cooling Tower 49	2,500	115	gallons per minute
CT050	I	Q4 2025	Q1 2029	--	--	Cooling Tower 50	2,500	115	gallons per minute
CT051	I	Q4 2025	Q1 2029	--	--	Cooling Tower 51	2,500	115	gallons per minute
CT052	I	Q4 2025	Q1 2029	--	--	Cooling Tower 52	2,500	115	gallons per minute
CT053	I	Q4 2025	Q1 2029	--	--	Cooling Tower 53	2,500	115	gallons per minute
CT054	I	Q4 2025	Q1 2029	--	--	Cooling Tower 54	2,500	115	gallons per minute
CT055	I	Q4 2025	Q1 2029	--	--	Cooling Tower 55	2,500	115	gallons per minute
CT056	I	Q4 2025	Q1 2029	--	--	Cooling Tower 56	2,500	115	gallons per minute
CT057	I	Q4 2025	Q1 2029	--	--	Cooling Tower 57	2,500	115	gallons per minute
CT058	I	Q4 2025	Q1 2029	--	--	Cooling Tower 58	2,500	115	gallons per minute
CT059	I	Q4 2025	Q1 2029	--	--	Cooling Tower 59	2,500	115	gallons per minute
CT060	I	Q4 2025	Q1 2029	--	--	Cooling Tower 60	2,500	115	gallons per minute
CT061	I	Q4 2025	Q1 2029	--	--	Cooling Tower 61	2,500	115	gallons per minute
CT062	I	Q4 2025	Q1 2029	--	--	Cooling Tower 62	2,500	115	gallons per minute
CT063	I	Q4 2025	Q1 2029	--	--	Cooling Tower 63	2,500	115	gallons per minute
CT064	I	Q4 2025	Q1 2029	--	--	Cooling Tower 64	2,500	115	gallons per minute
CT065	I	Q4 2025	Q1 2029	--	--	Cooling Tower 65	2,500	115	gallons per minute
CT066	I	Q4 2025	Q1 2029	--	--	Cooling Tower 66	2,500	115	gallons per minute
CT067	I	Q4 2025	Q1 2029	--	--	Cooling Tower 67	2,500	115	gallons per minute
CT068	I	Q4 2025	Q1 2029	--	--	Cooling Tower 68	2,500	115	gallons per minute
CT069	I	Q4 2025	Q1 2029	--	--	Cooling Tower 69	2,500	115	gallons per minute
CT070	I	Q4 2025	Q1 2029	--	--	Cooling Tower 70	2,500	115	gallons per minute
CT071	I	Q4 2025	Q1 2029	--	--	Cooling Tower 71	2,500	115	gallons per minute
CT072	I	Q4 2025	Q1 2029	--	--	Cooling Tower 72	2,500	115	gallons per minute
CT073	I	Q4 2025	Q1 2029	--	--	Cooling Tower 73	2,500	115	gallons per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
CT074	I	Q4 2025	Q1 2029	--	--	Cooling Tower 74	2,500	115	gallons per minute
CT075	I	Q4 2025	Q1 2029	--	--	Cooling Tower 75	2,500	115	gallons per minute
CT076	I	Q4 2025	Q1 2029	--	--	Cooling Tower 76	2,500	115	gallons per minute
CT077	I	Q4 2025	Q1 2029	--	--	Cooling Tower 77	2,500	115	gallons per minute
CT078	I	Q4 2025	Q1 2029	--	--	Cooling Tower 78	2,500	115	gallons per minute
CT079	I	Q4 2025	Q1 2029	--	--	Cooling Tower 79	2,500	115	gallons per minute
CT080	I	Q4 2025	Q1 2029	--	--	Cooling Tower 80	2,500	115	gallons per minute
CT081	I	Q4 2025	Q1 2029	--	--	Cooling Tower 81	2,500	115	gallons per minute
CT082	I	Q4 2025	Q1 2029	--	--	Cooling Tower 82	2,500	115	gallons per minute
CT083	I	Q4 2025	Q1 2029	--	--	Cooling Tower 83	2,500	115	gallons per minute
CT084	I	Q4 2025	Q1 2029	--	--	Cooling Tower 84	2,500	115	gallons per minute
CT085	I	Q4 2025	Q1 2029	--	--	Cooling Tower 85	2,500	115	gallons per minute
CT086	I	Q4 2025	Q1 2029	--	--	Cooling Tower 86	2,500	115	gallons per minute
CT087	I	Q4 2025	Q1 2029	--	--	Cooling Tower 87	2,500	115	gallons per minute
CT088	I	Q4 2025	Q1 2029	--	--	Cooling Tower 88	2,500	115	gallons per minute
CT089	I	Q4 2025	Q1 2029	--	--	Cooling Tower 89	2,500	115	gallons per minute
CT090	I	Q4 2025	Q1 2029	--	--	Cooling Tower 90	2,500	115	gallons per minute
CT091	I	Q4 2025	Q1 2029	--	--	Cooling Tower 91	2,500	115	gallons per minute
CT092	I	Q4 2025	Q1 2029	--	--	Cooling Tower 92	2,500	115	gallons per minute
CT093	I	Q4 2025	Q1 2029	--	--	Cooling Tower 93	2,500	115	gallons per minute
CT094	I	Q4 2025	Q1 2029	--	--	Cooling Tower 94	2,500	115	gallons per minute
CT095	I	Q4 2025	Q1 2029	--	--	Cooling Tower 95	2,500	115	gallons per minute
CT096	I	Q4 2025	Q1 2029	--	--	Cooling Tower 96	2,500	115	gallons per minute
CT097	I	Q4 2025	Q1 2029	--	--	Cooling Tower 97	2,500	115	gallons per minute
CT098	I	Q4 2025	Q1 2029	--	--	Cooling Tower 98	2,500	115	gallons per minute
CT099	I	Q4 2025	Q1 2029	--	--	Cooling Tower 99	2,500	115	gallons per minute
CT100	I	Q4 2025	Q1 2029	--	--	Cooling Tower 100	2,500	115	gallons per minute
CT101	I	Q4 2025	Q1 2029	--	--	Cooling Tower 101	2,500	115	gallons per minute
CT102	I	Q4 2025	Q1 2029	--	--	Cooling Tower 102	2,500	115	gallons per minute
CT103	I	Q4 2025	Q1 2029	--	--	Cooling Tower 103	2,500	115	gallons per minute
CT104	I	Q4 2025	Q1 2029	--	--	Cooling Tower 104	2,500	115	gallons per minute
CT105	I	Q4 2025	Q1 2029	--	--	Cooling Tower 105	2,500	115	gallons per minute
CT106	I	Q4 2025	Q1 2029	--	--	Cooling Tower 106	14,500	115	gallons per minute
CT107	I	Q4 2025	Q1 2029	--	--	Cooling Tower 107	14,500	115	gallons per minute
CT108	I	Q4 2025	Q1 2029	--	--	Cooling Tower 108	14,500	115	gallons per minute
CT109	I	Q4 2025	Q1 2029	--	--	Cooling Tower 109	14,500	115	gallons per minute
CT110	I	Q4 2025	Q1 2029	--	--	Cooling Tower 110	14,500	115	gallons per minute
CT111	I	Q4 2025	Q1 2029	--	--	Cooling Tower 111	14,500	115	gallons per minute
AS093	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS094	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS095	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS096	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS097	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS098	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS099	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
AS100	K	Q3 2028	Q4 2030	001	wet scrubber		36,500	39	cubic feet per minute
ST082	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 13	10,000	15	gallons
ST083	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 14	10,000	15	gallons
ST084	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 15	10,000	15	gallons
ST085	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 16	10,000	15	gallons
ST086	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 17	10,000	15	gallons
ST087	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 18	10,000	15	gallons
ST088	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 19	10,000	15	gallons
ST089	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 20	10,000	15	gallons
ST090	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 21	10,000	15	gallons
ST091	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 22	10,000	15	gallons

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
ST092	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 23	10,000	15	gallons
ST093	I	Q3 2028	Q4 2030	--	--	Hydrogen Peroxide 31% Tank 24	10,000	15	gallons
ST094	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 9	10,000	15	gallons
ST095	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 10	10,000	15	gallons
ST096	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 11	10,000	15	gallons
ST097	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 12	10,000	15	gallons
ST098	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 13	10,000	15	gallons
ST099	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 14	10,000	15	gallons
ST100	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 15	10,000	15	gallons
ST101	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 96% Tank 16	10,000	15	gallons
ST102	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 49% Tank 5	10,000	15	gallons
ST103	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 49% Tank 6	10,000	15	gallons
ST104	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 49% Tank 7	10,000	15	gallons
ST105	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 49% Tank 8	10,000	15	gallons
ST106	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 100:1 Tank 5	6,500	15	gallons
ST107	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 100:1 Tank 6	6,500	15	gallons
ST108	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 100:1 Tank 7	6,500	15	gallons
ST109	I	Q3 2028	Q4 2030	--	--	Hydrofluoric Acid 100:1 Tank 8	6,500	15	gallons
ST110	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 93% Tank 5	7,600	15	gallons
ST111	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 93% Tank 6	7,600	15	gallons
ST112	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 93% Tank 7	7,600	15	gallons
ST113	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 93% Tank 8	7,600	15	gallons
WS067	I	Q3 2028	Q4 2030	--	--	Waste Sulfuric Acid Tank 7	13,209	15	gallons
WS068	I	Q3 2028	Q4 2030	--	--	Waste Sulfuric Acid Tank 8	13,209	15	gallons
WS069	I	Q3 2028	Q4 2030	--	--	Waste Sulfuric Acid Tank 9	13,209	15	gallons
WS070	I	Q3 2028	Q4 2030	--	--	Waste Sulfuric Acid Tank 10	13,209	15	gallons
WS071	I	Q3 2028	Q4 2030	--	--	Waste Sulfuric Acid Tank 11	13,209	15	gallons
WS072	I	Q3 2028	Q4 2030	--	--	Waste Sulfuric Acid Tank 12	13,209	15	gallons
AS101	K	Q3 2028	Q4 2030	001	wet scrubber		12,000	39	cubic feet per minute
AS102	K	Q3 2028	Q4 2030	001	wet scrubber		12,000	39	cubic feet per minute
AS103	K	Q3 2028	Q4 2030	001	wet scrubber		12,000	39	cubic feet per minute
AS104	K	Q3 2028	Q4 2030	001	wet scrubber		12,000	39	cubic feet per minute
ST114	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 70% Tank 2	12,000	39	cubic feet per minute
BS041	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS042	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS043	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS044	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS045	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS046	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS047	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
BS048	K	Q3 2028	Q4 2030	001	wet scrubber		18,000	39	cubic feet per minute
ST115	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 9	6,500	39	cubic feet per minute
ST116	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 10	6,500	39	cubic feet per minute
ST117	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 11	6,500	39	cubic feet per minute
ST118	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 12	6,500	39	cubic feet per minute
ST119	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 13	6,500	39	cubic feet per minute
ST120	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 14	6,500	39	cubic feet per minute
ST121	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 15	6,500	39	cubic feet per minute
ST122	I	Q3 2028	Q4 2030	--	--	Aqueous Ammonia 29% Tank 16	6,500	39	cubic feet per minute
ST123	I	Q3 2028	Q4 2030	--	--	TMAH 25% Tank 5	5,000	39	cubic feet per minute
ST124	I	Q3 2028	Q4 2030	--	--	TMAH 25% Tank 6	5,000	39	cubic feet per minute
ST125	I	Q3 2028	Q4 2030	--	--	TMAH 25% Tank 7	5,000	39	cubic feet per minute
ST126	I	Q3 2028	Q4 2030	--	--	TMAH 25% Tank 8	5,000	39	cubic feet per minute
ST127	I	Q3 2028	Q4 2030	--	--	Dilute TMAH with Surfactant Tank 5	6,500	39	cubic feet per minute
ST128	I	Q3 2028	Q4 2030	--	--	Dilute TMAH with Surfactant Tank 6	6,500	39	cubic feet per minute
ST129	I	Q3 2028	Q4 2030	--	--	Dilute TMAH with Surfactant Tank 7	6,500	39	cubic feet per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
ST130	I	Q3 2028	Q4 2030	--	--	Dilute TMAH with Surfactant Tank 8	6,500	39	cubic feet per minute
ST131	I	Q3 2028	Q4 2030	--	--	Dilute TMAH Tank 5	6,500	39	cubic feet per minute
ST132	I	Q3 2028	Q4 2030	--	--	Dilute TMAH Tank 6	6,500	39	cubic feet per minute
ST133	I	Q3 2028	Q4 2030	--	--	Dilute TMAH Tank 7	6,500	39	cubic feet per minute
ST134	I	Q3 2028	Q4 2030	--	--	Dilute TMAH Tank 8	6,500	39	cubic feet per minute
TO081	K	Q4 2025	Q1 2029	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO082	K	Q4 2026	Q1 2030	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO083	K	Q4 2027	Q1 2031	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO084	K	Q4 2028	Q1 2032	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO085	K	Q4 2029	Q1 2033	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO086	K	Q4 2030	Q1 2034	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO087	K	Q4 2031	Q1 2035	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
TO088	K	Q4 2032	Q1 2036	302	vapor recovery system (vapor adsorption/absorption unit)		24,150	39	cubic feet per minute
				127	thermal oxidation				
ST135	I	Q3 2028	Q4 2030	--	--	IPA Tank 9	10,000	15	gallons
ST136	I	Q3 2028	Q4 2030	--	--	IPA Tank 10	10,000	15	gallons
ST137	I	Q3 2028	Q4 2030	--	--	IPA Tank 11	10,000	15	gallons
ST138	I	Q3 2028	Q4 2030	--	--	IPA Tank 12	10,000	15	gallons
ST139	I	Q3 2028	Q4 2030	--	--	IPA Tank 13	10,000	15	gallons
ST140	I	Q3 2028	Q4 2030	--	--	IPA Tank 14	10,000	15	gallons
ST141	I	Q3 2028	Q4 2030	--	--	IPA Tank 15	10,000	15	gallons
ST142	I	Q3 2028	Q4 2030	--	--	IPA Tank 16	10,000	15	gallons
ST143	I	Q3 2028	Q4 2030	--	--	PGMEA Tank 5	6,500	15	gallons
ST144	I	Q3 2028	Q4 2030	--	--	PGMEA Tank 6	6,500	15	gallons
ST145	I	Q3 2028	Q4 2030	--	--	PGMEA Tank 7	6,500	15	gallons
ST146	I	Q3 2028	Q4 2030	--	--	PGMEA Tank 8	6,500	15	gallons
SOD02	I	Q3 2028	Q4 2030	--	--		--	--	--
DT005	I	Q3 2028	Q4 2030	--	--	Diesel Tank 5	25,000	15	gallons
DT006	I	Q3 2028	Q4 2030	--	--	Diesel Tank 6	25,000	15	gallons
DT007	I	Q3 2028	Q4 2030	--	--	Diesel Tank 7	25,000	15	gallons
DT008	I	Q3 2028	Q4 2030	--	--	Diesel Tank 8	25,000	15	gallons
ST147	I	Q3 2028	Q4 2030	--	--	Sodium Hypochlorite 12% Tank 2	7,000	15	gallons
ST148	I	Q3 2028	Q4 2030	--	--	Biocide Tank 2	2,000	15	gallons
ST149	I	Q3 2028	Q4 2030	--	--	Corrosion Inhibitor Tank 2	2,000	15	gallons
ST150	I	Q3 2028	Q4 2030	--	--	Antiscalant and Biocide Tank 2	2,000	15	gallons
CT112	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT113	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT114	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT115	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT116	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT117	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT118	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT119	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT120	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT121	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT122	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT123	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT124	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT125	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
CT126	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT127	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT128	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT129	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT130	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT131	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT132	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT133	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT134	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT135	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT136	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT137	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT138	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT139	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT140	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT141	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT142	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT143	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT144	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT145	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT146	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT147	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT148	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT149	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT150	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT151	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT152	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT153	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT154	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT155	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT156	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT157	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT158	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT159	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT160	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT161	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT162	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT163	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT164	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT165	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT166	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT167	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT168	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT169	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT170	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT171	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT172	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT173	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT174	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT175	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT176	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT177	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT178	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT179	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT180	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT181	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
CT182	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT183	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT184	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT185	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT186	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT187	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT188	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT189	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT190	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT191	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT192	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT193	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT194	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT195	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT196	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT197	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT198	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT199	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT200	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT201	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT202	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT203	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT204	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT205	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT206	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT207	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT208	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT209	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT210	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT211	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT212	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT213	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT214	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT215	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT216	I	Q3 2028	Q4 2030	--	--		2,500	115	gallons per minute
CT217	I	Q3 2028	Q4 2030	--	--		14,500	115	gallons per minute
CT218	I	Q3 2028	Q4 2030	--	--		14,500	115	gallons per minute
CT219	I	Q3 2028	Q4 2030	--	--		14,500	115	gallons per minute
CT220	I	Q3 2028	Q4 2030	--	--		14,500	115	gallons per minute
CT221	I	Q3 2028	Q4 2030	--	--		14,500	115	gallons per minute
CT222	I	Q3 2028	Q4 2030	--	--		14,500	115	gallons per minute
AS105	K	Q4 2025	Q1 2029	001	wet scrubber		15,000	39	cubic feet per minute
AS106	K	Q4 2025	Q1 2029	001	wet scrubber		15,000	39	cubic feet per minute
AS107	K	Q4 2025	Q1 2029	001	wet scrubber		15,000	39	cubic feet per minute
AS108	K	Q4 2025	Q1 2029	001	wet scrubber		15,000	39	cubic feet per minute
WWT01	I	Q4 2025	Q1 2029	--	--		--	--	--
ST151	I	Q4 2025	Q1 2029	--	--	Hydrochloric Acid 36% Tank 1	10,000	15	gallons
ST152	I	Q4 2025	Q1 2029	--	--	Hydrochloric Acid 36% Tank 2	10,000	15	gallons
ST153	I	Q4 2025	Q1 2029	--	--	Sodium Bisulphite Tank 1	5,000	15	gallons
ST154	I	Q4 2025	Q1 2029	--	--	Sodium Bisulphite Tank 2	5,000	15	gallons
ST155	I	Q4 2025	Q1 2029	--	--	Calcium Chloride 35% Tank 1	16,000	15	gallons
ST156	I	Q4 2025	Q1 2029	--	--	Calcium Chloride 35% Tank 2	16,000	15	gallons
ST157	I	Q4 2025	Q1 2029	--	--	Calcium Chloride 35% Tank 3	16,000	15	gallons
ST158	I	Q4 2025	Q1 2029	--	--	Calcium Chloride 35% Tank 4	16,000	15	gallons
ST159	I	Q4 2025	Q1 2029	--	--	Aluminium Sulfate, 8% Tank 1	16,000	15	gallons
ST160	I	Q4 2025	Q1 2029	--	--	Aluminium Sulfate, 8% Tank 2	16,000	15	gallons

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
ST161	I	Q4 2025	Q1 2029	--	--	Aluminium Chlorohydrate, 23% Tank 1	5,300	15	gallons
ST162	I	Q4 2025	Q1 2029	--	--	Aluminium Chlorohydrate, 23% Tank 2	5,300	15	gallons
ST163	I	Q4 2025	Q1 2029	--	--	Catalase Tank 1	2,600	15	gallons
ST164	I	Q4 2025	Q1 2029	--	--	Catalase Tank 2	2,600	15	gallons
ST165	I	Q4 2025	Q1 2029	--	--	Sulfuric acid Tank 1	15,000	15	gallons
ST166	I	Q4 2025	Q1 2029	--	--	Sulfuric acid Tank 2	15,000	15	gallons
ST167	I	Q4 2025	Q1 2029	--	--	Ferric Chloride Tank 1	16,500	15	gallons
ST168	I	Q4 2025	Q1 2029	--	--	Ferric Chloride Tank 2	16,500	15	gallons
WS073	I	Q4 2025	Q1 2029	--	--	Waste Phosphoric Acid Tank 1	13,209	15	gallons
WS074	I	Q4 2025	Q1 2029	--	--	Waste Phosphoric Acid Tank 2	13,209	15	gallons
WS075	I	Q4 2025	Q1 2029	--	--	Waste Phosphoric Acid Tank 3	13,209	15	gallons
WS076	I	Q4 2025	Q1 2029	--	--	Waste Phosphoric Acid Tank 4	13,209	15	gallons
WS077	I	Q4 2025	Q1 2029	--	--	Waste Concentrated HF Tank 1	13,209	15	gallons
WS078	I	Q4 2025	Q1 2029	--	--	Waste Concentrated HF Tank 2	13,209	15	gallons
WS079	I	Q4 2025	Q1 2029	--	--	Waste Concentrated HF Tank 3	13,209	15	gallons
WS080	I	Q4 2025	Q1 2029	--	--	Waste Concentrated HF Tank 4	13,209	15	gallons
WS081	I	Q4 2025	Q1 2029	--	--	Waste Nitric Acid Tank 1	13,209	15	gallons
WS082	I	Q4 2025	Q1 2029	--	--	Waste Nitric Acid Tank 2	13,209	15	gallons
WS083	I	Q4 2025	Q1 2029	--	--	Waste Nitric Acid Tank 3	13,209	15	gallons
WS084	I	Q4 2025	Q1 2029	--	--	Waste Nitric Acid Tank 4	13,209	15	gallons
WS085	I	Q4 2025	Q1 2029	--	--	Waste Copper Sulfate Tank 1	2,642	15	gallons
WS086	I	Q4 2025	Q1 2029	--	--	Waste Copper Sulfate Tank 2	2,642	15	gallons
WS087	I	Q4 2025	Q1 2029	--	--	Waste Copper Sulfate Tank 3	2,642	15	gallons
WS088	I	Q4 2025	Q1 2029	--	--	Waste Copper Sulfate Tank 4	2,642	15	gallons
WS089	I	Q4 2025	Q1 2029	--	--	Waste Dilute Sulfuric Peroxide Tank 1	13,209	15	gallons
WS090	I	Q4 2025	Q1 2029	--	--	Waste Dilute Sulfuric Peroxide Tank 2	13,209	15	gallons
WS091	I	Q4 2025	Q1 2029	--	--	Waste Dilute Sulfuric Peroxide Tank 3	13,209	15	gallons
WS092	I	Q4 2025	Q1 2029	--	--	Waste Dilute Sulfuric Peroxide Tank 4	13,209	15	gallons
WLB01	I	Q4 2025	Q1 2029	--	--		--	--	--
BS049	K	Q4 2025	Q1 2029	001	wet scrubber		2,000	39	cubic feet per minute
BS050	K	Q4 2025	Q1 2029	001	wet scrubber		2,000	39	cubic feet per minute
BS051	K	Q4 2025	Q1 2029	001	wet scrubber		2,000	39	cubic feet per minute
ST169	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide 50% Tank 1	21,000	15	gallons
ST170	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide 50% Tank 2	21,000	15	gallons
ST171	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide 50% Tank 3	21,000	15	gallons
ST172	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide 50% Tank 4	21,000	15	gallons
ST173	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide 50% Tank 5	21,000	15	gallons
ST174	I	Q4 2025	Q1 2029	--	--	Sodium Hypochlorite 12% Tank 1	8,000	15	gallons
ST175	I	Q4 2025	Q1 2029	--	--	Sodium Hypochlorite 12% Tank 2	8,000	15	gallons
TO089	K	Q4 2025	Q1 2029	127	thermal oxidation		2,000	39	cubic feet per minute
TO090	K	Q4 2025	Q1 2029	127	thermal oxidation		2,000	39	cubic feet per minute
TO091	K	Q4 2025	Q1 2029	127	thermal oxidation		2,000	39	cubic feet per minute
SIL01	I	Q4 2025	Q1 2029	--	--	Lime Silo 1	111.4	34	tons
SIL02	I	Q4 2025	Q1 2029	--	--	Lime Silo 2	111.4	34	tons
OS001	I	Q4 2025	Q1 2029	--	--	General/ Odor Scrubber 1	66,234	39	cubic feet per minute
OS002	I	Q4 2025	Q1 2029	--	--	General/ Odor Scrubber 2	66,234	39	cubic feet per minute
BIO01	I	Q4 2025	Q1 2029	--	--		N/A		
ST176	I	Q4 2025	Q1 2029	--	--	Sodium Hydroxide 50% Tank 1	18,000	15	gallons
ST177	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 70% Tank 1	6,500	15	gallons
ST178	I	Q4 2025	Q1 2029	--	--	Sulfuric Acid 70% Tank 2	6,500	15	gallons
ST179	I	Q4 2025	Q1 2029	--	--	Sodium Bisulphite 25% Tank 1	10,000	15	gallons
ST180	I	Q4 2025	Q1 2029	--	--	Phosphoric Acid 85% Tank 1	10,000	15	gallons
ST181	I	Q4 2025	Q1 2029	--	--	Phosphoric Acid 85% Tank 2	10,000	15	gallons
ST182	I	Q4 2025	Q1 2029	--	--	Citric Acid 50% Tank 1	5,000	15	gallons
ST183	I	Q4 2025	Q1 2029	--	--	Sodium Hypochlorite 12% Tank 1	20,000	15	gallons
AS109	K	Q3 2028	Q4 2030	001	wet scrubber		15,000	39	cubic feet per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
AS110	K	Q3 2028	Q4 2030	001	wet scrubber		15,000	39	cubic feet per minute
AS111	K	Q3 2028	Q4 2030	001	wet scrubber		15,000	39	cubic feet per minute
AS112	K	Q3 2028	Q4 2030	001	wet scrubber		15,000	39	cubic feet per minute
WWT02	I	Q3 2028	Q4 2030	--	--		--	--	--
ST184	I	Q3 2028	Q4 2030	--	--	Hydrochloric Acid 36% Tank 3	10,000	15	gallons
ST185	I	Q3 2028	Q4 2030	--	--	Hydrochloric Acid 36% Tank 4	10,000	15	gallons
ST186	I	Q3 2028	Q4 2030	--	--	Sodium Bisulphite Tank 3	5,000	15	gallons
ST187	I	Q3 2028	Q4 2030	--	--	Sodium Bisulphite Tank 4	5,000	15	gallons
ST188	I	Q3 2028	Q4 2030	--	--	Calcium Chloride 35% Tank 5	16,000	15	gallons
ST189	I	Q3 2028	Q4 2030	--	--	Calcium Chloride 35% Tank 6	16,000	15	gallons
ST190	I	Q3 2028	Q4 2030	--	--	Calcium Chloride 35% Tank 7	16,000	15	gallons
ST191	I	Q3 2028	Q4 2030	--	--	Calcium Chloride 35% Tank 8	16,000	15	gallons
ST192	I	Q3 2028	Q4 2030	--	--	Aluminium Sulfate, 8% Tank 3	16,000	15	gallons
ST193	I	Q3 2028	Q4 2030	--	--	Aluminium Sulfate, 8% Tank 4	16,000	15	gallons
ST194	I	Q3 2028	Q4 2030	--	--	Aluminium Chlorohydrate, 23% Tank 3	5,300	15	gallons
ST195	I	Q3 2028	Q4 2030	--	--	Aluminium Chlorohydrate, 23% Tank 4	5,300	15	gallons
ST196	I	Q3 2028	Q4 2030	--	--	Catalase Tank 3	2,600	15	gallons
ST197	I	Q3 2028	Q4 2030	--	--	Catalase Tank 4	2,600	15	gallons
ST198	I	Q3 2028	Q4 2030	--	--	Sulfuric acid Tank 3	15,000	15	gallons
ST199	I	Q3 2028	Q4 2030	--	--	Sulfuric acid Tank 4	15,000	15	gallons
ST200	I	Q3 2028	Q4 2030	--	--	Ferric Chloride Tank 3	16,500	15	gallons
ST201	I	Q3 2028	Q4 2030	--	--	Ferric Chloride Tank 4	16,500	15	gallons
WS093	I	Q3 2028	Q4 2030	--	--	Waste Phosphoric Acid Tank 5	13,209	15	gallons
WS094	I	Q3 2028	Q4 2030	--	--	Waste Phosphoric Acid Tank 6	13,209	15	gallons
WS095	I	Q3 2028	Q4 2030	--	--	Waste Phosphoric Acid Tank 7	13,209	15	gallons
WS096	I	Q3 2028	Q4 2030	--	--	Waste Phosphoric Acid Tank 8	13,209	15	gallons
WS097	I	Q3 2028	Q4 2030	--	--	Waste Concentrated HF Tank 5	13,209	15	gallons
WS098	I	Q3 2028	Q4 2030	--	--	Waste Concentrated HF Tank 6	13,209	15	gallons
WS099	I	Q3 2028	Q4 2030	--	--	Waste Concentrated HF Tank 7	13,209	15	gallons
WS100	I	Q3 2028	Q4 2030	--	--	Waste Concentrated HF Tank 8	13,209	15	gallons
WS101	I	Q3 2028	Q4 2030	--	--	Waste Nitric Acid Tank 5	13,209	15	gallons
WS102	I	Q3 2028	Q4 2030	--	--	Waste Nitric Acid Tank 6	13,209	15	gallons
WS103	I	Q3 2028	Q4 2030	--	--	Waste Nitric Acid Tank 7	13,209	15	gallons
WS104	I	Q3 2028	Q4 2030	--	--	Waste Nitric Acid Tank 8	13,209	15	gallons
WS105	I	Q3 2028	Q4 2030	--	--	Waste Copper Sulfate Tank 5	2,642	15	gallons
WS106	I	Q3 2028	Q4 2030	--	--	Waste Copper Sulfate Tank 6	2,642	15	gallons
WS107	I	Q3 2028	Q4 2030	--	--	Waste Copper Sulfate Tank 7	2,642	15	gallons
WS108	I	Q3 2028	Q4 2030	--	--	Waste Copper Sulfate Tank 8	2,642	15	gallons
WS109	I	Q3 2028	Q4 2030	--	--	Waste Dilute Sulfuric Peroxide Tank 5	13,209	15	gallons
WS110	I	Q3 2028	Q4 2030	--	--	Waste Dilute Sulfuric Peroxide Tank 6	13,209	15	gallons
WS111	I	Q3 2028	Q4 2030	--	--	Waste Dilute Sulfuric Peroxide Tank 7	13,209	15	gallons
WS112	I	Q3 2028	Q4 2030	--	--	Waste Dilute Sulfuric Peroxide Tank 8	13,209	15	gallons
WLB02	I	Q3 2028	Q4 2030	--	--		--	--	--
BS052	K	Q3 2028	Q4 2030	001	wet scrubber		2,000	39	cubic feet per minute
BS053	K	Q3 2028	Q4 2030	001	wet scrubber		2,000	39	cubic feet per minute
BS054	K	Q3 2028	Q4 2030	001	wet scrubber		2,000	39	cubic feet per minute
ST202	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide 50% Tank 6	21,000	15	gallons
ST203	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide 50% Tank 7	21,000	15	gallons
ST204	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide 50% Tank 8	21,000	15	gallons
ST205	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide 50% Tank 9	21,000	15	gallons
ST206	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide 50% Tank 10	21,000	15	gallons
ST207	I	Q3 2028	Q4 2030	--	--	Sodium Hypochlorite 12% Tank 3	8,000	15	gallons
ST208	I	Q3 2028	Q4 2030	--	--	Sodium Hypochlorite 12% Tank 4	8,000	15	gallons
TO092	K	Q3 2028	Q4 2030	127	thermal oxidation		2,000	39	cubic feet per minute
TO093	K	Q3 2028	Q4 2030	127	thermal oxidation		2,000	39	cubic feet per minute
TO094	K	Q3 2028	Q4 2030	127	thermal oxidation		2,000	39	cubic feet per minute

Emission Source		Date of Construction	Date of Operation	Control Type		Manufacturer Name/ Model Number/ Description (if not described on EU Matrix)	Design Capacity	Design Capacity Units	
ID	Type			Code	Description			Code	Description
SIL04	I	Q3 2028	Q4 2030	--	--	Lime Silo 3	111.4	34	tons
SIL05	I	Q3 2028	Q4 2030	--	--	Lime Silo 4	111.4	34	tons
OS003	I	Q3 2028	Q4 2030	--	--	General/ Odor Scrubber 3	66,234	39	cubic feet per minute
OS004	I	Q3 2028	Q4 2030	--	--	General/ Odor Scrubber 4	66,234	39	cubic feet per minute
BIO02	I	Q3 2028	Q4 2030	--	--		--	--	--
ST209	I	Q3 2028	Q4 2030	--	--	Sodium Hydroxide 50% Tank 2	18,000	15	gallons
ST210	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 70% Tank 3	6,500	15	gallons
ST211	I	Q3 2028	Q4 2030	--	--	Sulfuric Acid 70% Tank 4	6,500	15	gallons
ST212	I	Q3 2028	Q4 2030	--	--	Sodium Bisulphite 25% Tank 2	10,000	15	gallons
ST213	I	Q3 2028	Q4 2030	--	--	Phosphoric Acid 85% Tank 3	10,000	15	gallons
ST214	I	Q3 2028	Q4 2030	--	--	Phosphoric Acid 85% Tank 4	10,000	15	gallons
ST215	I	Q3 2028	Q4 2030	--	--	Citric Acid 50% Tank 2	5,000	15	gallons
ST216	I	Q3 2028	Q4 2030	--	--	Sodium Hypochlorite 12% Tank 2	20,000	15	gallons
AS113	K	Q4 2025	Q1 2029	001	wet scrubber		10,000	39	cubic feet per minute
AS114	K	Q4 2025	Q1 2029	001	wet scrubber		10,000	39	cubic feet per minute
ALB01	I	Q4 2025	Q1 2029	--	--		--	--	--
TO095	K	Q4 2025	Q1 2029	127	thermal oxidation		4,000	39	cubic feet per minute
TO096	K	Q4 2025	Q1 2029	127	thermal oxidation		4,000	39	cubic feet per minute
AS115	K	Q3 2028	Q4 2030	001	wet scrubber		10,000	39	cubic feet per minute
AS116	K	Q3 2028	Q4 2030	001	wet scrubber		10,000	39	cubic feet per minute
ALB02	I	Q3 2028	Q4 2030	--	--		--	--	--
TO097	K	Q3 2028	Q4 2030	127	thermal oxidation		4,000	39	cubic feet per minute
TO098	K	Q3 2028	Q4 2030	127	thermal oxidation		4,000	39	cubic feet per minute

Table A-3 - Section IV Pg. 6 Process Description

Emission Unit	Process	Description	Source Classification Code (SCC)	Operating Schedule		Building	Emission Point Identifiers	Emission Source/Control Identifiers
				Hours/Day	Days/Year			
1-FABOP	FA1	Fab 1 semiconductor manufacturing processes exhausting to centralized acid gas scrubbers, including Ion Implant, Plasma Etch, and Wet Etch/Wet Clean processes, as well as associated safety and support equipment and control devices, including point-of-use (POU) control devices and regenrative catalytic systems (RCS).	31306599	24	365	FAB1	1F001 - 1F040	AS001 - AS040 PLE01 POU01 RCS01 - RCS10 IMP01 WET01
1-FABOP	FC1	Fab 1 semiconductor manufacturing processes exhausting to centralized ionizing wet scrubbers capable of scrubbing NO2, including Thin Films/Diffusion Deposition processes as well as associated safety and support equipment.	31306599	24	365	FAB1	1F041 - 1F056	CS001 - CS016 TFD01
1-FABOP	FB1	Fab 1 semiconductor manufacturing processes exhausting to centralized caustic gas scrubbers, including Photolithography, Wet Etch/Wet Clean, and Chemical-Mechanical Planarization processes, as well as associated safety and support equipment.	31306599	24	365	FAB1	1F057 - 1F072	BS001 - BS016 PHO01 WET01 CMP01 ST001 - ST006
1-FABOP	FS1	Fab 1 semiconductor manufacturing processes exhausting to centralized rotor-concentrator thermal oxidizers, including Photolithography and Wet Etch/Wet Clean processes, solvent waste storage, as well as associated safety and support equipment.	31306599	24	365	FAB1	1F073 - 1F144	TO001 - TO036 PHO01 WET01 WS001 - WS030
1-FABOP	FG1	General ventilation for Fab 1 including the cleanroom, which may include emissions of air contaminants not collected by other semiconductor manufacturing process exhaust systems.	31306599	24	365	FAB1	1F145 - 1F184	GN001 - GN040
2-FABOP	FA2	Fab 2 semiconductor manufacturing processes exhausting to centralized acid gas scrubbers, including Ion Implant, Plasma Etch, and Wet Etch/Wet Clean processes, as well as associated safety and support equipment and control devices, including point-of-use (POU) control devices and regenrative catalytic systems (RCS).	31306599	24	365	FAB2	2F001 - 2F040	AS041 - AS080 PLE02 POU02 RCS11 - RCS20 IMP02 WET02
2-FABOP	FC2	Fab 2 semiconductor manufacturing processes exhausting to centralized ionizing wet scrubbers capable of scrubbing NO2, including Thin Films/Diffusion Deposition processes as well as associated safety and support equipment.	31306599	24	365	FAB2	2F041 - 2F056	CS017 - CS032 TFD02
2-FABOP	FB2	Fab 2 semiconductor manufacturing processes exhausting to centralized caustic gas scrubbers, including Photolithography, Wet Etch/Wet Clean, and Chemical-Mechanical Planarization processes, as well as associated safety and support equipment.	31306599	24	365	FAB2	2F057 - 2F072	BS017 - BS032 PHO02 WET02 CMP02 ST007 - ST012
2-FABOP	FS2	Fab 2 semiconductor manufacturing processes exhausting to centralized rotor-concentrator thermal oxidizers, including Photolithography and Wet Etch/Wet Clean processes, solvent waste storage, as well as associated safety and support equipment.	31306599	24	365	FAB2	2F073 - 2F144	TO037 - TO072 PHO02 WET02 WS031-WS060
2-FABOP	FG2	General ventilation for Fab 1 including the cleanroom, which may include emissions of air contaminants not collected by other semiconductor manufacturing process exhaust systems.	31306599	24	365	FAB2	2F145 - 2F184	GN041 - GN080
1-CMBOP	BLR	Natural-gas fired boilers.	10200602	24	250	CUB1	1U001 - 1U003	BLR01 - BLR03
1-CMBOP	WBV	Water bath vaporizers fired by natural gas as a backup measure to vaporize liquid nitrogen.	10200602	24	83.3	N/A	1U004 - 1U007	WBV01 - WBV04
1-CMBOP	EMD	Diesel-fired emergency generators.	20100102	Variable	Variable	CUB1	1U008 - 1U067	DG001 - DG060
1-CMBOP	DFP	Diesel-fired backup fire pump engine.	20200102	0.5	52	N/A	1FP01	FP001
2-CMBOP	BLR	Natural-gas fired boilers.	10200602	24	250	CUB2	2U001 - 2U003	BLR04 - BLR06
2-CMBOP	WBV	Water bath vaporizers fired by natural gas as a backup measure to vaporize liquid nitrogen.	10200602	24	83.3	N/A	2U004 - 2U007	WBV05 - WBV08
2-CMBOP	EMD	Diesel-fired emergency generators.	20100102	Variable	Variable	CUB2	2U008 - 2U065	DG061 - DG118
1-HPMCU	HA1	Storage of acidic raw materials and waste materials exhausting to acid gas scrubbers in the HPM buildings supporting Fab 1.	2520010020	24	365	HPM1	1H001 - 1H008	AS081 - AS088 ST013 - ST044 WS061 - WS066

Emission Unit	Process	Description	Source Classification Code (SCC)	Operating Schedule		Building	Emission Point Identifiers	Emission Source/Control Identifiers
				Hours/Day	Days/Year			
1-HPMCU	CA1	Storage of acidic raw materials exhausting to acid gas scrubbers in the CUB building supporting Fab 1.	2520010020	24	365	CUB1	1C001 - 1C004	AS089 - AS092 ST045
1-HPMCU	HB1	Storage of basic raw materials exhausting to caustic gas scrubbers in the HPM buildings supporting Fab 1.	2520010010	24	365	HPM1	1H009 - 1H016	BS033 - BS040 ST046 - ST065
1-HPMCU	HS1	Storage of solvents in the HPM buildings supporting Fab 1.	2640010004	24	365	HPM1	1H017 - 1H032	TO073 - TO080 ST066 - ST077 SOD01
1-HPMCU	DT1	Storage of diesel fuel to support Fab 1 engines.	2501010090; 2501995090	24	365	N/A	1D001 - 1D004	DT001 - DT004
1-HPMCU	FU1	Fugitive emissions related to Fab 1.	31306599	24	365	CUB1	-	ST078 - ST081
1-HPMCU	CT1	Cooling towers supporting Fab 1.	38500110	24	365	CUB1	1C005 - 1C109 1G001 - 1G006	CT001 - CT105 CT106 - CT111
2-HPMCU	HA2	Storage of acidic raw materials and waste materials exhausting to acid gas scrubbers in the HPM buildings supporting Fab 2.	2520010020	24	365	HPM2	2H001 - 2H008	AS093 - AS100 ST082 - ST113 WS067 - WS072
2-HPMCU	CA2	Storage of acidic raw materials exhausting to acid gas scrubbers in the CUB building supporting Fab 2.	2520010020	24	365	CUB2	2C001 - 2C004	AS101 - AS104 ST114
2-HPMCU	HB2	Storage of basic raw materials exhausting to caustic gas scrubbers in the HPM buildings supporting Fab 2.	2520010010	24	365	HPM2	2H009 - 2H016	BS041 - BS048 ST115 - ST134
2-HPMCU	HS2	Storage of solvents in the HPM buildings supporting Fab 2.	2640010004	24	365	HPM2	2H017 - 2H032	TO081 - TO088 ST135 - ST146 SOD02
2-HPMCU	DT2	Storage of diesel fuel to support Fab 2 engines.	2501010090; 2501995090	24	365	N/A	2D001 - 2D004	DT005 - DT008
2-HPMCU	FU2	Fugitive emissions related to Fab 2.	31306599	24	365	CUB2	-	ST147 - ST150
2-HPMCU	CT2	Cooling towers supporting Fab 2.	38500110	24	365	CUB2	2C005 - 2C109 2G001 - 2G006	CT112 - CT216 CT217 - CT222
1-WWBIO	WA1	Wastewater treatment operations and storage of acidic raw materials and waste materials exhausting to acid gas scrubbers in the WWT building supporting Fab 1.	2520010020	24	365	WWT1	1W001 - 1W004	AS105 - AS108 WWT01 ST151 - ST168 WS073 - WS092 WLB01
1-WWBIO	WB1	Wastewater treatment operations and storage of basic raw materials exhausting to caustic gas scrubbers in the WWT building supporting Fab 1.	2520010010	24	365	WWT1	1W005 - 1W007	BS049 - BS051 WWT01 ST169 - ST175 WLB01
1-WWBIO	WS1	Wastewater treatment operations and storage of solvents exhausting to rotor-concentrator thermal oxidizers in the WWT building supporting Fab 1.	2640010004	24	365	WWT1	1W008 - 1W010	TO089 - TO091 WWT01 WLB01
1-WWBIO	SL1	Solid material storage silos supporting Fab 1.	30501613	24	365	N/A	1W011, 1W012	SIL01 - SIL02
1-WWBIO	BG1	Bilological treatment processes and storage of raw materials supporting Fab 1.	2630010000	24	365	BIO1	1B001 - 1B002	OS001 - OS002 BIO01 ST176 - ST178 BLB01
1-WWBIO	FU1	Fugitive emissions related to Fab 1.	31306599	24	365	BIO1	-	ST179 - ST183
2-WWBIO	WA2	Wastewater treatment operations and storage of acidic raw materials and waste materials exhausting to acid gas scrubbers in the WWT building supporting Fab 2.	2520010020	24	365	WWT2	2W001 - 2W004	AS109 - AS112 WWT02 ST184 - ST201 WS093 - WS0112 WLB02

Emission Unit	Process	Description	Source Classification Code (SCC)	Operating Schedule		Building	Emission Point Identifiers	Emission Source/Control Identifiers
				Hours/Day	Days/Year			
2-WWBIO	WB2	Wastewater treatment operations and storage of basic raw materials exhausting to caustic gas scrubbers in the WWT building supporting Fab 2.	2520010010	24	365	WWT2	2W005 - 2W007	BS052 - BS054 WWT02 ST202 - ST208 WLB02
2-WWBIO	WS2	Wastewater treatment operations and storage of solvents exhausting to rotor-concentrator thermal oxidizers in the WWT building supporting Fab 2.	2640010004	24	365	WWT2	2W008 - 2W010	TO092 - TO094 WWT02 WLB02
2-WWBIO	SL2	Solid material storage silos supporting Fab 2.	30501613	24	365	N/A	2W011, 2W012	SIL03 - SIL04
2-WWBIO	BG2	Bilological treatment processes and storage of raw materials supporting Fab 2.	2630010000	24	365	BIO2	2B001 - 2B002	OS003 - OS004 BIO02 ST209 - ST211 BLB02
2-WWBIO	FU2	Fugitive emissions related to Fab 2.	31306599	24	365	BIO2	-	ST212 - ST216
1-ADMPR	AA1	Laboratory operations exhausting to acid gas scrubbers in the Admin/Probe buildings supporting Fab 1.	31306599	24	365	PROBE1	1A001 - 1A002	AS113 - AS114 ALB01
1-ADMPR	AS1	Laboratory operations exhausting solvent gases in the Admin/Probe buildings supporting Fab 1.	31306599	24	365	PROBE1	1A003 - 1A004	TO095 - TO096 ALB01
2-ADMPR	AA2	Laboratory operations exhausting to acid gas scrubbers in the Admin/Probe buildings supporting Fab 2.	31306599	24	365	PROBE2	2A001 - 2A002	AS115 - AS116 ALB02
2-ADMPR	AS2	Laboratory operations exhausting solvent gases in the Admin/Probe buildings supporting Fab 2.	31306599	24	365	PROBE2	2A003 - 2A004	TO097 - TO098 ALB02

APPENDIX B. LIST OF EXEMPT ACTIVITIES

New York State Department of Environmental Conservation
Air Permit Application

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

DEC ID
- -

Date of Form
March 2025

List of Exempt Activities

Instructions

Applicants for Title V facility permits must provide a listing of each exempt activity, as described in 6 NYCRR Part 201-3.2(c), that is currently operated at the facility. This form must be provided with each application for a new Title V facility permit and Title V facility permit renewal, or whenever changes are necessary. In order to complete this form, enter the number and building location of each exempt activity conducted. Building IDs used on this form should match those used in the Title V permit application. Provide all additional information where requested. If a listed activity is not operated at the facility, leave the corresponding information blank.

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
	Combustion		
(1)	Stationary or portable combustion installations where the furnace has a maximum rated heat input capacity less than 10 MMBtu/hr burning liquid or gaseous fuels; or a maximum heat input capacity of less than 1 MMBtu/hr burning solid fuels. This activity does not include combustion installations burning any material classified as solid waste, as defined in 6 NYCRR Part 360, hazardous waste, as defined in 6 NYCRR Part 371, or waste oil, as defined in 6 NYCRR Subpart 225-2. **For each activity listed, attach documentation indicating the date of construction, heat input (MMBtu/hr), and the type of fuel combusted.**		
(2)	Space heaters burning waste oil at eligible facilities, as defined in 6 NYCRR Subpart 225-2, generated on-site or at a facility under common control, alone or in conjunction with used oil generated by a do-it-yourself oil changer as described in 6 NYCRR Subpart 374-2.		
(3)(i)	Stationary or portable internal combustion engines that are liquid or gaseous fuel powered and located within the New York City metropolitan area or the Orange County towns of Blooming Grove, Chester, Highlands, Monroe, Tuxedo, Warwick, or Woodbury, and have a maximum mechanical power rating of less than 200 brake horsepower. **For each activity listed, attach documentation indicating the date of construction, engine model year, engine rating (hp), displacement (L/cylinder), type of fuel combusted, and EPA issued certificate of conformity.**		

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
(3)(ii)	Stationary or portable internal combustion engines that are liquid or gaseous fuel powered and located outside of the New York City metropolitan area or the Orange County towns of Blooming Grove, Chester, Highlands, Monroe, Tuxedo, Warwick, or Woodbury, and have a maximum mechanical power rating of less than 400 brake horsepower. **For each activity listed, attach documentation indicating the date of construction, engine model year, engine rating (hp), displacement (L/cylinder), type of fuel combusted, and EPA issued certificate of conformity.**		
(3)(iii)	Stationary or portable internal combustion engines that are gasoline powered and have a maximum mechanical power rating of less than 50 brake horsepower.		
(4)	Reserved.		
(5)	Gas turbines with a heat input at peak load less then 10 MMBtu/hour		
(6)	Emergency power generating stationary internal combustion engines, as defined in 6 NYCRR Part 200.1(cq). Stationary internal combustion engines used for peak shaving and/or demand response programs are not exempt. **For each activity listed, attach documentation indicating the date of construction, engine model year, engine rating (hp), displacement (L/cylinder), type of fuel combusted, and EPA issued certificate of conformity.**	119	Various
Combustion Related			
(7)	Non-contact water cooling towers and water treatment systems for process cooling water and other water containers designed to cool, store or otherwise handle water that has not been in direct contact with gaseous or liquid process streams.	222	CUB 1, CUB 2
Agricultural			
(8)	Feed and grain milling, cleaning, conveying, drying and storage operations including grain storage silos, where such silos exhaust to an appropriate emissions control device, excluding grain terminal elevators with permanent storage capacities over 2.5 million U.S. bushels, and grain storage elevators with capacities above one million bushels.		

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
(9)	Equipment used exclusively to slaughter animals, but not including other equipment at slaughterhouses, such as rendering cookers, boilers, heating plants, incinerators, and electrical power generating equipment.		
	Commercial - Food Service Industries		
(10)	Flour silos at bakeries, provided all such silos are exhausted through an appropriate emission control device.		
(11)	Emissions from flavorings added to a food product where such flavors are manually added to the product.		
	Commercial - Graphic Arts		
(12)	Screen printing inks/coatings or adhesives which are applied by a hand-held squeegee. A hand-held squeegee is one that is not propelled though the use of mechanical conveyance and is not an integral part of the screen printing process.		
(13)	Graphic arts processes at facilities located outside the New York City metropolitan area or the Orange County towns of Blooming Grove, Chester, Highlands, Monroe, Tuxedo, Warwick, or Woodbury whose facility-wide total emissions of volatile organic compounds from inks, coatings, adhesives, fountain solutions and cleaning solutions are less than three tons during any 12-month period.		
(14)	Graphic label and/or box labeling operations where the inks are applied by stamping or rolling.		
(15)	Graphic arts processes which are specifically exempted from regulation under 6 NYCRR Part 234, with respect to emissions of volatile organic compounds which are not given an A rating as described in 6 NYCRR Part 212.		
	Commercial - Other		
(16)	Gasoline dispensing sites registered with the department pursuant to 6 NYCRR Part 613.		

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
(17)	Surface coating and related activities at facilities which use less than 25 gallons per month of total coating materials, or with actual volatile organic compound emissions of 1,000 pounds or less from coating materials in any 12-month period. Coating materials include all paints and paint components, other materials mixed with paints prior to application, and cleaning solvents, combined. This exemption is subject to the following: (i) The facility is located outside of the New York City metropolitan area or the Orange County towns of Blooming Grove, Chester, Highlands, Monroe, Tuxedo, Warwick, or Woodbury; and (ii) All abrasive cleaning and surface coating operations are performed in an enclosed building where such operations are exhausted into appropriate emission control devices.		
(18)	Abrasive cleaning operations which exhaust to an appropriate emission control device.		
(19)	Ultraviolet curing operations.		
	Municipal/Public Health Related		
(20)	Landfill gas ventilating systems at landfills with design capacities less than 2.5 million megagrams (3.3 million tons) and 2.5 million cubic meters (2.75 million cubic yards), where the systems are vented directly to the atmosphere, and the ventilating system has been required by, and is operating under, the conditions of a valid 6 NYCRR Part 360 permit, or order on consent.		
	Storage Vessels		
(21)	Distillate fuel oil, residual fuel oil, and biodiesel storage tanks with storage capacities below 300,000 barrels.	8	N/A
(22)	Pressurized fixed roof tanks which are capable of maintaining a working pressure at all times to prevent emissions of volatile organic compounds to the outdoor atmosphere.		
(23)	External floating roof tanks which are of welded construction and are equipped with a metallic-type shoe primary seal and a secondary seal from the top of the shoe seal to the tank wall.		

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
(24)	External floating roof tanks which are used for the storage of a petroleum or volatile organic liquid with a true vapor pressure less than 4.0 psi (27.6 kPa), are of welded construction and are equipped with one of the following: (i) a metallic-type shoe seal; (ii) a liquid-mounted foam seal; (iii) a liquid-mounted liquid-filled type seal; or (iv) equivalent control equipment or device.		
(25)	Storage tanks, including petroleum liquid storage tanks as defined in 6 NYCRR Part 229, and liquid asphalt storage tanks with capacities less than 10,000 gallons, except those subject to 6 NYCRR Part 229 or Part 233.	76	Various
(26)	Horizontal petroleum or volatile organic liquid storage tanks.		
(27)	Storage of solid materials, provided all such storage is exhausted through an appropriate emission control device. This exemption does not include raw material, clinker, or finished product storage at Portland cement plants.	4	N/A
	Industrial		
(28)	Processing equipment at existing sand and gravel and stone crushing plants which were installed or constructed before August 31, 1983, where water is used for operations such as wet conveying, separating, and washing. This exemption does not include processing equipment at existing sand and gravel and stone crushing plants where water is used for dust suppression.		
(29)(i)	Sand and gravel, crushed stone, concrete, or recycled asphalt processing lines at non-metallic mineral processing facilities that are a permanent or fixed installation with a maximum rated processing capacity of 25 tons of minerals per hour or less.		
(29)(ii)	Sand and gravel, crushed stone, concrete, or recycled asphalt processing lines at non-metallic mineral processing facilities that are a portable emission source with a maximum rated processing capacity of 150 tons of minerals per hour or less.		

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
(29)(iii)	Sand and gravel, crushed stone, concrete, or recycled asphalt processing lines at non-metallic mineral processing facilities that are used exclusively to screen minerals at a facility where no crushing or grinding takes place.		
(30)	Reserved.		
(31)	Surface coating operations which are specifically exempted from regulation under 6 NYCRR Subparts 228-1 and 228-2, with respect to emissions of volatile organic compounds which are not given an A rating pursuant to 6 NYCRR Part 212.		
(32)	Pharmaceutical tablet branding operations.		
(33)	Thermal packaging operations, including, but not limited to, therimage labeling, blister packing, shrink wrapping, shrink banding, and carton gluing.		
(34)	Powder coating operations.		
(35)	All tumblers used for the cleaning and/or deburring of metal products without abrasive blasting.		
(36)	Presses used exclusively for molding or extruding plastics except where halogenated polymers are used or where halogenated carbon compounds or hydrocarbon solvents are used as foaming agents.		
(37)	Concrete batch plants where the cement weigh hopper and all bulk storage silos are exhausted through fabric filters, and the batch drop point is controlled by a shroud or other emission control device.		
(38)	Cement storage operations not located at Portland cement plants where materials are transported by screw or bucket conveyors.		
(39)(i)	Cold cleaning degreasers with an open surface area of 11 square feet or less and an internal volume of 93 gallons or less or, having an organic solvent loss of 3 gallons per day or less.		
39(ii)	Conveyorized degreasers with an air/vapor interface smaller than 22 square feet (2 square meters), unless subject to the requirements of 40 CFR 63 Subpart T.		
(39)(iii)	Open-top vapor degreasers with an open-top area smaller than 11 square feet (1.0 square meter), unless subject to the requirements in 40 CFR 63, Subpart T.		
Miscellaneous			
(40)	Ventilating and exhaust systems for laboratory operations. This exemption does not include laboratory operations used to produce products for sale except in a de minimis manner.	8	WWT1, WWT2 Probe1, Probe2

Rule Citation 201-3.2(c)	Description	Number of Activities	Building Location
(41)	Exhaust or ventilating systems for the melting of gold, silver, platinum and other precious metals.		
(42)	Exhaust systems for paint mixing, transfer, filling or sampling and/or paint storage rooms or cabinets, provided the paints stored within these locations are stored in closed containers when not in use.		
(43)	Exhaust systems for solvent transfer, filling or sampling, and/or solvent storage rooms provided the solvents are stored in closed containers when not in use.		
(44)	Reserved		
(45)	The application of odor counteractants and/or neutralizers.		
(46)	Hydrogen, natural gas, and methane fuel cells.		
(47)	Dry cleaning equipment that uses only water-based cleaning processes or those using liquid carbon dioxide.		
(48)	Manure spreading, handling and storage at farms and agricultural facilities.		
(49)	Covered manure storage at farms that exhausts to a flare or other appropriate emission control device. This activity does not include anaerobic digestion processes operating with or without stationary or portable combustion installations.		
(50)	Coffee roasting processes which have a maximum operating capacity of 3 kilograms or less of green coffee beans per batch and no greater than 25 tons of green coffee beans per year, that are vented through an unobstructed, vertical stack that ensures proper dispersion of air contaminants.		
(51)	Process emission sources at breweries with total combined beer and/or malt liquor production of 60,000 barrels per year or less.		
(52)	Process emission sources at wineries with total combined wine and/or brandy production of 700,000 gallons per year or less.		
(53)	Process emission sources at distilleries with 10,000 distiller's bushels of grain input per year or less.		
(54)	Process emission sources at wood and lumber drying kilns with an annual throughput of untreated wood of 275,000 board feet or less.		

APPENDIX D. OPERATIONAL FLEXIBILITY PROTOCOL

This appendix presents the Operational Flexibility Protocol that Micron is proposing in accordance with Title 6 of the New York Codes, Rules and Regulations (NYCRR) 201-6.4(f)(2) to allow for future physical or operational changes to be made without the need for a permit modification.

1.1 Introduction

The nature of Micron's business requires rapidly-changing product mix, architecture, and functionality to meet customer needs. The nature and rapid pace of constant technological change affects the type, number, and configuration of semiconductor process tools required to fabricate devices. A single fab may involve dozens or hundreds of such tools that are connected to the same exhaust header, where process emissions are comingled and then exhausted to centralized (or "house") control devices such as scrubbers and rotor concentrator thermal oxidizers.

The need to frequently adjust the operation of, or replace, tools within the fab, and the centralized emission collection and control system, are both unique to the semiconductor industry. This is demonstrated through the definition of the affected source for the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Semiconductor Manufacturing (Title 40 of the Code of Federal Regulations [CFR], Part 63, Subpart BBBBB, or "Semiconductor MACT"), which is applicable to the operations of the Proposed Air Permit Project.

> *An affected source subject to this subpart is the collection of all semiconductor manufacturing process units used to manufacture p-type and n-type semiconductors and active solid-state devices from a wafer substrate, including research and development activities integrated into a semiconductor manufacturing process unit. A semiconductor manufacturing process unit includes the equipment assembled and connected by ductwork or hard-piping including furnaces and associated unit operations; associated wet and dry work benches; associated recovery devices; feed, intermediate, and product storage tanks; product transfer racks and connected ducts and piping; pumps, compressors, agitators, pressure-relief devices, sampling connecting systems, open-ended valves or lines, valves, connectors, and instrumentation systems; and control devices. [40 CFR 63.7182]*

The lack of specific definition of individual equipment that may generate air emissions in the NESHAP definition of affected sources acknowledges that all of the equipment in a semiconductor fab operation operate as a whole. Due to rapidly changing technologies, this complex collection of equipment needs to be adjusted on a near-daily basis. As such, regulations specific to the semiconductor industry have historically avoided addressing individual pieces of semiconductor manufacturing equipment.

Further, the Semiconductor MACT regulates emissions from the affected source at the process vent to atmosphere for inorganic HAP process vents, organic HAP process vents, or combined process HAP process

vents. As defined in 40 CFR 63.7195, the term "process vent means the point at which HAP emissions are released to the atmosphere from a semiconductor manufacturing process unit or storage tank by means of a stack, chimney, vent, or other functionally equivalent opening…"

An evaluation of the process emission sources (PES) that will be regulated for the Proposed Air Permit Project under 6 NYCRR Part 212 determined that the PES for semiconductor manufacturing operations consist of the group of process tools and supporting equipment that are vented to a common header, and that the emission rate potential (and therefore degree of air cleaning required) for process tools connected to a common header will be determined at the exhaust of the header into the control devices or to the atmosphere if uncontrolled.

The Semiconductor MACT and 6 NYCRR Part 212 are the two primary regulations that dictate control requirements and allowable emission rates for the semiconductor fab process operations planned for the Proposed Air Permit Project. The fact that all operational equipment that vents to a combined header, and then to a process vent/emission point, is assessed on a cumulative basis in the both the Semiconductor MACT and Part 212 supports the approach to allow flexibility within fab operations using this Operational Flexibility Protocol. With that context, Micron is proposing the following Operational Flexibility Protocol to allow for flexibility in the operation of the semiconductor manufacturing operational equipment (process tools, process equipment exhaust conditioners, and point-of-use control devices). Semiconductor manufacturing operational equipment will vent to a header, then to a centralized control device before exhausting to the atmosphere.

This protocol includes requirements to demonstrate that Annual Guideline Concentrations (AGCs) are met following each change, similar to what was recently approved for another semiconductor permit within New York State. This protocol also includes other operations at the facility associated with semiconductor fab manufacturing (e.g., wastewater treatment plant, storage tanks).

1.2 Proposed Operational Flexibility Protocol

Micron proposes that the following Operational Flexibility Protocol is added to the Title V air permit as allowed under 6 NYCRR 201-6.4(f)(2).

I. Protocol Objective

The objective of this condition is to ensure compliance with applicable requirements while also maximizing operational flexibility at the facility. This protocol is designed to build into the Title V permit the capability to make certain changes to the semiconductor manufacturing operations and support equipment without first obtaining a permit modification by using this protocol. As provided under 6 NYCRR 201-6.4(f), changes made under an approved protocol may be made without a Title V permit modification if the changes are not modifications under any provision of Title I of the Clean Air Act and do not exceed, or cause the facility to exceed, an emissions cap or limitation in the permit.

This protocol provides flexibility to make changes that meet the criteria identified in this Protocol.

II. Operational Flexibility Protocol

A. Criteria to Allow Change Under this Protocol

1. Changes reviewed under this protocol shall be evaluated in accordance with the following criteria:

a. The Title V permit must include the federal and state requirements with which the new or changed emission source must comply. The permittee will retain a list of each Title V permit condition(s) that is applicable to new or changed emission sources following the proposed change and any associated monitoring requirements used to demonstrate compliance.

b. Any new or changed emission source shall not be part of a project that results in a significant net emissions increase that exceeds an applicable Prevention of Significant Deterioration or Nonattainment New Source Review (PSD/NNSR) threshold identified in 6 NYCRR Part 231.

c. The facility shall not use the protocol to make physical changes or change(s) in the method(s) of operation of existing emissions source(s) that would require a new or modified federally enforceable cap either to avoid major PSD/NNSR requirements or to address and comply with state air regulations and other Clean Air Act requirements. Such changes must be addressed via the permit modification provisions in 6 NYCRR 201-6.

d. If change results in the emission of an air contaminant that was not previously emitted or an increased emission rate of an air contaminant subject to 6 NYCRR Part 212, the provisions outlined in Section II.D of this Operational Flexibility Protocol must be followed.

e. Proposed changes must comply with any applicable 6 NYCRR Part 212 requirements.

B. Changes That Do Not Require Notification

1. Changes that meet the following criteria may be made without notification to the NYSDEC. Such changes may include adjustments to the operating parameters of semiconductor manufacturing operational equipment, replacement of such equipment with similar equipment, and other similar changes provided that the following criteria are met:

a. The change does not result in reduced control efficiency of any equipment that reduces emissions of air contaminants to the atmosphere.

b. The change does not affect parameters used in the air dispersion modeling demonstration of compliance with NAAQS or 6 NYCRR Part 212, such as building dimensions, stack height, or exhaust flowrate, except as allowed in Section II.D of this Operational Flexibility Protocol.

c. Documentation must be prepared demonstrating that the change will meet conditions II.B.1.a. – II.B.1.b of this Protocol. Such documentation must be retained on site for (5) years and made available to the NYSDEC upon request.

C. Changes that Do Require Notification

1. Any change that does not meet the criteria established in II.B.1. above requires 15 days written notice to the NYSDEC before the change is initiated.

2. Notifications made in accordance with this protocol will include the following documentation:

a. Identification of the Title V permit emission unit(s), process(es), emission source(s), and emission point(s) affected by the proposed change;

b. Description of the proposed change, including the operating parameters affected;

c. If appropriate, identification and description of emissions control technology;

d. Documentation of compliance with respect to all state and/or federally applicable requirements, including the following components:

i. Calculation of the emission rate potential and/or potential to emit as required to confirm regulatory applicability and compliance for all contaminants affected by the change.

ii. Documentation demonstrating major PSD/NNSR program non-applicability.

iii. Identification and evaluation of the applicability of all regulations that are triggered by the new or changed emission source.

iv. Demonstration of the applicability of, and compliance with, 6 NYCRR Part 212 requirements for each affected process emission source. If air dispersion modeling is required to demonstrate compliance, the requirements of II.D must be met.

v. Proposed operating and record keeping procedures necessary to ensure compliance.

e. Any other relevant information necessary for NYSDEC's evaluation of the proposed project or emission source under this Protocol.

D. Demonstration of Off-site Impact as Required

1. If required by Sections II.A, the permittee will evaluate the impact of proposed changes on the aggregate use and emissions of a contaminant.

2. Air dispersion modeling will be completed following the methods specified in the most recent NYSDEC-approved modeling protocol, with changes approved by the NYSDEC as necessary. The most recent version of AERMOD approved by the EPA will be utilized for such modeling.

3. The predicted offsite concentrations will be compared against Air Guideline Concentration (AGC) values as established in DAR-1:

f. If projected contaminant emission impact is less than 10% of the AGC, the permittee may proceed with the change.

g. If projected contaminant emission impact is greater than 10% but less than 30% of the AGC, the permittee will include a summary of these changes in the annual compliance report.

h. If projected contaminant emission impact is greater than 30% and less than 100% of the AGC, the permittee shall notify the NYSDEC of these results at least 7 days prior to the anticipated date on which the change will be made. The permittee may evaluate and submit to the NYSDEC the impact of the proposed change with an approved dispersion model using site-specific factors.

i. In cases where an AGC or interim AGC has not been developed for a specific contaminant, the guidelines detailed in DAR-1 will be followed.

E. Review and Approval of Changes

1. If notification is required, the permittee is authorized to proceed with the proposed change, unless the NYSDEC responds to the permittee in writing within 15 days of receipt of the notification from the permittee indicating that the change does not meet the criteria of this Protocol.

2. If the NYSDEC responds as set forth in II.E.1, it may instruct the permittee not to undertake the proposed change until it completes a more detailed review. The NYSDEC's determination shall include a list of any additional information required for such further review.

3. The NYSDEC may require a permit modification in order to impose new applicable requirements or additional permit conditions if it determines that changes proposed pursuant to notification do not meet the criteria under Section II.A above or that the changes may have a significant air quality impact or be otherwise potentially significant under SEQRA (6 NYCRR Part 617).

4. Changes that meet the criteria in II.B.1 above do not require notification or response prior to making the change. Records will be retained for NYSDEC inspection and review.

F. Additional Compliance Obligations for Changes Made Under this Protocol

1. Upon commencement of the change, the facility shall comply with all applicable requirements and permit conditions, including any amended or proposed in accordance with paragraph II.A.1 above.

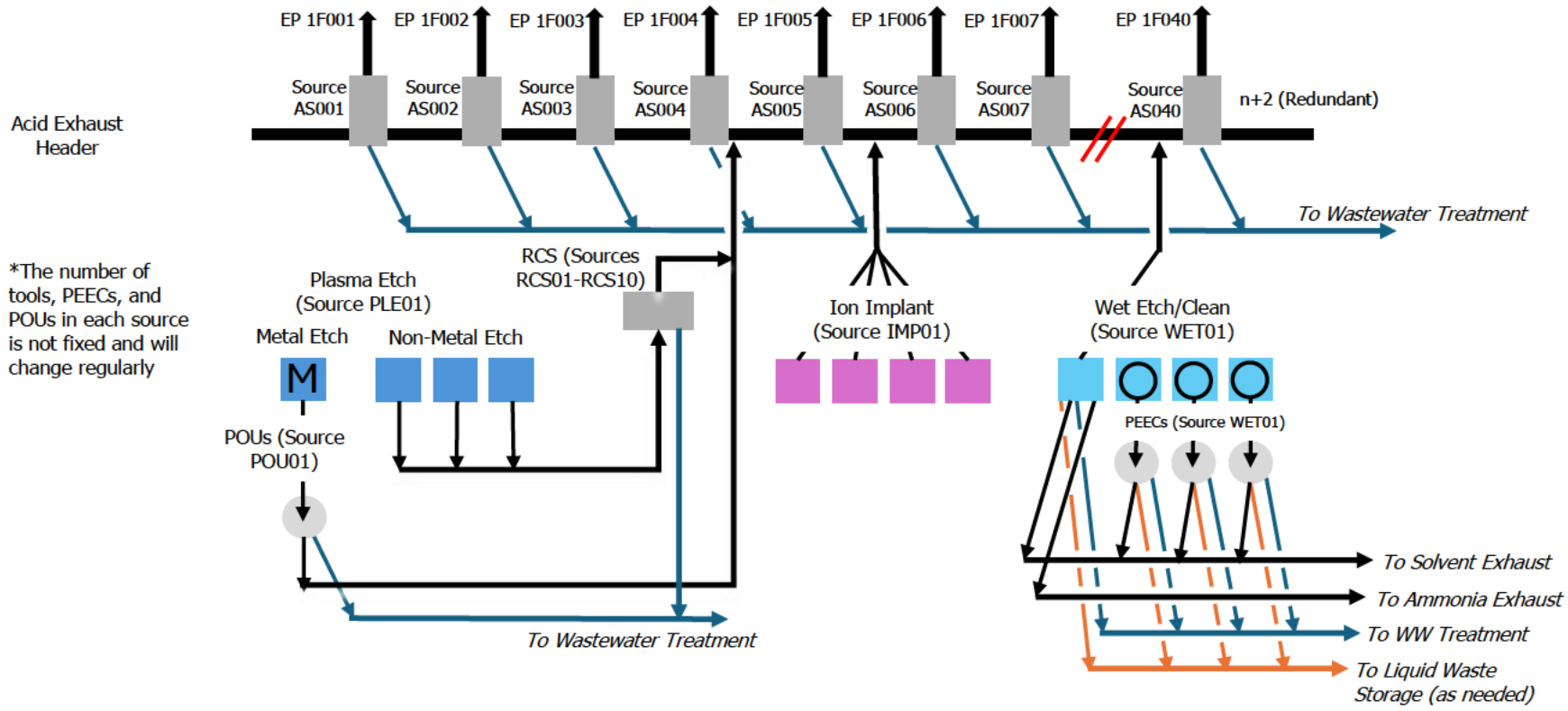
2. Any compliance certifications, recordkeeping, or reporting required by the Title V permit must incorporate and consider any approved changes made pursuant to this Operational Flexibility Protocol.

3. Micron shall provide a summary of the changes made in accordance with this protocol during the semiannual period during which the change is made, and an indication of the compliance status of the change, with the required semi-annual monitoring report.

4. The permittee shall include information regarding each change completed using this Protocol which required notification to the NYSDEC in the next application for Title V permit renewal. If appropriate, the permittee will recommend change(s) that should be incorporated into the Title V permit.

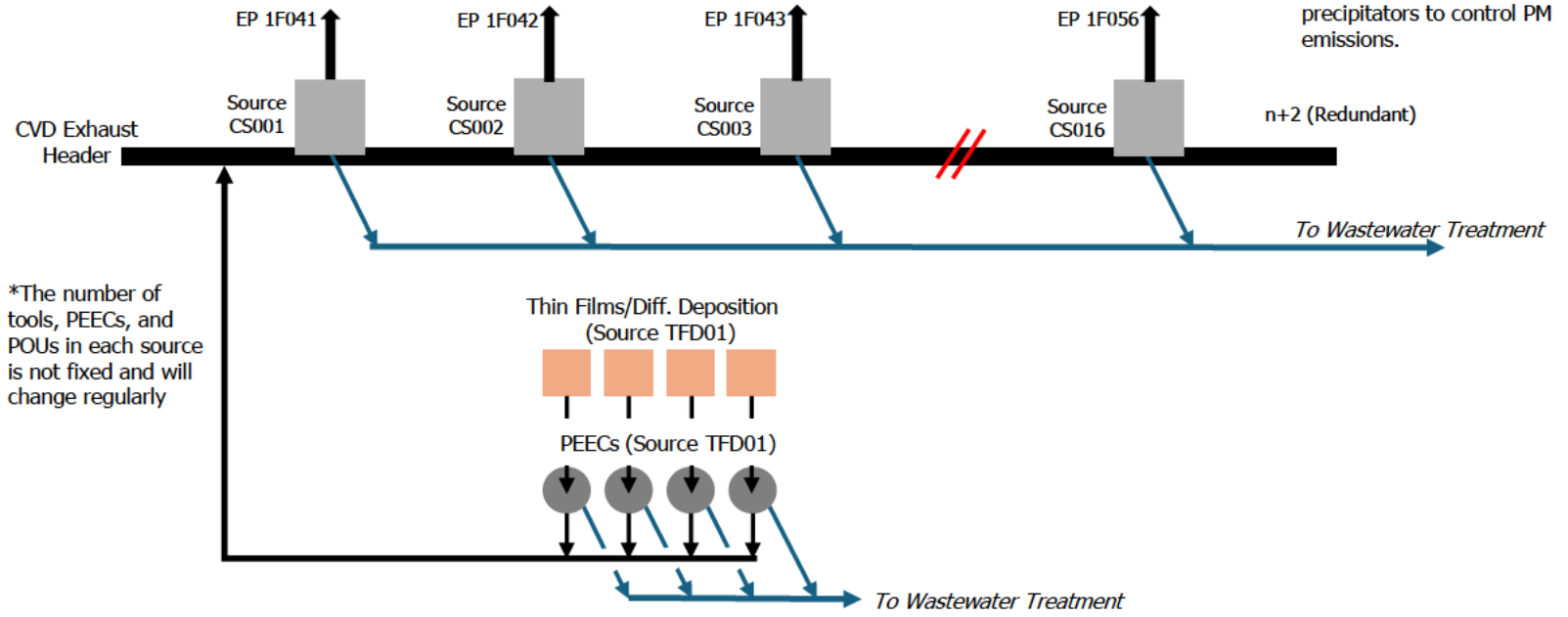
APPENDIX E. PROCESS FLOW DIAGRAMS

Example Acid Exhaust Configuration Serving One Half of Each Fab
Title V codes align with Fab 1 (1-FABOP), Process FA1

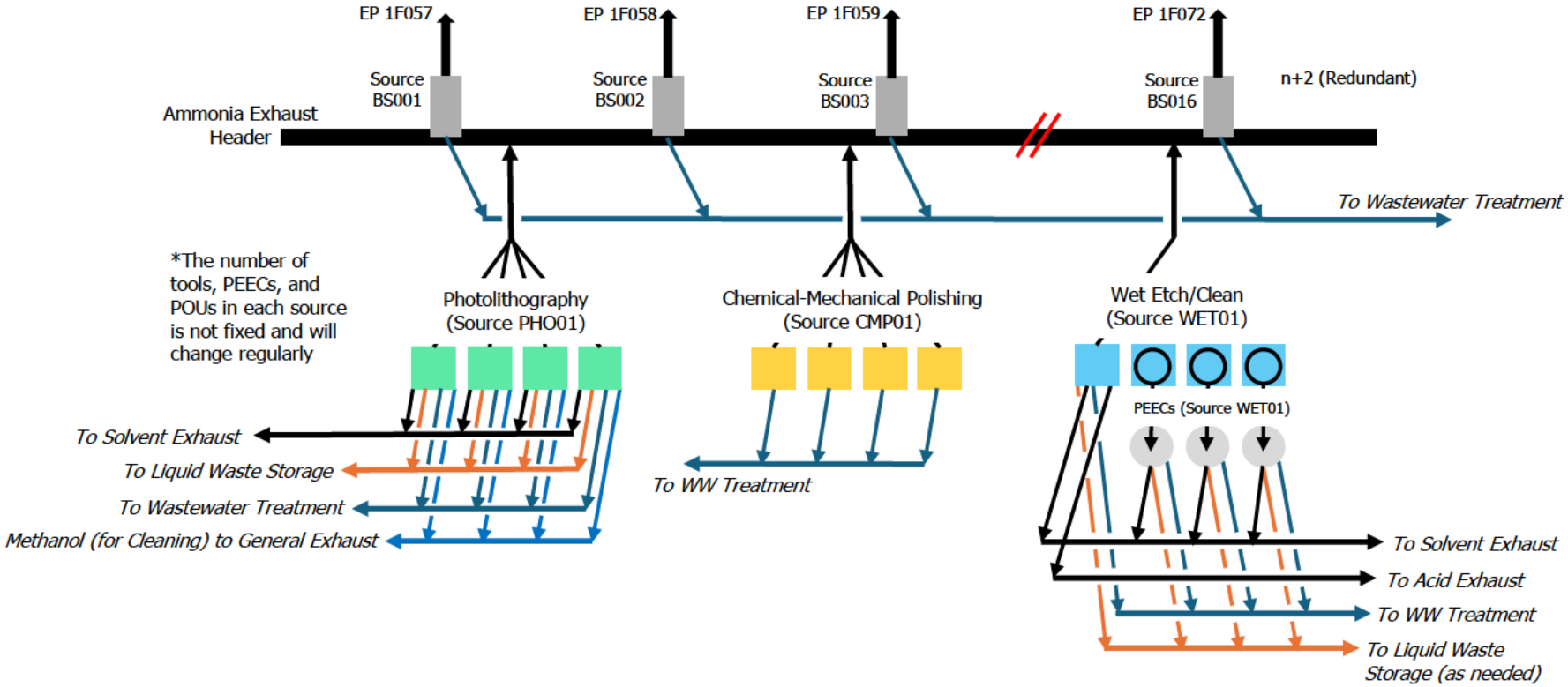


Example CVD Exhaust Configuration Serving One Half of Each Fab
Title V codes align with Fab 1 (1-FABOP), Process FC1

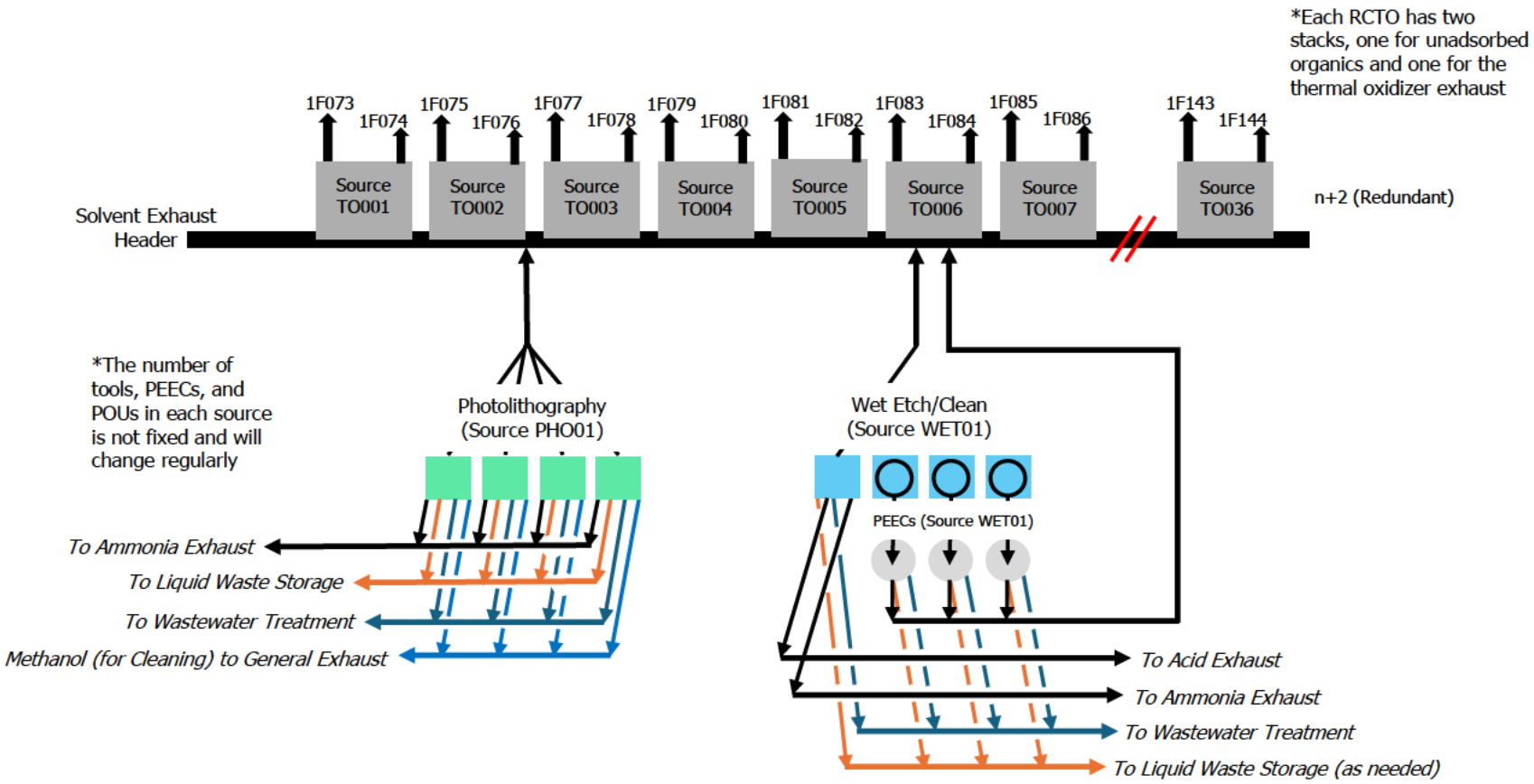
*The CVD scrubbers are multi-stage and include wet scrubbing of NO_2 and other pollutants and electrostatic precipitators to control PM emissions.



Example Ammonia Exhaust Configuration Serving One Half of Each Fab
Title V codes align with Fab 1 (1-FABOP), Process FB1



Example Solvent Exhaust Configuration Serving One Half of Each Fab
Title V codes align with Fab 1 (1-FABOP), Process FS1



Micron - Clay, NY Fabs 1 & 2
Total Emissions Summary
Note - Yellow cells indicate changes from Permit Application 1. Cells whose value changed as a result of other changes are not highlighted.

Table 1-1: Criteria Pollutant Annual Potential Emissions - By Source Type

CAS#	Chemical Name	Semiconductor Process Tools	Heat Transfer Fluids	IPA Cleaning	Wastewater Treatment	Tool-Level Thermal Oxidation Systems	RCTO Combustion	Water Bath Vaporizers	Boilers	Emergency Generators	Cooling Towers	Storage Tanks & Silos	Roadway	SF_6 Leaks	Lab Operations	SOD Waste Processing	RCS Combustion	Fire Pump Engine	Total PTE
		(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
0NY075-00-0	PM	34.2	--	--	0.01	4.04	9.92	1.28	4.39	0.27	15.5	0.08	6.59	--	--	0.97	0.39	0.02	77.7
0NY075-00-5	PM_{10}	34.2	--	--	0.01	4.04	9.92	1.28	4.39	0.26	10.1	0.08	1.32	--	--	0.97	0.39	0.02	67.0
0NY750-02-5	$PM_{2.5}$	34.2	--	--	0.01	4.04	9.92	1.28	4.39	0.26	0.07	0.08	0.32	--	--	0.97	0.39	0.02	56.0
0NY998-00-0	VOC	131.3	1.74	93.7	32.0	8.11	7.18	0.92	1.00	6.17	--	0.80	--	--	0.29	3.87	0.28	0.41	287.7
0NY100-00-0	Total HAP	82.2	--	--	2.31E-05	2.79	2.47	0.32	1.09	0.08	--	2.06E-03	--	--	0.31	2.79	0.10	6.16E-04	92.2
0NY750-00-0	GHG (CO_2e 100-yr)	485,957	110,084	--	22,430	177,955	157,495	40,399	69,382	8,233	--	--	--	4,712	--	79.3	6,217	26.0	1,082,968
0NY210-00-0	NO_x	138.9	--	--	--	44.0	130.5	5.80	26.1	21.8	--	--	--	--	--	1.48	5.15	0.41	374.2
007446-09-5	SO_x	19.2	--	--	--	0.89	0.78	0.10	0.35	0.24	--	--	--	--	--	--	0.03	0.13	21.7
N/A	Fluorides	2.48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.48
630-08-0	CO	4.07	--	--	--	619.5	548.3	14.1	88.3	113.7	--	--	--	--	--	--	21.6	0.36	1,410
7439-92-1	Lead	--	--	--	--	7.38E-04	6.53E-04	8.40E-05	2.89E-04	--	--	--	--	--	--	--	2.58E-05	--	1.79E-03
N/A	Direct GHG (CO_2e 20-yr)	378,913	111,272	--	61,545	178,142	157,660	40,442	69,456	8,251	--	--	--	3,509	--	79.3	6,223	26.1	1,015,518
N/A	Upstream GHG (CO_2e 20-yr)	--	--	--	--	135,983	119,994	30,885	53,044	2,612	--	--	--	--	--	--	4,737	8.26	346,863
10028-15-6	Ozone	0.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50

Table 1-2: Criteria Pollutant Annual Potential Emissions - By Emission Unit

CAS#	Chemical Name	1-FABOP	2-FABOP	1-CMBOP	2-CMBOP	1-HPMCU	2-HPMCU	1-WWBIO	2-WWBIO	1-ADMPR	2-ADMPR	1-FUGEM	2-FUGEM
		(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
0NY075-00-0	PM	24.3	24.3	2.99	2.96	8.26	8.26	0.01	0.01	0.00	0.00	3.30	3.30
0NY075-00-5	PM_{10}	24.3	24.3	2.98	2.96	5.58	5.58	0.01	0.01	0.00	0.00	0.66	0.66
0NY750-02-5	$PM_{2.5}$	24.3	24.3	2.98	2.96	0.56	0.56	0.01	0.01	0.00	0.00	0.16	0.16
0NY998-00-0	VOC	121.4	121.4	4.51	4.00	2.08	2.08	16.0	16.0	0.09	0.09	0.00	0.00
0NY100-00-0	Total HAP	43.8	43.8	0.74	0.74	1.39	1.39	0.05	0.05	0.11	0.11	0.00	0.00
0NY750-00-0	GHG (CO_2e 100-yr)	468,854	468,854	59,102	58,937	39.7	39.7	11,215	11,215	0.00	0.00	2,356	2,356
0NY210-00-0	NO_x	159.3	159.3	27.4	26.7	0.74	0.74	0.00	0.00	0.00	0.00	0.00	0.00
007446-09-5	SO_x	10.5	10.5	0.47	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N/A	Fluorides	1.24	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
630-08-0	CO	596.7	596.7	109.4	107.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7439-92-1	Lead	7.08E-04	7.08E-04	1.86E-04	1.86E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N/A	Direct GHG (CO_2e 20-yr)	416,105	416,105	59,170	59,005	39.7	39.7	30,773	30,773	0.00	0.00	1,754	1,754
N/A	Upstream GHG (CO_2e 20-yr)	130,157	130,157	43,301	43,248	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10028-15-6	Ozone	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1-3: 6 NYCRR Part 212 Applicability and Compliance - Individual Contaminants

CAS#	Chemical Name	PTE from Process Operations	VOC	HAP	HTAC	PM	Env. Rating[1,2,3,4]	SGC	AGC	ERP (lb/hr)											Applicable Part 212 Citation	Compliance Requirement
		(lb/yr)						(ug/m³)	(ug/m³)	Fab Acid	Fab CVD	Fab Ammonia	Fab Solvent	Fab General	HPM Acid	HPM Solvent	WWT Acid	WWT Ammonia	WWT Solvent	BIO General	Indiv. Tank		
288-88-0	1,2,4-Triazole	7,299	X				INT-B	-	0.48	-	-	0.03	-	-	-	-	-	-	0.37	0.55	-	212-1.5(f)	Comply w/ VOC LAER
95-63-6	1,2,4-Trimethylbenzene	164.0	X				B	-	60.0	-	-	-	0.19	-	-	1.95	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
1436-34-6	1,2-Epoxyhexane	0.12	X				INT-B	-	-	-	-	-	1.40E-04	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-B																
123-91-1	1,4-Dioxane	0.19	X	X			B	3,000	0.20	-	-	-	2.22E-04	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-B																
[redacted]			X			X	INT-B																
107-98-2	1-Methoxy-2-propanol	214.9	X				B	36,850	2,000	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
872-50-4	1-Methyl-2-pyrrolidone	5,017	X				B	-	100	-	-	-	3.95	-	-	-	-	-	0.10	0.14	-	212-1.5(f)	Comply w/ VOC LAER
929-06-6	2-(2-aminoethoxy)ethanol	65.1	X				INT-B	1,500	18.0	-	-	-	0.08	-	-	-	-	-	7.87E-11	3.40E-10	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-B																
[redacted]			X				B*																
[redacted]			X				INT-B																
[redacted]			X				INT-B*																
[redacted]			X			X	INT-B																
108-65-6	2-Methoxy-1-methylethyl acetate	87,410	X				B	36,850	2,000	-	-	-	103.9	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]			X				INT-B																
[redacted]			X				INT-B																
[redacted]			X				INT-A																
75-65-0	2-Methylpropan-2-ol	0.01	X				B*	-	720	-	-	-	9.91E-06	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-B																
123-42-2	4-Hydroxy-4-methylpentan-2-one	0.02	X				B	-	570	-	-	-	2.81E-05	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				B*																
108-11-2	4-Methylpentan-2-ol	788.0	X				B*	17,000	250	-	-	-	-	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]			X				INT-B																
[redacted]			X				INT-B																
[redacted]			X			X	INT-B																
64-19-7	Acetic acid	419.4	X				B*	-	71.0	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
74-86-2	Acetylene	375.2	X				INT-C	3,700	60.0	-	-	-	-	-	-	-	-	-	1.59E-08	6.63E-08	-	N/A - Part of Analog Group	
[redacted]			X				INT-B	2,400	500	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
1344-28-1	Aluminum oxide	420.6				X	B*	-	2.40	0.01	0.03	-	-	-	-	-	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
7664-41-7	Ammonia	109,122					C	2,400	500	-	-	-	-	-	-	0.78	-	376.5	-	-	-	N/A - Part of Analog Group	
7784-42-1	Arsine	4.15		X	X		A	0.20	0.05	1.48E-04	-	-	-	-	-	-	-	-	-	-	-	212-1.5(e)(2)	MEL - 10 lb/yr
1303-86-2	Boron trioxide	1,134				X	B*	-	24.0	0.04	0.02	-	-	-	-	-	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
7726-95-6	Bromine	26,103					B	130	1.60	1.86	-	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
124-38-9	Carbon dioxide	69,102,756					D	-	21,000	153.9	18.0	-	2,088	-	-	113.2	-	-	-	819.9	-	212-1.4(a)	None

Table 1-3: 6 NYCRR Part 212 Applicability and Compliance - Individual Contaminants

CAS#	Chemical Name	PTE from Process Operations (lb/yr)	VOC	HAP	HTAC	PM	Env. Rating[1,2,3,4]	SGC (ug/m³)	AGC (ug/m³)	ERP (lb/hr)												Applicable Part 212 Citation	Compliance Requirement
										Fab Acid	Fab CVD	Fab Ammonia	Fab Solvent	Fab General	HPM Acid	HPM Solvent	WWT Acid	WWT Ammonia	WWT Solvent	BIO General	Indiv. Tank	
463-58-1	Carbonyl sulfide	14.4	X	X			B	250	28.0	0.05	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
7782-50-5	Chlorine	79,183		X			B	116	0.20	2.82	-	-	-	-	-	-	-	-	-	-	-	212-1.5(e)(2)	Comply w/ NESHAP
77-92-9	Citric acid	166.5	X				INT-B	2,100	20.0	0.01	-	-	-	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]			X				INT-B	[redacted]															
[redacted]			X				INT-B																
108-94-1	Cyclohexanone	1,565	X				B	20,000	190	-	-	-	1.86	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]			X				B	[redacted]															
120-92-3	Cyclopentanone	0.98	X				INT-B	4,000	30.0	-	-	-	1.17E-03	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
19287-45-7	Diborane	1.97					B*	-	0.26	-	7.01E-05	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
142-96-1	Dibutyl ether	145.6	X				INT-C	15,000	2,887	-	-	-	0.17	-	-	3.46	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
109-89-7	Diethylamine	227.2	X				B*	4,500	36.0	-	0.01	-	-	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]			X				B	[redacted]															
75-10-5	Difluoromethane	86.4	X				INT-C	-	50,600	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
124-40-3	Dimethylamine	78.5	X				B*	2,800	22.0	-	2.80E-03	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-B	[redacted]															
74-84-0	Ethane	186.9					N/A	N/A	N/A	-	0.01	-	-	-	-	-	-	-	-	-	-	212-1.4(a)	None
107-21-1	Ethanediol	173.5	X	X			B*	1,000	400	-	-	0.01	-	-	-	-	-	-	2.73E-08	1.42E-07	-	212-1.5(e)(2)	Comply w/ NESHAP
64-17-5	Ethanol	551.1	X				C	-	45,000	-	0.02	-	-	-	-	8.13	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]			X				B	[redacted]															
687-47-8	ethyl (S)-2-hydroxypropionate	215.7	X				INT-B	-	71.0	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
97-64-3	Ethyl lactate	190.9	X				INT-B	370	71.0	-	-	-	0.23	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
7782-41-4	Fluorine	3,488					B	5.30	[illegible]	-	0.12	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
593-53-3	Fluoromethane	65.5	X				INT-C	-	50,600	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
50-00-0	Formaldehyde	14.8	X	X	X		A	30.0	6.0E-02	-	5.27E-04	-	-	-	-	-	-	-	-	-	-	212-1.5(e)(2)	MEL - 100 lb/yr
96-48-0	Gamma-butyrolactone	82.6	X				B	-	3.60	-	-	-	0.10	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
1310-53-8	Germanium dioxide	34.1				X	INT-B	-	12.9	-	0.01	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-C	[redacted]															
[redacted]						X	INT-B																
110-43-0	Heptan-2-one	14.2	X				B*	-	550	-	-	-	0.02	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
685-63-2	Hexafluorobutadiene	49.4	X				INT-A	7.50	0.10	0.09	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
76-16-4	Hexafluoroethane	286.2					INT-C*	-	50,400	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
999-97-3	Hexamethyldisilazane	1,318	X				INT-B	-	36.0	-	-	-	1.57	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
10035-10-6	Hydrogen bromide	528.4					C	680	-	1.88	-	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
7647-01-0	Hydrogen chloride	59,991		X			B	2,100	20.0	5.46	0.08	-	-	-	-	-	1.21	-	-	-	-	212-1.5(e)(2)	Comply w/ NESHAP
7664-39-3	Hydrogen fluoride	24,423		X			B	5.60	0.07	24.7	0.27	-	-	-	4.72E-03	-	1.50E-03	-	-	-	-	212-1.5(e)(2)	Comply w/ NESHAP
7722-84-1	Hydrogen peroxide	17,121					B*	-	3.30	0.61	-	-	-	-	0.08	-	8.45E-04	-	-	-	-	212-2.3(b)	Dispersion Modeling
[redacted]			X			X	INT-B	[redacted]															
13966-94-4	Indium iodide	0.01				X	INT-A	100	0.24	3.12E-07	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
67-63-0	Isopropanol	382,396	X				B	98,000	7,000	2.64	0.29	0.44	167.3	6.69	-	-	-	-	5.11	2.70	-	212-1.5(f)	Comply w/ VOC LAER
[redacted]						X	INT-B	[redacted]															
[redacted]						X	INT-B																
[redacted]			X				INT-B																
[redacted]			X			X	INT-B																
79-41-4	Methacrylic Acid	134.2	X				B*	Not in DAR-1	170.0	-	-	-	0.16	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
74-82-8	Methane	1,410,078					N/A	N/A	N/A	0.12	1.89E-03	-	-	-	-	-	-	-	-	199.3	-	212-1.4(a)	None
67-56-1	Methanol	575.9	X	X			B	33,000	4,000	-	0.01	-	-	0.01	-	-	-	-	4.21E-06	2.20E-06	-	212-1.5(e)(2) 212-1.5(f)	Comply w/ NESHAP VOC LAER (WWT)
2110-78-3	Methyl 2-hydroxy-2-methylpropionate	37.0	X				INT-B	-	71.0	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
1319-77-3	Mixed cresols	0.19	X	X			B	-	180	-	-	-	2.22E-04	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X				INT-B	[redacted]															
91-20-3	Naphthalene	82.0	X	X			B	7,900	3.00	-	-	-	0.10	-	-	0.78	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
123-86-4	n-Butyl acetate	10,682	X				C	71,300	565	-	-	-	12.7	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
7697-37-2	Nitric acid	26,902					B	86.0	12.3	1.60	-	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
7783-54-2	Nitrogen trifluoride	3,048					B*	6.60	0.08	1.52	0.03	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
10024-97-2	Nitrous oxide	327,782					B*	-	210	-	11.2	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Demonstrate T-BACT
115-25-3	Octafluorocyclobutane	90.1					INT-C*	-	50,400	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
[redacted]			X			X	B	[redacted]															
10028-15-6	Ozone	1,000					N/A	N/A	N/A	0.03	3.55E-03	-	-	-	-	-	-	-	-	-	-	N/A - See Section 3 of App	
7803-51-2	Phosphine	8.12		X			B	21.0	0.30	2.47E-04	4.24E-05	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
7664-38-2	Phosphoric acid	458.9				X	B	300	10.0	0.02	-	-	-	-	-	-	1.58E-04	-	-	-	1.67E-03	212-2.4(b)(1)	PM Grain Standard
1314-56-3	Phosphorus pentoxide	2,028				X	INT-B	300	4.80	0.07	0.01	-	-	-	-	-	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
1310-58-3	Potassium hydroxide	11.9				X	B*	200	-	4.24E-04	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
74-98-6	Propane	2.32	X				N/A	N/A	N/A	-	8.26E-05	-	-	-	-	-	-	-	-	-	-	NOIA Cmt. #58	None
52125-53-8	Propanol, 1(or 2)-ethoxy-	111.7	X				INT-B	36,850	2,000	-	-	-	0.13	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER

Table 1-3: 6 NYCRR Part 212 Applicability and Compliance - Individual Contaminants

CAS#	Chemical Name	PTE from Process Operations (lb/yr)	VOC	HAP	HTAC	PM	Env. Rating[1,2,3,4]	SGC (ug/m³)	AGC (ug/m³)	ERP (lb/hr) Fab Acid	Fab CVD	Fab Ammonia	Fab Solvent	Fab General	HPM Acid	HPM Solvent	WWT Acid	WWT Ammonia	WWT Solvent	BIO General	Indiv. Tank	Applicable Part 212 Citation	Compliance Requirement
115-07-1	Propylene	70.2	X				B*	-	3,000	-	2.50E-03	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
110-86-1	Pyridine	2.27	X				C	-	74.0	-	-	-	2.71E-03	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X			X	INT-C*																
7631-86-9	Silicon dioxide	50,246				X	INT-B	-	2.00	0.03	3.31	-	1.17	-	-	1.38	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
64742-94-5	Solvent naphtha (petroleum), heavy arom.	1,640	X				B	-	100	-	-	-	1.95	-	-	39.0	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
7446-09-5	Sulfur dioxide	38,415					B*	196	80.0	1.37	-	-	7.66E-04	-	-	-	-	-	-	-	-	212-2.3(a)	Dispersion Modeling
2551-62-4	Sulfur hexafluoride	59.7					B*	6.80	0.09	0.05	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
7664-93-9	Sulfuric acid	6,719				X	B	120	1.00	-	-	-	-	-	6.91E-06	-	1.27E-06	-	-	-	-	N/A - Part of Analog Group	
75-73-0	Tetrafluoromethane	114,405					INT-B	-	300	9.70	3.01	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
109-99-9	Tetrahydrofuran	463.9	X				B																
97-99-4	Tetrahydrofurfuryl Alcohol	21.4	X				INT-B*	TBD	TBD	-	-	-	0.03	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
[redacted]			X			X	INT-B																
			X			X	INT-B																
75-59-2	Tetramethylammonium hydroxide	963.8	X			X	INT-B	3,600	29.0	-	-	0.03	-	-	-	-	-	-	9.40E-05	4.09E-03	-	212-1.5(f) 212-2.4(b)(1)	Comply w/ VOC LAER PM Grain Standard
13463-67-7	Titanium dioxide	2,318				X	B*	-	24.0	1.26E-03	0.45	-	-	-	-	-	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
[redacted]			X			X	INT-C																
121-44-8	Triethylamine	9.82	X	X			B*	2,800	7.00	3.50E-04	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
75-46-7	Trifluoromethane	503.4					INT-C	-	50,600	-	-	-	-	-	-	-	-	-	-	-	-	N/A - Part of Analog Group	
1314-35-8	Tungsten trioxide	838.2				X	INT-B	-	7.10	-	0.17	-	-	-	-	-	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
1314-23-4	Zirconium oxide	783.8				X	INT-B	380	12.0	-	0.16	-	-	-	-	-	-	-	-	-	-	212-2.4(b)(1)	PM Grain Standard
7783-06-4	Hydrogen sulfide	186.4					B	-	2.00	-	-	-	-	-	-	-	-	-	-	2.66	-	212-2.3(a)	Dispersion Modeling
1310-73-2	Sodium hydroxide	5.10					B*	200	-	-	-	-	-	-	-	-	-	-	-	-	-	212-1.5(g)	Actuals < 100 lb/yr
7681-52-9	Sodium hypochlorite	26.1					INT-B	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	212-1.5(g)	Actuals < 100 lb/yr
108-67-8	1,3,5-Trimethylbenzene	273.3	X				B	-	60.0	-	-	-	-	-	-	1.95	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER

1. B* indicates that a compound is listed in DAR-1 with no toxicity rating assigned.
2. INT - (X) indicates an environmental rating was assigned by NYSDEC for chemicals not listed in DAR-1.
3. INT - (X*) indicates an environmental rating assigned pending review by NYSDEC for chemicals not listed in DAR-1.
4. Table 1-3 only includes chemicals with a non-zero PTE from process operations.
5. Table 1-3 does not address emissions of NO_2 and CO. These pollutants are addressed individually in the regulatory analysis in Section 3 of the application.

Table 1-4: 6 NYCRR Part 212 Applicability and Compliance - Analog Groups

Analog CAS#	Analog Chemical Name and Group Title	Emission Chemical CAS#	Emission Chemical Name	Analog Group PTE From Process Ops (lb/yr)	VOC	HAP	HTAC	PM	Env. Rating[1,2,3]	SGC (ug/m³)	AGC (ug/m³)	ERP (lb/hr) Fab Acid	Fab CVD	Fab Ammonia	Fab Solvent	Fab General	HPM Acid	HPM Solvent	WWT Acid	WWT Ammonia	WWT Solvent	BIO General	Indiv. Tank	Applicable Part 212 Citation	Compliance Requirement
[redacted]					X			X	INT-B																
					X			X	INT-B																
107-98-2	1-Methoxy-2-propanol Group	107-98-2	1-Methoxy-2-propanol		X				B	36,850	2,000														
		[redacted]			X				INT-B																
64-19-7	Acetic Acid Group	64-19-7	Acetic acid		X				B*	3,700	60.0														
		[redacted]			X			X	INT-B																
7664 41-7	Ammonia Group	7664-41-7	Ammonia						C	2,400	500														
		74-86-2	Acetylene		X				INT-C	2,400	500														
[redacted]					X			X	INT-C																
138-22-7	Butyl Lactate Group	687-47-8	Ethyl (S)-2-Hydroxypropionate	252.7	X				INT-B	-	71.0	-	-	-	0.30	-	-	-	-	-	-	-	-	212-1.5(f)	Comply w/ VOC LAER
		2110-78-3	Methyl 2-Hydroxy-2-Methylpropionate		X				INT-B	-	71.0														
75-10-5	Difluoromethane Group	75-10-5	Difluoromethane	655.3	X				INT-C	-	50,600	0.54	-	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
		593-53-3	Fluoromethane		X				INT-C	-	50,600														
		75-46-7	Trifluoromethane						INT-C	-	50,600														
[redacted]					X				INT-C																
					X			X	INT-B																
76-16-4	Hexafluoroethane Group	76-16-4	Hexafluoroethane	886.2					INT-C*	-	50,400	1.58	-	-	-	-	-	-	-	-	-	-	-	212-2.3(b)	Dispersion Modeling
		115-25-3	Octafluorocyclobutane						INT-C*	-	50,400														
7664-93-9	Sulfuric Acid Group	7664-93-9	Sulfuric acid	6,719				X	B	120	1.00	0.84	-	-	-	-	6.91E-06	-	1.27E-06	-	-	-	-	212-2.4(a)(1)	PM Grain Standard
		3144-16-9	2-Oxobornane-10-Sulphonic Acid		X				INT-B	120	1.00														
7803-62-5	Silane Group	[redacted]		[redacted]					B	-	16.0	[redacted]													
		1590-87-0	Disilane		X				INT-B	-	16.0														

1. B* indicates that a compound listed in DAR-1 with no toxicity rating assigned.
2. INT-(X) indicates an environmental rating was assigned by NYSDEC for chemicals, but it is not yet listed in DAR-1.
3. INT - (X*) indicates an environmental rating assigned pending review by NYSDEC for chemicals not listed in DAR-1.
4. [redacted] and 2-Oxobornane-10-Sulphonic acid are no longer planned to be used as part of the Proposed Air Permit Project. Their projected PTE from process operations is 0.0 lbs/yr.
5. The Silane Group PTE from process [redacted].

Table 1-5: 6 NYCRR Part 212 Compliance - Particulate Matter

Exhaust Type	Number of Operational Stacks	Exhaust Rate (ACFM)	PM PTE from Process Operations (lb/yr)	Applicable Part 212 Grain Standard (gr/dscf)	Potential Exhaust PM Concentration (gr/dscf)
Fab Acid	72	80,000	17,826	0.05	0.003
Fab CVD	24	26,800	21,331	0.05	0.011
Fab Ammonia	24	40,000	2,308	0.05	0.001
Fab Solvent	64	52,800	32,967	0.05	0.008
HPM Solvent	12	24,150	2,004	0.05	0.001
WWT Solvent	4	2,000	0.7	0.05	4.39E-06
BIO General	2	66,234	28.6	0.05	5.76E-06

1. PM emitted from the Fab Solvent exhaust will be created in and emitted from the RCTO burner, not the zeolite rotor exhaust. However, the combined exhaust rate from the RCTO burners and zeolite rotor is considered the total "exhaust gas" from the "process emission source" for purposes of compliance with 6 NYCRR 212-2.4(b)(1).
2. PM concentration estimates assume dry standard conditions in each stack

Micron - Clay, NY 4 Fabs
Emission Reduction Credit Summary by Phase

Table 2-1: NOx ERC Summary

Source	Proposed Air Permit Project Potential Emissions (tpy)	ERC Multiplier	ERCs Required
Semiconductor Process Tools	138.9	1.15	159.8
Heat Transfer Fluids	--	1.15	0.00
IPA Cleaning	--	1.15	0.00
Wastewater Treatment	--	1.15	0.00
Tool-Level Thermal Oxidation Systems	44.0	1.15	50.6
RCTO Combustion	130.5	1.15	150.1
Water Bath Vaporizers	5.80	1.15	6.67
Boilers	26.1	1.15	30.0
Emergency Generators	21.8	1.15	25.0
Cooling Towers	--	1.15	0.00
Storage Tanks & Silos	--	1.15	0.00
Roadway	--	1.15	0.00
SF6 Leaks	--	1.15	0.00
Lab Operations	--	1.15	0.00
SOD Waste Processing	1.48	1.15	1.71
RCS Combustion	5.15	1.15	5.93
Fire Pump Engine	0.41	1.15	0.47
Total	374.2	--	431.0

Table 2-2: VOC ERC Summary

Source	Proposed Air Permit Project Potential Emissions (tpy)	ERC Multiplier	ERCs Required
Semiconductor Process Tools	131.3	1.15	150.9
Heat Transfer Fluids	1.74	1.15	2.01
IPA Cleaning	93.7	1.15	107.8
Wastewater Treatment	32.0	1.15	36.8
Tool-Level Thermal Oxidation Systems	8.11	1.15	9.33
RCTO Combustion	7.18	1.15	8.26
Water Bath Vaporizers	0.92	1.15	1.06
Boilers	1.00	1.15	1.15
Emergency Generators	6.17	1.15	7.10
Cooling Towers	--	1.15	0.00
Storage Tanks & Silos	0.80	1.15	0.92
Roadway	--	1.15	0.00
SF6 Leaks	--	1.15	0.00
Lab Operations	0.29	1.15	0.33
SOD Waste Processing	3.87	1.15	4.45
RCS Combustion	0.28	1.15	0.33
Fire Pump Engine	0.41	1.15	0.47
Total	287.7	--	331.0

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Oxidation Emission Factor Derivation

Air contaminant Emission Factors (EF) are presented in pounds of air contaminant emitted per pound of process chemical used.

Table 3-1: Oxidation Emission Factors for Process Chemicals

					Molar Mass (g/mol) ->	44.01		46.01		64.07		60.08		69.62		79.87		104.61		141.94		123.22		101.96		231.84		210.49
CAS No.	**SHOW?**	**Process Chemical Name**	**Molecular Formula**	**Molar Mass (g/mol)**	**# of C**	**CO_2 EF**	**# of N**	**NO_2 EF**	**# of S**	**SO_2 EF**	**# of Si**	**SiO_2 EF**	**# of B**	**B_2O_3 EF**	**# of Ti**	**TiO_2 EF**	**# of Ge**	**GeO_2 EF**	**# of P**	**P_2O_5 EF**	**# of Zr**	**ZrO_2 EF**	**# of Al**	**Al_2O_3 EF**	**# of W**	**WO_3 EF**	**# of Hf**	**HfO_2 EF**
[redacted]	Y	[redacted]																										
95-63-6	Y	1,2,4-Trimethylbenzene	C_9H_{12}	120.19	9	3.30	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
1436-34-6	Y	1,2-Epoxyhexane	$C_6H_{12}O$	100.16	6	2.64	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
123-91-1	Y	1,4-Dioxane	$C_4H_8O_2$	88.11	4	2.00	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
1569-02-4	Y	1-Ethoxypropan-2-ol	$C_5H_{12}O_2$	104.15	5	2.11	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
107-98-2	Y	1-Methoxy-2-propanol	$C_4H_{10}O_2$	90.12	4	1.95	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
872-50-4	Y	1-Methyl-2-pyrrolidone	C_5H_9NO	99.13	5	2.22	1	0.46	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
929-06-6	Y	2-(2-aminoethoxy)ethanol	$C_4H_{11}NO_2$	105.14	4	1.67	1	0.44	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
108-65-6	Y	2-Methoxy-1-methylethyl acetate	$C_6H_{12}O_3$	132.16	6	2.00	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
75-65-0	Y	2-Methylpropan-2-ol	$C_4H_{10}O$	74.12	4	2.38	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
123-42-2	Y	4-Hydroxy-4-methylpentan-2-one	$C_6H_{12}O_2$	116.16	6	2.27	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
108-11-2	Y	4-Methylpentan-2-ol	$C_6H_{14}O$	102.18	6	2.58	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
74-86-2	Y	Acetylene	C_2H_2	26.04	2	3.38	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
7664-41-7	Y	Ammonia	NH_3	17.03	N/A	-	1	1.08	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
100-66-3	Y	Anisole	C_7H_8O	108.14	7	2.85	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
10294-34-5	Y	Boron trichloride	BCl_3	117.17	N/A	-	N/A	-	N/A	-	N/A	-	1	0.01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
463-58-1	Y	Carbonyl sulphide	COS	60.07	1	0.73	N/A	-	1	1.07	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
108-94-1	Y	Cyclohexanone	$C_6H_{10}O$	98.14	6	2.69	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
120-92-3	Y	Cyclopentanone	C_5H_8O	84.12	5	2.62	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
19287-45-7	Y	Diborane	B_2H_6	27.67	N/A	-	N/A	-	N/A	-	N/A	-	2	2.52	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
142-96-1	Y	Dibutyl ether	$C_8H_{18}O$	130.23	8	2.70	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
4109-96-0	Y	Dichlorosilane	H_2SiCl_2	101.01	N/A	-	N/A	-	N/A	-	1	0.59	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
75-10-5	Y	Difluoromethane	CH_2F_2	52.02	1	0.85	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
1590-87-0	Y	Disilane	Si_2H_6	62.22	N/A	-	N/A	-	N/A	-	2	1.93	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
107-21-1	Y	Ethanediol	$C_2H_6O_2$	62.07	2	1.42	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
687-47-8	Y	ethyl (S)-2-hydroxypropionate	$C_5H_{10}O_3$	118.13	5	1.86	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
97-64-3	Y	Ethyl lactate	$C_5H_{10}O_3$	118.13	5	1.86	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
74-85-1	Y	Ethylene	C_2H_4	28.05	2	3.14	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
593-53-3	Y	Fluoromethane	CH_3F	34.03	1	1.29	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
96-48-0	Y	Gamma-butyrolactone	$C_4H_6O_2$	86.09	4	2.04	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
62566-74-9	Y	Germanium tetrafluoride	GeF_4	148.62	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	0.70	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
7782-65-2	Y	Germanium tetrahydride	GeH_4	76.66	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	1.36	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
110-43-0	Y	Heptan-2-one	$C_7H_{14}O$	114.19	7	2.70	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
13465-77-5	Y	Hexachlorodisilane	Si_2Cl_6	268.89	N/A	-	N/A	-	N/A	-	2	0.45	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
685-63-2	Y	Hexafluorobutadiene	C_4F_6	162.03	4	1.09	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
999-97-3	Y	Hexamethyldisilazane	$C_6H_{19}NSi_2$	161.39	6	1.64	1	0.29	N/A	-	2	0.74	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
67-63-0	Y	Isopropanol	C_3H_8O	60.10	3	2.20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
79-41-4	Y	Methacrylic acid	$C_4H_6O_2$	86.09	4	2.04	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
74-82-8	Y	Methane	CH_4	16.04	1	2.74	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
67-56-1	Y	Methanol	CH4O	32.04	1	1.37	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
2110-78-3	Y	Methyl 2-hydroxy-2-methylpropionate	$C_5H_{10}O_3$	118.13	5	1.86	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
1319-77-3	Y	Mixed cresols	C_7H_8O	108.14	7	2.85	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
68-12-2	Y	N,N-Dimethylformamide	C_3H_7NO	73.09	3	1.81	1	0.63	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
91-20-3	Y	Naphthalene	$C_{10}H_8$	128.17	10	3.43	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
123-86-4	Y	n-Butyl acetate	$C_6H_{12}O_2$	116.16	6	2.27	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
7783-54-2	Y	Nitrogen trifluoride	NF_3	71.00	N/A	-	1	0.65	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
10024-97-2	Y	Nitrous oxide	N_2O	44.01	N/A	-	2	1.25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
10024-97-2	Y	*Nitrous oxide*	N_2O	44.01	N/A	-	2	0.21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
115-25-3	Y	Octafluorocyclobutane	C_4F_8	200.03	4	0.88	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
556-67-2	Y	Octamethylcyclotetrasiloxane	$C_8H_{24}O_4Si_4$	296.61	8	1.19	N/A	-	N/A	-	4	0.81	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
7803-51-2	Y	Phosphine	PH_3	34.00	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	2.09	N/A	-	N/A	-	N/A	-	N/A	-
7783-55-3	Y	Phosphorous trifluoride	PF_3	87.97	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	0.81	N/A	-	N/A	-	N/A	-	N/A	-
52125-53-8	Y	Propanol, 1(or 2)-ethoxy-	$C_5H_{12}O_2$	104.15	5	2.11	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
115-07-1	Y	Propylene	C_3H_6	42.08	3	3.14	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
110-86-1	Y	Pyridine	C_5H_5N	79.10	5	2.78	1	0.58	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
7803-62-5	Y	Silane	SiH_4	32.12	N/A	-	N/A	-	N/A	-	1	1.87	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]	Y	[redacted]																										
10026-04-7	Y	Silicon tetrachloride	$SiCl_4$	169.90	N/A	-	N/A	-	N/A	-	1	0.02	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
7783-61-1	Y	Silicon tetrafluoride	SiF_4	104.08	N/A	-	N/A	-	N/A	-	1	0.58	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
64742-94-5	Y	Solvent naphtha (petroleum), heavy arom.	Varies	192.00	16	3.67	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
2551-62-4	Y	Sulfur hexafluoride	SF_6	146.06	N/A	-	N/A	-	1	0.44	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
78-10-4	Y	Tetraethyl orthosilicate	$SiC_8H_{20}O_4$	208.33	8	1.69	N/A	-	N/A	-	1	0.29	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-

Table 3-1: Oxidation Emission Factors for Process Chemicals

					Molar Mass (g/mol) ->	44.01		46.01		64.07		60.08		69.62		79.87		104.61		141.94		123.22		101.96		231.84		210.49
CAS No.	**SHOW?**	**Process Chemical Name**	**Molecular Formula**	**Molar Mass (g/mol)**	**# of C**	**CO_2 EF**	**# of N**	**NO_2 EF**	**# of S**	**SO_2 EF**	**# of Si**	**SiO_2 EF**	**# of B**	**B_2O_3 EF**	**# of Ti**	**TiO_2 EF**	**# of Ge**	**GeO_2 EF**	**# of P**	**P_2O_5 EF**	**# of Zr**	**ZrO_2 EF**	**# of Al**	**Al_2O_3 EF**	**# of W**	**WO_3 EF**	**# of Hf**	**HfO_2 EF**
75-73-0	Y	Tetrafluoromethane	CF_4	88.00	1	0.50	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]																												
97-99-4	Y	Tetrahydrofurfuryl alcohol	$C_5H_{10}O_2$	102.13	5	2.15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]																												
7550-45-0	Y	Titanium tetrachloride	$TiCl_4$	189.68	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	0.42	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
150-46-9	Y	Triethyl borate	$C_6H_{15}BO_3$	145.99	6	1.81	N/A	-	N/A	-	N/A	-	1	0.24	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
78-40-0	Y	Triethyl phosphate	$C_6H_{15}O_4P$	182.15	6	1.45	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	0.39	N/A	-	N/A	-	N/A	-	N/A	-
75-46-7	Y	Trifluoromethane	CHF_3	70.01	1	0.63	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
75-24-1	Y	Trimethylaluminium	C_3H_9Al	72.09	3	1.83	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	0.71	N/A	-	N/A	-
993-07-7	Y	Trimethylsilane	$C_3H_{10}Si$	74.20	3	1.78	N/A	-	N/A	-	1	0.81	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
[redacted]																												
7783-82-6	Y	Tungsten hexafluoride	WF_6	297.83	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1	0.04	N/A	-

1. For compounds with variable chemical composition, including [redacted] the number of carbon or nitrogen atoms was estimated to be conservatively high based on available information, and the molecular weight was estimated as 12 times the number of carbon atoms to be conservatively low, resulting conservatively high emission factors

2. Emission factors derived in this table are utilized for calculating emissions in table 6-1.

3. Nitrogen monoxide may be processed similarly to nitrous oxide. It is conservatively assumed that the usage quantity of nitrous oxide includes a small quantity of nitrogen monoxide.

4. 60% of nitrous oxide exiting the process chamber is assumed to be converted to nitrogen dioxide in the PEEC burner based on default DRE listed in the IPCC 2019 Refinement (Volume 3, Chapter 6) Additionally, 10% of Nitrous oxide is assumed to be converted to nitrogen dioxide in the process chanber. This additional emission factor is presented in the row in italics.

5. A total of 40% of ammonia used is assumed to be converted to nitrogen dioxide as demonstrated by Micron test data of comparable processes et existing facilities.

6. Boron trichloride, silicon tetrachloride, and tungsten hexafluoride will be used in tools exhausting to POUs or PEECs with pre-wet scrubbing sections to minimize particulate buildup in ductwork. The oxidation emission factors for these chemicals reflects 95% removal prior to the combustion equipment in which oxidation would occur.

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Greenhouse Gas Process Emission Factors

Table 4-1: GHG Emission Factors

Primary Chemical			Process Used	Emission Chemical			Process Emission Factor (lb emitted / lb used)[2,3,4]
CAS #	Chemical Name	Molecular Formula		CAS #	Chemical Name	Molecular Formula	
75-10-5	Difluoromethane	CH2F2	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.2
75-10-5	Difluoromethane	CH2F2	Plasma Etch	124-38-9	Carbon Dioxide	CO2	0.846
75-10-5	Difluoromethane	CH2F2	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.0044
75-10-5	Difluoromethane	CH2F2	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.044
75-10-5	Difluoromethane	CH2F2	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.769
75-10-5	Difluoromethane	CH2F2	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.06
75-10-5	Difluoromethane	CH2F2	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.057
75-10-5	Difluoromethane	CH2F2	Plasma Etch	115-25-3	Octoflourocyclobutane	C4F8	0.072
7782-41-4	Fluorine	F2	Thin Films / Diffusion Deposition	75-73-0	Tetrafluoromethane	CF4	0.116
593-53-3	Fluoromethane	CH3F	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.32
593-53-3	Fluoromethane	CH3F	Plasma Etch	124-38-9	Carbon Dioxide	CO2	1.29
593-53-3	Fluoromethane	CH3F	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.0023
593-53-3	Fluoromethane	CH3F	Plasma Etch	685-63-2	Hexafluorobutadiene	C4F6	0.0012
593-53-3	Fluoromethane	CH3F	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.011
593-53-3	Fluoromethane	CH3F	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.588
593-53-3	Fluoromethane	CH3F	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.031
593-53-3	Fluoromethane	CH3F	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.0016
593-53-3	Fluoromethane	CH3F	Plasma Etch	115-25-3	Octoflourocyclobutane	C4F8	0.007
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	685-63-2	Hexafluorobutadiene	C4F6	0.15
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	124-38-9	Carbon Dioxide	CO2	1.09
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.00003
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.00065
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.062
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.741
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.059
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.017
685-63-2	Hexafluorobutadiene	C4F6	Plasma Etch	115-25-3	Octoflourocyclobutane	C4F8	0.0051
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	7783-54-2	Nitrogen Trifluoride	NF3	0.16
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.00086
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.008
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.045
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.845
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	10102-44-0	Nitrogen Dioxide	NO2	0.648
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.045
7783-54-2	Nitrogen Trifluoride	NF3	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.025
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - In-Situ Clean	7783-54-2	Nitrogen Trifluoride	NF3	0.2
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - In-Situ Clean	7664-39-3	Hydrogen Fluoride	HF	0.845
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - In-Situ Clean	10102-44-0	Nitrogen Dioxide	NO2	0.648
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - In-Situ Clean	75-73-0	Tetrafluoromethane	CF4	0.037
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Remote Clean	7783-54-2	Nitrogen Trifluoride	NF3	0.018
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Remote Clean	7782-41-4	Fluorine	F2	0.803
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Remote Clean	7664-39-3	Hydrogen Fluoride	HF	0.845
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Remote Clean	10102-44-0	Nitrogen Dioxide	NO2	0.648
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Remote Clean	75-73-0	Tetrafluoromethane	CF4	0.038
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Remote Clean	75-73-0	Tetrafluoromethane	CF4	0.093
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Thermal Clean	7783-54-2	Nitrogen trifluoride	NF3	0.28
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Thermal Clean	7664-39-3	Hydrogen Fluoride	HF	0.845
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Thermal Clean	10102-44-0	Nitrogen dioxide	NO2	0.648
7783-54-2	Nitrogen Trifluoride	NF3	Thin Films - Thermal Clean	75-73-0	Tetrafluoromethane	CF4	0.01
10024-97-2	Nitrous Oxide	N2O	Thin Films / Diffusion Deposition	10024-97-2	Nitrous Oxide	N2O	0.5
10024-97-2	Nitrous Oxide	N2O	Thin Films / Diffusion Deposition	10102-44-0	Nitrogen Dioxide	NO2	2.09
10024-97-2	Nitrous Oxide	N2O	Other	10024-97-2	Nitrous Oxide	N2O	1
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	115-25-3	Octafluorocyclobutane	C4F8	0.18
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	124-38-9	Carbon Dioxide	CO2	0.88
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.0014
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.0022
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	685-63-2	Hexafluorobutadiene	C4F6	0.0094
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.027
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.8
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.045
115-25-3	Octafluorocyclobutane	C4F8	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.029
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	559-40-0	Octafluorocyclopentene	C5F8	0.1
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	124-38-9	Carbon Dioxide	CO2	1.04
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.083
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.755
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.11
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.0069
559-40-0	Octafluorocyclopentene	C5F8	Plasma Etch	76-19-7	Octafluoropropane	C3F8	0.00012
76-19-7	Octafluoropropane	C3F8	Plasma Etch	76-19-7	Octafluoropropane	C3F8	0.3
76-19-7	Octafluoropropane	C3F8	Plasma Etch	124-38-9	Carbon Dioxide	CO2	0.702
76-19-7	Octafluoropropane	C3F8	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.00073
76-19-7	Octafluoropropane	C3F8	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.18
76-19-7	Octafluoropropane	C3F8	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.851
76-19-7	Octafluoropropane	C3F8	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.21
76-19-7	Octafluoropropane	C3F8	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.012
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	2551-62-4	Sulfur Hexafluoride	SF6	0.29
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.00002

Table 4-1: GHG Emission Factors

Primary Chemical			Process Used	Emission Chemical			Process Emission Factor (lb emitted / lb used)[2,3,4]
CAS #	Chemical Name	Molecular Formula		CAS #	Chemical Name	Molecular Formula	
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.0082
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.041
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.822
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.034
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.0039
2551-62-4	Sulfur Hexafluoride	SF6	Plasma Etch	7446-09-5	Sulfur Dioxide	SO2	1.000
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.65
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	124-38-9	Carbon Dioxide	CO2	0.5
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.014
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.0053
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	685-63-2	Hexafluorobutadiene	C4F6	0.0015
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.061
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.910
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.013
75-73-0	Tetrafluoromethane	CF4	Plasma Etch	115-25-3	Octafluorocyclobutane	C4F8	0.0033
75-46-7	Trifluoromethane	CHF3	Plasma Etch	75-46-7	Trifluoromethane	CHF3	0.38
75-46-7	Trifluoromethane	CHF3	Plasma Etch	124-38-9	Carbon Dioxide	CO2	0.629
75-46-7	Trifluoromethane	CHF3	Plasma Etch	75-10-5	Difluoromethane	CH2F2	0.0026
75-46-7	Trifluoromethane	CHF3	Plasma Etch	593-53-3	Fluoromethane	CH3F	0.037
75-46-7	Trifluoromethane	CHF3	Plasma Etch	685-63-2	Hexafluorobutadiene	C4F6	0.0001
75-46-7	Trifluoromethane	CHF3	Plasma Etch	76-16-4	Hexafluoroethane	C2F6	0.062
75-46-7	Trifluoromethane	CHF3	Plasma Etch	7664-39-3	Hydrogen Fluoride	HF	0.857
75-46-7	Trifluoromethane	CHF3	Plasma Etch	75-73-0	Tetrafluoromethane	CF4	0.076
75-46-7	Trifluoromethane	CHF3	Plasma Etch	115-25-3	Octafluorocyclobutane	C4F8	0.00067

1. Emission factors summarized in this table are utilized for calculating emissions in Table 6-1.
2. Emission factors for HF, CO_2, NO_2, and SO_2 were derived as documented in Appendix G - Emission Factors.
3. Emission factors for CF_4 generated from combustion of F_2 are from the IPCC 2019 Refinement Equation 6.15 on pages 6.31 and 6.32. F2 may be used directly or generated as a byproduct of use of NF3 in remote clean processes
4. Emission factors chemicals not covered by footnotes 2 and 3 are from the IPCC 2019 Refinement Table 6.11

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Destruction and Removal Efficiency (DRE) and PEEC Management Values

Table 5-1: Process Equipment Exhaust Conditioner (PEEC) Management

Category/Chemical Controlled[1]	Chemical Names(s)	CAS #	Fleet Average Fraction Managed	Source
Flammable	Includes pyrophorics	Multiple	0.99	Engineering Estimate
Reactive	Cl2, etc	Multiple	0.99	Engineering Estimate
Acid Gas	HCl and HF	Multiple	0.99	Engineering Estimate
PM	SiO2, metal oxides, etc	Multiple	0.00	Engineering Estimate
F_2	Fluorine	7782-41-4	0.995	Engineering Estimate
NH3	Ammonia	7664-41-7	0.95	Engineering Estimate
CF4	Tetrafluoromethane	75-73-0	0.89	IPCC Table 6.17
N2O	Nitrous Oxide-Other	10024-97-2	0.60	IPCC Table 6.17
N2O	Nitrous Oxide-CVD	10024-97-2	0.60	IPCC Table 6.17
NF3	Nitrogen Trifluoride-In Situ	7783-54-2	0.95	IPCC Table 6.17
NF3	Nitrogen Trifluoride-Remote	7783-54-2	0.95	IPCC Table 6.17

1. CF_4 generated in a PEEC as a result of management of F_2 is not itself managed in the PEEC

Table 5-2: Point-of-Use Control Device DRE Values

Category/Chemical Controlled	Chemical Names(s)	CAS #	Fleet Average DRE Value	Source
Flammable	Includes pyrophorics	Multiple	0.99	Engineering Estimate
Br2	Bromine	7726-95-6	0.50	Engineering Estimate
Acid Gas	HCl, HF, and HBr	Multiple	0.99	Engineering Estimate
PM	SiO2, metal oxides, etc	Multiple	0.00	Engineering Estimate
CO2, NO2, SO2	Carbon Dioxide, Nitrogen Dioxide, Sulfur Dioxide	Multiple	0.00	Engineering Estimate
CH2F2	Difluoromethane	75-10-5	0.99	IPCC Table 6.17
CH3F	Fluoromethane	593-53-3	0.99	IPCC Table 6.17
CF4	Tetrafluoromethane	75-73-0	0.89	IPCC Table 6.17
C2F6	Hexafluoroethane	76-16-4	0.98	IPCC Table 6.17
CHF3	Trifluoromethane	75-46-7	0.98	IPCC Table 6.17
C4F8	Octafluorocyclobutane	115-25-3	0.98	IPCC Table 6.17
C4F6	Hexafluorobutadiene	685-63-2	0.98	IPCC Table 6.17
NF3	Nitrogen Trifluoride-Etch	7783-54-2	0.95	IPCC Table 6.17
SF6	Sulfur Hexafluoride	2551-62-4	0.96	IPCC Table 6.17

Table 5-3: Centralized Control Equipment DRE Values

Exhuast Type(s) Controlled	Chemical Names(s)	CAS #	Fleet Average DRE Value	Source
Acid & CVD	Hydrogen Fluoride	7664-39-3	0.60	Projected Performance from Preferred Vendor
Acid & CVD	Hydrogen Chloride	7647-01-0	0.60	Projected Performance from Preferred Vendor
Acid & CVD	Sulfuric Acid	7664-93-9	0.75	Projected Performance from Preferred Vendor
Acid & CVD	Nitric Acid	7697-37-2	0.40	Projected Performance from Preferred Vendor
Acid & CVD	Organic Acids	Multiple	0.00	Engineering Estimate
CVD	Particulate - CVD	Multiple	0.82	Projected Performance from Preferred Vendor
CVD	NO_2	0NY210-00-0	0.90	Projected Performance from Preferred Vendor
Ammonia	Ammonia	7664-41-7	0.98	Info. from Potential Supplier
Solvent	Solvent	Multiple	0.97	VOC LAER limit at projected inlet concentration

Table 5-4: Regenerative Catalytic System DRE Values

Category/Chemical Controlled	Chemical Names(s)	Primary CAS #	Fleet Average DRE Value	Source
C4F8	Octafluorocyclobutane	115-25-3	0.98	Info. from Potential Supplier
C4F6	Hexafluorobutadiene	685-63-2	0.98	Info. from Potential Supplier
CH2F2	Difluoromethane	75-10-5	0.99	Info. from Potential Supplier
CH3F	Fluoromethane	593-53-3	0.99	Info. from Potential Supplier
CHF3	Trifluoromethane	75-46-7	0.98	Info. from Potential Supplier
CF4	Tetrafluoromethane	75-73-0	0.89	Info. from Potential Supplier
NF3	Nitrogen Trifluoride-All	7783-54-2	0.95	Info. from Potential Supplier
SF6	Sulfur Hexafluoride	2551-62-4	0.96	Info. from Potential Supplier
C2F6	Hexafluoroethane	76-16-4	0.98	Info. from Potential Supplier
C3F8	Octafluoropropane	76-19-7	0.89	Assumed to be the same as CF4
C5F8	Octafluorocyclopentene	559-40-0	0.98	IPCC Table 6.17
N2O	Nitrous Oxide-All	10024-97-2	0.60	IPCC Table 6.17
CO2	Carbon Dioxide	124-38-9	0.00	
CH4	Methane	74-82-8	0.89	Assumed to be the same as CF4

Micron - Clay, NY Fabs 1 & 2
1-FABDP and 2-FABDP
Process Chemical Emissions Calculations

Table 6-1: Process Chemical Emissions Calculations

Primary Chemical				Process Category	% of Total Usage	Projected Usage in Process Category (lb/yr)	Emission Chemical			Emission Chem Formation Depends on Primary Chem EF?	Process Emission Factor (lb emitted / lb used)	Emission Chemical Classifications									Exhaust Type	PEEC Fraction Managed	Process Emission Quantification				
CAS #	Chemical Name	Common Acronym/Alternate Name	Molecular Formula				CAS #	Emission Chemical	Molecular Formula			VOC	PM	NO_x	CO	SO_2	HAP	GHG	HTAC	Fluorides			Pre-Control Process Emissions (lb/yr)	POU or RCS DRE	Post POU Emissions (lb/yr)	Centralized Control DRE	Post-Control Emissions (lb/yr)
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]				[redacted]	X									Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]				[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-40-3	Dimethylamine	C2H7N		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]				[redacted]		X								Fab CVD	0.00	[redacted]	N/A	[redacted]	0.82	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	67-56-1	Methanol	CH3OH		[redacted]	X					X				Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2		[redacted]			X							Fab CVD	0.00	[redacted]	N/A	[redacted]	0.90	[redacted]
20654-88-0	[11B]boron trifluoride		$^{11}BF_3$	Ion Implant	100%	158.4	20654-88-0	[11B]boron trifluoride	11BF3		0.00									X	Fab Acid	0.00	0.00	N/A	N/A	0.00	0.00
20654-88-0	[11B]boron trifluoride		$^{11}BF_3$	Ion Implant	100%	158.4	1303-86-2	Boron trioxide	B2O3		0.13		X								Fab Acid	0.00	20.3	N/A	N/A	0.00	20.3
20654-88-0	[11B]boron trifluoride		$^{11}BF_3$	Ion Implant	100%	158.4	7664-39-3	Hydrogen fluoride	HF		0.89						X				Fab Acid	0.00	140.2	N/A	N/A	0.60	56.1
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]				[redacted]	X									Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	67-56-1	Methanol	CH3OH		[redacted]	X					X				Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	7631-86-9	Silicon dioxide	SiO2		[redacted]		X								Fab CVD	0.00	[redacted]	N/A	[redacted]	0.82	[redacted]
288-88-0	1,2,4-Triazole		$C_2H_3N_3$	CMP	100%	17,354	288-88-0	1,2,4-Triazole	C2H3N3		0.05	X									Fab Ammonia	0.00	867.7	N/A	N/A	0.00	867.7
95-63-6	1,2,4-Trimethylbenzene	TMB	C_9H_{12}	Photolithography	100%	27,331	95-63-6	1,2,4-Trimethylbenzene	C9H12		0.20	X									Fab Solvent	0.00	5,466	N/A	N/A	0.97	164.0
95-63-6	1,2,4-Trimethylbenzene	TMB	C_9H_{12}	Photolithography	100%	27,331	124-38-9	Carbon dioxide	CO2	X	3.30							X			Fab Solvent	0.00	18,014	N/A	N/A	0.00	18,014
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X	X								Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2	X	[redacted]			X							Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	7446-09-5	Sulfur dioxide	SO2	X	[redacted]					X					Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
1436-34-6	1,2-Epoxyhexane		$C_6H_{12}O$	Photolithography	100%	19.7	1436-34-6	1,2-Epoxyhexane	C6H12O		0.20	X									Fab Solvent	0.00	3.93	N/A	N/A	0.97	0.12
1436-34-6	1,2-Epoxyhexane		$C_6H_{12}O$	Photolithography	100%	19.7	124-38-9	Carbon dioxide	CO2	X	2.64							X			Fab Solvent	0.00	10.4	N/A	N/A	0.00	10.4
[redacted]				Wet Etch / Wet Clean	100%	[redacted]	[redacted]				[redacted]	X									Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
123-91-1	1,4-Dioxane		$C_4H_8O_2$	Photolithography	100%	31.1	123-91-1	1,4-Dioxane	C4H8O2		0.20	X					X				Fab Solvent	0.00	6.23	N/A	N/A	0.97	0.19
123-91-1	1,4-Dioxane		$C_4H_8O_2$	Photolithography	100%	31.1	124-38-9	Carbon dioxide	CO2	X	2.00							X			Fab Solvent	0.00	12.4	N/A	N/A	0.00	12.4
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]	X									Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
1569-02-4	1-Ethoxypropan-2-ol		$C_5H_{12}O_2$	Photolithography	100%	0.00	1569-02-4	1-Ethoxypropan-2-ol	C5H12O2		0.20	X									Fab Solvent	0.00	0.00	N/A	N/A	0.97	0.00
1569-02-4	1-Ethoxypropan-2-ol		$C_5H_{12}O_2$	Photolithography	100%	0.00	124-38-9	Carbon dioxide	CO2	X	2.11							X			Fab Solvent	0.00	0.00	N/A	N/A	0.00	0.00
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]	X	X								Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
107-98-2	1-Methoxy-2-propanol	PGME	$C_4H_{10}O_2$	Photolithography	100%	35,817	107-98-2	1-Methoxy-2-propanol	C4H10O2		0.20	X									Fab Solvent	0.00	7,163	N/A	N/A	0.97	214.9
107-98-2	1-Methoxy-2-propanol	PGME	$C_4H_{10}O_2$	Photolithography	100%	35,817	124-38-9	Carbon dioxide	CO2	X	1.95							X			Fab Solvent	0.00	13,993	N/A	N/A	0.00	13,993
872-50-4	1-Methyl-2-pyrrolidone	NMP	C_5H_9NO	Wet Etch / Wet Clean	100%	2,213.132	872-50-4	1-Methyl-2-pyrrolidone	C5H9NO		0.05	X									Fab Solvent	0.00	110.657	N/A	N/A	0.97	3.320
872-50-4	1-Methyl-2-pyrrolidone	NMP	C_5H_9NO	Wet Etch / Wet Clean	100%	2,213.132	124-38-9	Carbon dioxide	CO2	X	2.22							X			Fab Solvent	0.00	245.630	N/A	N/A	0.00	245.630
872-50-4	1-Methyl-2-pyrrolidone	NMP	C_5H_9NO	Wet Etch / Wet Clean	100%	2,213.132	10102-44-0	Nitrogen dioxide	NO2	X	0.46			X							Fab Solvent	0.00	51.353	N/A	N/A	0.00	51.353
929-06-6	2-(2-aminoethoxy)ethanol		$C_4H_{11}NO_2$	Photolithography	100%	10.845	929-06-6	2-(2-aminoethoxy)ethanol	C4H11NO2		0.20	X									Fab Solvent	0.00	2.169	N/A	N/A	0.97	65.1
929-06-6	2-(2-aminoethoxy)ethanol		$C_4H_{11}NO_2$	Photolithography	100%	10,845	124-38-9	Carbon dioxide	CO2	X	1.67							X			Fab Solvent	0.00	3,632	N/A	N/A	0.00	3,632
929-06-6	2-(2-aminoethoxy)ethanol		$C_4H_{11}NO_2$	Photolithography	100%	10,845	10102-44-0	Nitrogen dioxide	NO2	X	0.44			X							Fab Solvent	0.00	949.1	N/A	N/A	0.00	949.1
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2	X	[redacted]			X							Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]	X									Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.99	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	10102-44-0	Nitrogen Dioxide	NO2	X	[redacted]			X							Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X	X								Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
108-65-6	2-Methoxy-1-methylethyl acetate	PGMEA	$C_6H_{12}O_3$	Photolithography	37%	5,352,987	108-65-6	2-Methoxy-1-methylethyl acetate	C6H12O3		0.20	X									Fab Solvent	0.00	1,070,597	N/A	N/A	0.97	32,118
108-65-6	2-Methoxy-1-methylethyl acetate	PGMEA	$C_6H_{12}O_3$	Photolithography	37%	5,352,987	124-38-9	Carbon dioxide	CO2	X	2.00							X			Fab Solvent	0.00	2,139,105	N/A	N/A	0.00	2,139,105
108-65-6	2-Methoxy-1-methylethyl acetate	PGMEA	$C_6H_{12}O_3$	Wet Etch / Wet Clean	63%	9,210,208	108-65-6	2-Methoxy-1-methylethyl acetate	C6H12O3		0.20	X									Fab Solvent	0.00	1,842,042	N/A	N/A	0.97	55,261
108-65-6	2-Methoxy-1-methylethyl acetate	PGMEA	$C_6H_{12}O_3$	Wet Etch / Wet Clean	63%	9,210,208	124-38-9	Carbon dioxide	CO2	X	2.00							X			Fab Solvent	0.00	3,680,487	N/A	N/A	0.00	3,680,487
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]	X									Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
75-65-0	2-Methylpropan-2-ol		$C_4H_{10}O$	Photolithography	100%	138.9	75-65-0	2-Methylpropan-2-ol	C4H10O		0.20	X									Fab Solvent	0.99	0.28	N/A	N/A	0.97	0.01
75-65-0	2-Methylpropan-2-ol		$C_4H_{10}O$	Photolithography	100%	138.9	124-38-9	Carbon dioxide	CO2	X	2.38							X			Fab Solvent	0.00	66.0	N/A	N/A	0.00	66.0
3144-16-9	2-oxobornane-10-sulphonic acid		$C_{10}H_{16}O_4S$	Wet Etch / Wet Clean	100%	0.00	3144-16-9	2-oxobornane-10-sulphonic acid	C10H16O4S		1.00E-03	X	X								Fab Acid	0.00	0.00	N/A	N/A	0.00	0.00
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X	X								Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]	X									Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
123-42-2	4-Hydroxy-4-methylpentan-2-one		$C_6H_{12}O_2$	Photolithography	100%	393.4	123-42-2	4-Hydroxy-4-methylpentan-2-one	C6H12O2		0.20	X									Fab Solvent	0.99	0.79	N/A	N/A	0.97	0.02
123-42-2	4-Hydroxy-4-methylpentan-2-one		$C_6H_{12}O_2$	Photolithography	100%	393.4	124-38-9	Carbon dioxide	CO2	X	2.27							X			Fab Solvent	0.00	178.9	N/A	N/A	0.00	178.9
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
108-11-2	4-Methylpentan-2-ol		$C_6H_{14}O$	Photolithography	100%	131,329	108-11-2	4-Methylpentan-2-ol	C6H14O		0.20	X									Fab Solvent	0.00	26,266	N/A	N/A	0.97	788.0
108-11-2	4-Methylpentan-2-ol		$C_6H_{14}O$	Photolithography	100%	131,329	124-38-9	Carbon dioxide	CO2	X	2.58							X			Fab Solvent	0.00	67,878	N/A	N/A	0.00	67,878

Table 6-1: Process Chemical Emissions Calculations

Primary Chemical						Emission Chemical					Emission Chemical Classifications										Process Emission Quantification					
CAS #	Chemical Name	Common Acronym/Alternate Name	Molecular Formula	Process Category	% of Total Usage	Projected Usage in Process Category (lb/yr)	CAS #	Emission Chemical	Molecular Formula	Emission Chem Formation Depends on Primary Chem EF?	Process Emission Factor (lb emitted / lb used)	VOC	PM	NO_x	CO	SO_2	HAP	GHG	HTAC	Fluorides	Exhaust Type	PEEC Fraction Managed	Pre-Control Process Emissions (lb/yr)	POU or RCS DRE	Post POU Emissions (lb/yr)	Centralized Control DRE	Post-Control Emissions (lb/yr)
[redacted]				Photolithography	100%	[redacted]					[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
				Photolithography	100%		124-38-9	Carbon dioxide	CO2	X								X			Fab Solvent	0.00		N/A		0.00	
				Photolithography	100%		10102-44-0	Nitrogen dioxide	NO2	X				X							Fab Solvent	0.00		N/A		0.00	
				CMP	100%							X									Fab Ammonia	0.00		N/A		0.00	
				CMP	100%							X	X								Fab Ammonia	0.00		N/A		0.00	
64-19-7	Acetic acid		CH_3CO_2	Wet Etch / Wet Clean	100%	8,389	64-19-7	Acetic acid	CH4CO2		0.05	X									Fab Acid	0.00	419.4	N/A	N/A	0.00	419.4
74-86-2	Acetylene		C_2H_2	Thin Films / Diffusion Deposition	100%	37,524	74-86-2	Acetylene	C2H2		1.00	X									Fab CVD	0.99	375.2	N/A	N/A	0.00	375.2
74-86-2	Acetylene		C_2H_2	Thin Films / Diffusion Deposition	100%	37,524	124-38-9	Carbon dioxide	CO2	X	3.38							X			Fab CVD	0.00	126,839	N/A	N/A	0.00	126,839
[redacted]				Photolithography	100%	[redacted]					[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
				Photolithography	100%		124-38-9	Carbon dioxide	CO2	X								X			Fab Solvent	0.00		N/A		0.00	
7664-41-7	Ammonia		NH_3	Thin Films / Diffusion Deposition	16%	446,468	7664-41-7	Ammonia	NH3		0.90										Fab CVD	0.95	20,091	N/A	N/A	0.00	20,091
7664-41-7	Ammonia		NH_3	Thin Films / Diffusion Deposition	16%	446,468	10102-44-0	Nitrogen dioxide	NO2		1.08			X							Fab CVD	0.00	482,414	N/A	N/A	0.90	48,241
7664-41-7	Ammonia		NH_3	CMP	10%	272,102	7664-41-7	Ammonia	NH3		0.50										Fab Ammonia	0.00	136,051	N/A	N/	0.98	2,721
7664-41-7	Ammonia		NH_3	Wet Etch / Wet Clean	74%	2,026,052	7664-41-7	Ammonia	NH3		0.50										Fab Ammonia	0.00	1,013,026	N/A	N/A	0.98	20,261
1341-49-7	Ammonium bifluoride		F_2H_5N	Wet Etch / Wet Clean	100%	588,349	1341-49-7	Ammonium bifluoride	F2H5N		0.00		X							X	Fab Acid	0.00	0.00	N/A	N/A	0.00	0.00
1341-49-7	Ammonium bifluoride		F_2H_5N	Wet Etch / Wet Clean	100%	588,349	7664-41-7	Ammonia	NH3		0.01										Fab Acid	0.00	5,883	N/A	N/A	0.00	5,883
1341-49-7	Ammonium bifluoride		F_2H_5N	Wet Etch / Wet Clean	100%	588,349	7664-39-3	Hydrogen fluoride	HF		0.02						X				Fab Acid	0.00	11,767	N/A	N/A	0.60	4,707
12125-01-8	Ammonium fluoride		NH_4F	Wet Etch / Wet Clean	100%	724,074	12125-01-8	Ammonium fluoride	NH4F		0.00		X							X	Fab Acid	0.00	0.00	N/A	N/A	0.00	0.00
12125-01-8	Ammonium fluoride		NH_4F	Wet Etch / Wet Clean	100%	724,074	7664-41-7	Ammonia	NH3		0.01										Fab Acid	0.00	7,241	N/A	N/A	0.00	7,241
12125-01-8	Ammonium fluoride		NH_4F	Wet Etch / Wet Clean	100%	724,074	7664-39-3	Hydrogen fluoride	HF		0.01						X				Fab Acid	0.00	7,241	N/A	N/A	0.60	2,896
100-66-3	Anisole		C_7H_8O	Photolithography	100%	0.00	100-66-3	Anisole	C7H8O		0.20	X									Fab Solvent	0.00	0.00	N/A	N/A	0.97	0.00
100-66-3	Anisole		C_7H_8O	Photolithography	100%	0.00	124-38-9	Carbon dioxide	CO2	X	2.85							X			Fab Solvent	0.00	0.00	N/A	N/A	0.00	0.00
7784-42-1	Arsine		AsH_3	Ion Implant	100%	82.9	7784-42-1	Arsine	AsH3		0.05						X		X		Fab Acid	0.00	4.15	N/A	N/A	0.00	4.15
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]					[redacted]	X									Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
				Thin Films / Diffusion Deposition	100%		7664-41-7	Ammonia	NH3												Fab CVD	0.99		N/A		0.00	
				Thin Films / Diffusion Deposition	100%		124-38-9	Carbon dioxide	CO2									X			Fab CVD	0.00		N/A		0.00	
				Thin Films / Diffusion Deposition	100%		124-40-3	Dimethylamine	C2H7N			X									Fab CVD	0.99		N/A		0.00	
				Thin Films / Diffusion Deposition	100%		74-82-8	Methane	CH4									X			Fab CVD	0.99		N/A		0.00	
				Thin Films / Diffusion Deposition	100%		10102-44-0	Nitrogen dioxid	NO2					X							Fab CVD	0.00		N/A		0.90	
				Thin Films / Diffusion Deposition	100%		7631-86-9	Silicon dioxide	SiO2				X								Fab CVD	0.00		N/A		0.82	
				CMP	100%							X									Fab Ammonia	0.00		N/A		0.00	
10294-34-5	Boron trichloride		BCl_3	Plasma Etch	100%	68,999	10294-34-5	Boron trichloride	BCl3		0.00										Fab Acid	0.00	0.00	0.95	0.00	0.00	0.00
10294-34-5	Boron trichloride		BCl_3	Plasma Etch	100%	68,999	1344-28-1	Aluminum oxide	Al2O3		3.92E-03		X								Fab Acid	0.00	270.1	0	270.1	0.00	270.1
10294-34-5	Boron trichloride		BCl_3	Plasma Etch	100%	68,999	1303-86-2	Boron trioxide	B2O3		0.01		X								Fab Acid	0.00	1,025	0	1,025	0.00	1,025
10294-34-5	Boron trichloride		BCl_3	Plasma Etch	100%	68,999	7647-01-0	Hydrogen chloride	HCl		0.05						X				Fab Acid	0.00	3,222	0.99	32.2	0.60	12.9
10294-34-5	Boron trichloride		BCl_3	Plasma Etch	100%	68,999	13463-67-7	Titanium dioxide	TiO2		5.10E-04		X								Fab Acid	0.00	35.2	0	35.2	0.00	35.2
124-38-9	Carbon dioxide		CO_2	Wet Etch / Wet Clean	100%	4,047,301	124-38-9	Carbon dioxide	CO2		1.00							X			Fab Acid	0.00	4,047,301	N/A	N/A	0.00	4,047,301
630-08-0	Carbon monoxide		CO	Plasma Etch	100%	36.835	630-08-0	Carbon monoxide	CO		1.00				X						Fab Acid	0.00	36,835	0.99	368.3	0.00	368.3
463-58-1	Carbonyl sulfide		COS	Plasma Etch	100%	1,442	463-58-1	Carbonyl sulfide	COS		1.00	X					X				Fab Acid	0.00	1,442	0.99	14.4	0.00	14.4
463-58-1	Carbonyl sulphide		COS	Plasma Etch	100%	1,442	124-38-9	Carbon dioxide	CO2	X	0.73							X			Fab Acid	0.00	1,057	0	1,057	0.00	1,057
463-58-1	Carbonyl sulphide		COS	Plasma Etch	100%	1,442	7446-09-5	Sulfur dioxide	SO2	X	1.07					X					Fab Acid	0.00	1,53_	0 _	1,53	0.00	1,53
7782-50-5	Chlorine		Cl_2	Plasma Etch	100%	79,183	7782-50-5	Chlorine	Cl2		1.00						X				Fab Acid	0.00	79,183	0	79,183	0.00	79,183
7790-91-2	Chlorine trifluoride		ClF_3	Thin Films / Diffusion Deposition	100%	6,845	7790-91-2	Chlorine trifluoride	ClF3		0.00									X	Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
7790-91-2	Chlorine trifluoride		ClF_3	Thin Films / Diffusion Deposition	100%	6,845	7647-01-0	Hydrogen chloride	HCl		0.39						X				Fab CVD	0.99	27.0	N/A	N/A	0.60	10.8
7790-91-2	Chlorine trifluoride		ClF_3	Thin Films / Diffusion Deposition	100%	6,845	7664-39-3	Hydrogen fluoride	HF		0.65						X				Fab CVD	0.99	44.4	N/A	N/A	0.60	17.8
77-92-9	Citric acid		$C_6H_8O_7$	Wet Etch / Wet Clean	100%	3,331	77-92-9	Citric acid	C6H8O7		0.05	X									Fab Acid	0.00	166.5	N/A	N/A	0.00	166.5
[redacted]				Photolithography	100%	[redacted]					[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
				Photolithography	100%		124-38-9	Carbon dioxide	CO2	X								X			Fab Solvent	0.00		N/A		0.00	
				Photolithography	100%		10102-44-0	Nitrogen dioxide	NO2	X				X							Fab Solvent	0.00		N/A		0.00	
				Photolithography	100%	[redacted]						X									Fab Solvent	0.00		N/A		0.97	
				Photolithography	100%		124-38-9	Carbon dioxide	CO2	X								X			Fab Solvent	0.00		N/A		0.00	
				Photolithography	100%		10102-44-0	Nitrogen dioxide	NO2	X				X							Fab Solvent	0.00		N/A		0.00	
				Photolithography	100%		7446-09-5	Sulfur dioxide	SO2	X						X					Fab Solvent	0.00		N/A		0.00	
108-94-1	Cyclohexanone		$C_6H_{10}O$	Photolithography	100%	260,863	108-94-1	Cyclohexanone	C6H10O		0.20	X									Fab Solvent	0.00	52,173	N/A	N/A	0.97	1,565
108-94-1	Cyclohexanone		$C_6H_{10}O$	Photolithography	100%	260,863	124-38-9	Carbon dioxide	CO2	X	2.69							X			Fab Solvent	0.00	140,378	N/A	N/A	0.00	140,378
120-92-3	Cyclopentanone		C_5H_8O	Photolithography	100%	[redacted]	120-92-3	Cyclopentanone	C5H8O		[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	N/A	0.97	0.98
120-92-3	Cyclopentanone		C_5H_8O	Photolithography	100%	164.1	124-38-9	Carbon dioxide	CO2	X	2.62							X			Fab Solvent	0.00	85.9	N/A	N/A	0.00	85.9
19287-45-7	Diborane		B_2H_6	Thin Films / Diffusion Deposition	100%	196.6	19287-45-7	Diborane	B2H6		1.00										Fab CVD	0.99	1.97	N/A	N/A	0.00	1.97
19287-45-7	Diborane		B_2H_6	Thin Films / Diffusion Deposition	100%	196.6	1303-86-2	Boron trioxide	B2O3	X	2.52		X								Fab CVD	0.00	494.6	N/A	N/A	0.82	89.0
142-96-1	Dibutyl ether		$C_8H_{18}O$	Photolithography	100%	24,263	142-96-1	Dibutyl ether	C8H18O		0.20	X									Fab Solvent	0.00	4,853	N/A	N/A	0.97	145.6
142-96-1	Dibutyl ether		$C_8H_{18}O$	Photolithography	100%	24,263	124-38-9	Carbon dioxide	CO2	X	2.70							X			Fab Solvent	0.00	13,119	N/A	N/A	0.00	13,119
4109-96-0	Dichlorosilane	DCS	H_2SiCl_2	Thin Films / Diffusion Deposition	100%	201,565	4109-96-0	Dichlorosilane	H2SiCl2		0.00										Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
4109-96-0	Dichlorosilane	DCS	H_2SiCl_2	Thin Films / Diffusion Deposition	100%	201,565	7647-01-0	Hydrogen chlorid	HCl		0.72						X				Fab CVD	0.99	1,455	N/A	N/A	0.60	582.1
4109-96-0	Dichlorosilane	DCS	H_2SiCl_2	Thin Films / Diffusion Deposition	100%	201,565	7631-86-9	Silicon dioxide	SiO2		0.59		X								Fab CVD	0.90	11,989	N/A	N/A	0.82	2,158
[redacted]			[redacted]	CMP	100%	[redacted]					[redacted]	X									Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
75-10-5	Difluoromethane		CH_2F_2	[illegible]	100%	14,066	75-10-5	Difluoromethane	CH2F2		0.20	X						X			Fab Acid	0.00	2,813	0.99	28.1	0.00	28.1
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	[illegible]	[illegible]	[illegible]	Carbon dioxide	CO2		0.85							X			Fab Acid	0.00	[illegible]	0	11,900	0.00	11,900
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	100%	14,066	593-53-3	[illegible]	CH3F		4.40E-03	X						X			Fab Acid	0.00	61.9	0.99	0.62	0.00	0.62
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	100%	14,066	76-16-4	Hexafluoroethane	C2F6		0.04							X			Fab Acid	0.00	618.9	0.98	12.4	0.00	12.4
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	100%	14,066	7664-39-3	Hydrogen fluoride	HF		0.77						X				Fab Acid	0.00	10,817	0.99	108.2	0.60	43.3
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	100%	14,066	75-73-0	Tetrafluoromethane	CF4		0.06							X			Fab Acid	0.00	843.9	0.89	92.8	0.00	92.8
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	100%	14,066	75-46-7	Trifluoromethane	CHF3		0.06							X			Fab Acid	0.00	801.8	0.98	16.0	0.00	16.0
75-10-5	Difluoromethane		CH_2F_2	Plasma Etch	100%	14,066	115-25-3	Octafluorocyclobutane	C4F8		0.07							X			Fab Acid	0.00	1,013	0.98	20.3	0.00	20.3
1590-87-0	Disilane		Si_2H_6	Thin Films / Diffusion Deposition	100%	4,134	1590-87-0	Disilane	Si2H6		0.00										Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
1590-87-0	Disilane		Si_2H_6	Thin Films / Diffusion Deposition	100%	4,134	7631-86-9	Silicon dioxide	SiO2		1.93		X								Fab CVD	0.00	7,984	N/A	N/A	0.82	1,437
[redacted]			[redacted]	Wet Etch / Wet Clean	100%	[redacted]					[redacted]	X									Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
				CMP	100%		107-21-1	Ethanediol	C2H6O2			X					X				Fab Ammonia	0.00					
107-21-1	Ethanediol		$C_2H_6O_2$	Photolithography	100%	3,471					0.05	X									Fab Solvent	0.00	173.5	N/A	N/A	0.00	173.5
[redacted]			[redacted]	Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
																										0.00	

Table 6-1: Process Chemical Emissions Calculations

Primary Chemical				Process Category	% of Total Usage	Projected Usage in Process Category (lb/yr)	Emission Chemical			Emission Chem Formation Depends on Primary Chem EF?	Process Emission Factor (lb emitted / lb used)	Emission Chemical Classifications									Exhaust Type	Process Emission Quantification				
CAS #	Chemical Name	Common Acronym/Alternate Name	Molecular Formula				CAS #	Emission Chemical	Molecular Formula			VOC	PM	NO_x	CO	SO_2	HAP	GHG	HTAC	Fluorides		PEEC Fraction Managed	Pre-Control Process Emissions (lb/yr)	POU or RCS DRE	Post POU Emissions (lb/yr)	Centralized Control DRE	Post-Control Emissions (lb/yr)
[redacted]				Photolithography	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2	X	[redacted]			X							Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
687-47-8	ethyl (S)-2-hydroxypropionate		$C_5H_{10}O_3$	Photolithography	100%	35,947	687-47-8	ethyl (S)-2-hydroxypropionate	C5H10O3		0.20	X									Fab Solvent	0.00	7,189	N/A	N/A	0.97	215.7
687-47-8	ethyl (S)-2-hydroxypropionate		$C_5H_{10}O_3$	Photolithography	100%	35,947	124-38-9	Carbon dioxide	CO2	X	1.86							X			Fab Solvent	0.00	13,392	N/A	N/A	0.00	13,392
97-64-3	Ethyl lactate		$C_5H_{10}O_3$	Photolithography	100%	31,809	97-64-3	Ethyl lactate	C5H10O3		0.20	X									Fab Solvent	0.00	6,362	N/	N/A	0.97	190.9
97-64-3	Ethyl lactate		$C_5H_{10}O_3$	Photolithography	100%	31,809	124-38-9	Carbon dioxide	CO2	X	1.86							X			Fab Solvent	0.00	11,851	N/A	N/A	0.00	11,851
74-85-1	Ethylene		C_2H_4	Thin Films / Diffusion Deposition	100%	0.00	74-85-1	Ethylene	C2H4		1.00	X									Fab CVD	0.99	0.00	N/A	N/A	0.00	0.00
74-85-1	Ethylene		C_2H_4	Thin Films / Diffusion Deposition	100%	0.00	124-38-9	Carbon dioxide	CO2	X	3.14							X			Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
7782-41-4	Fluorine		F_2	Thin Films / Diffusion Deposition	100%	1,795	7782-41-4	Fluorine	F2		1.00									X	Fab CVD	0.995	8.97	N/A	N/A	0.00	8.97
7782-41-4	Fluorine		F_2	Thin Films / Diffusion Deposition	100%	1,795	7664-39-3	Hydrogen fluoride	HF		1.05						X				Fab CVD	0.99	18.8	N/A	N/A	0.60	7.54
7782-41-4	Fluorine		F_2	Thin Films / Diffusion Deposition	100%	1,795	75-73-0	Tetrafluoromethane	CF4		0.12							X			Fab CVD	0.00	208.2	N/A	N/A	0.00	208.2
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	593-53-3	Fluoromethane	CH3F		0.32	X						X			Fab Acid	0.00	1,024	0.99	10.2	0.00	10.2
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	124-38-9	Carbon dioxide	CO2		1.29							X			Fab Acid	0.00	4,140	0	4,140	0.00	4,140
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	75-10-5	Difluoromethane	CH2F2		2.30E-03	X						X			Fab Acid	0.00	7.36	0.99	0.07	0.00	0.07
593-53-3	Fluoromethane		CH3F	Plasma Etch	100%	3,201	685-63-2	Hexafluorobutadiene	C4F6		1.20E-03	X						X			Fab Acid	0.00	3.84	0.98	0.08	0.00	0.08
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	76-16-4	Hexafluoroethane	C2F6		0.01							X			Fab Acid	0.00	35.2	0.98	0.70	0.00	0.70
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	7664-39-3	Hydrogen fluoride	HF		0.59						X				Fab Acid	0.00	1,882	0.99	18.8	0.60	7.53
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	75-73-0	Tetrafluoromethane	CF4		0.03							X			Fab Acid	0.00	99.2	0.89	10.9	0.00	10.9
593-53-3	Fluoromethane		CH_3F	Plasma Etch	100%	3,201	75-46-7	Trifluoromethane	CHF3		1.60E-03							X			Fab Acid	0.00	5.12	0.98	0.10	0.00	0.10
593-53-3	Fluoromethane		CH3F	Plasma Etch	100%	3,201	115-25-3	Octafluorocyclobutane	C4F8		0.01							X			Fab Acid	0.00	22.4	0.98	0.45	0.00	0.45
96-48-0	Gamma-butyrolactone		$C_4H_6O_2$	Photolithography	100%	13,766	96-48-0	Gamma-butyrolactone	C4H6O2		0.20	X									Fab Solvent	0.00	2,753	N/A	N/A	0.97	82.6
96-48-0	Gamma-butyrolactone		$C_4H_6O_2$	Photolithography	100%	13,766	124-38-9	Carbon dioxide	CO2	X	2.04							X			Fab Solvent	0.00	5,630	N/A	N/A	0.00	5,630
62566-74-9	Germanium tetrafluoride		GeF_4	Thin Films / Diffusion Deposition	100%	81.5	62566-74-9	Germanium tetrafluoride	GeF4		0.00									X	Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
62566-74-9	Germanium tetrafluoride		GeF_4	Thin Films / Diffusion Deposition	100%	81.5	1310-53-8	Germanium dioxide	GeO2		0.70		X								Fab CVD	0.00	57.4	N/A	N/A	0.82	10.3
62566-74-9	Germanium tetrafluoride		GeF_4	Thin Films / Diffusion Deposition	100%	81.5	7664-39-3	Hydrogen fluoride	HF		0.54						X				Fab CVD	0.99	0.44	N/A	N/A	0.60	0.18
7782-65-2	Germanium tetrahydride	Germane	GeH_4	Thin Films / Diffusion Deposition	100%	96.6	7782-65-2	Germanium tetrahydride	GeH4		0.00										Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
7782-65-2	Germanium tetrahydride	Germane	GeH_4	Thin Films / Diffusion Deposition	100%	96.6	1310-53-8	Germanium dioxide	GeO2		1.36		X								Fab CVD	0.00	131.8	N/A	N/A	0.82	23.7
[redacted]				Wet Etch / Wet Clean	100%	[redacted]	[redacted]				[redacted]	X									Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
110-43-0	Heptan-2-one		$C_7H_{14}O$	Photolithography	100%	2,366	110-43-0	Heptan-2-one	C7H14O		0.20	X									Fab Solvent	0.00	473.1	N/A	N/A	0.97	14.2
110-43-0	Heptan-2-one		$C_7H_{14}O$	Photolithography	100%	2,366	124-38-9	Carbon dioxide	CO2	X	2.70							X			Fab Solvent	0.00	1,276	N/A	N/A	0.00	1,276
13465-77-5	Hexachlorodisilane		Si_2Cl_6	Thin Films / Diffusion Deposition	100%	5,266	13465-77-5	Hexachlorodisilane	Si2Cl6		0.00										Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
13465-77-5	Hexachlorodisilane		Si_2Cl_6	Thin Films / Diffusion Deposition	100%	5,266	7647-01-0	Hydrogen chloride	HCl		0.81						X				Fab CVD	0.99	42.9	N/A	N/A	0.60	17.1
13465-77-5	Hexachlorodisilane		Si_2Cl_6	Thin Films / Diffusion Deposition	100%	5,266	7631-86-9	Silicon dioxide	SiO2		0.45		X								Fab CVD	0.00	2,353	N/A	N/A	0.82	423.6
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	685-63-2	Hexafluorobutadiene	C4F6		0.15	X						X			Fab Acid	0.00	1,763	0.98	35.3	0.00	35.3
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	124-38-9	Carbon dioxide	CO2		1.09							X			Fab Acid	0.00	12,767	0	12,767	0.00	12,767
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	75-10-5	Difluoromethane	CH2F2		3.00E-05	X						X			Fab Acid	0.00	0.35	0.99	3.53E-03	0.00	3.53E-03
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	593-53-3	[redacted]	CH3F		6.50E-04	X						X			Fab Acid	0.00	7.64	0.99	0.08	0.00	0.08
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	76-16-4	Hexafluoroethane	C2F6		0.06							X			Fab Acid	0.00	728.6	0.98	14.6	0.00	14.6
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	7664-39-3	Hydrogen fluoride	HF		0.74						X				Fab Acid	0.00	8,708	0.99	87.1	0.60	34.8
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	75-73-0	Tetrafluoromethane	CF4		0.06							X			Fab Acid	0.00	693.3	0.89	76.3	0.00	76.3
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	75-46-7	Trifluoromethane	CHF3		0.02							X			Fab Acid	0.00	199.8	0.98	4.00	0.00	4.00
685-63-2	Hexafluorobutadiene		C_4F_6	Plasma Etch	100%	11,751	115-25-3	Octafluorocyclobutane	C4F8		0.01							X			Fab Acid	0.00	59.9	0.98	1.20	0.00	1.20
999-97-3	Hexamethyldisilazane	HMDS	$C_6H_{19}NSi_2$	Photolithography	100%	43,928	999-97-3	Hexamethyldisilazane	C6H19NSi2		1.00	X									Fab Solvent	0.00	43,928	N/A	N/A	0.97	1,318
999-97-3	Hexamethyldisilazane	HMDS	$C_6H_{19}NSi_2$	Photolithography	100%	43,928	124-38-9	Carbon dioxide	CO2	X	1.64							X			Fab Solvent	0.00	71,874	N/A	N/A	0.00	71,874
999-97-3	Hexamethyldisilazane	HMDS	$C_6H_{19}NSi_2$	Photolithography	100%	43,928	10102-44-0	Nitrogen dioxide	NO2	X	0.29			X							Fab Solvent	0.00	12,522	N/A	N/A	0.00	12,522
999-97-3	Hexamethyldisilazane	HMDS	$C_6H_{19}NSi_2$	Photolithography	100%	43,928	7631-86-9	Silicon dioxide	SiO2	X	0.74		X								Fab Solvent	0.00	32,706	N/A	N/A	0.00	32,706
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X									Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
10035-10-6	Hydrogen bromide		HBr	Plasma Etch	100%	52,840	10035-10-6	Hydrogen bromide	HBr		1.00										Fab Acid	0.00	52,840	0.99	528.4	0.00	528.4
10035-10-6	Hydrogen bromide		HBr	Plasma Etch	100%	52,840	7726-95-6	Bromine	Br2		0.99										Fab Acid	0.00	52,206	0.5	26,103	0.00	26,103
7647-01-0	Hydrogen chloride		HCl	Thin Films / Diffusion Deposition	1.2%	35,832	7647-01-0	Hydrogen chloride	HCl		1.00						X				Fab CVD	0.99	[illegible]	N/A	[illegible]	[illegible]	[illegible]
7647-01-0	Hydrogen chloride		HCl	Wet Etch / Wet Clean	99%	2,955,998	7647-01-0	Hydrogen chloride	HCl		0.05						X				Fab Acid	0.00	147,800	N/A	N/A	0.60	59,120
7664-39-3	Hydrogen fluoride		HF	Thin Films / Diffusion Deposition	0.1%	12,150	7664-39-3	Hydrogen fluoride	HF		1.00						X				Fab CVD	0.99	121.5	N/A	N/A	0.60	48.6
7664-39-3	Hydrogen fluoride		HF	Wet Etch / Wet Clean - Single Wafer Tools	94%	8,541,932	7664-39-3	Hydrogen fluoride	HF		0.05						X				Fab Acid	0.99	4,271	N/A	N/A	0.60	1,708
7664-39-3	Hydrogen fluoride		HF	Wet Etch / Wet Clean - Bench Tools	6%	471,036	7664-39-3	Hydrogen fluoride	HF		0.05						X				Fab Acid	0.00	23,552	N/A	N/A	0.60	9,421
7722-84-1	Hydrogen peroxide		H_2O_2	Wet Etch / Wet Clean	100%	17,068,915	7722-84-1	Hydrogen peroxide	H2O2		1.00E-03										Fab Acid	0.00	17,069	N/A	N/A	0.00	17,069
[redacted]				Wet Etch / Wet Clean	100%	[redacted]	[redacted]				[redacted]	X	X								Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
13966-94-4	Indium iodide		InI	Wet Etch / Wet Clean	100%	8.74	13966-94-4	Indium iodide	InI		1.00E-03		X								Fab Acid	0.00	0.01	N/A	N/A	0.00	0.01
67-63-0	Isopropanol	IPA	C_3H_8O	Wet Etch / Wet Clean	99%	23,237,104	67-63-0	Isopropanol	C3H8O		0.20	X									Fab Solvent	0.00	4,647,421	N/A	N/A	0.97	139,423
67-63-0	Isopropanol	IPA	C_3H_8O	Wet Etch / Wet Clean	99%	23,237,104	124-38-9	Carbon dioxide	CO2		2.20							X			Fab Solvent	0.00	51,048,166	N/A	N/A	0.00	51,048,166
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]		X								Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]		X								Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Wet Etch / Wet Clean	100%	[redacted]	[redacted]				[redacted]	X									Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	[redacted]				[redacted]	X	X								Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
79-41-4	Methacrylic Acid		$C_4H_6O_2$	Photolithography	100%	22,361	79-41-4	Methacrylic Acid	C4H6O2		0.20	X									Fab Solvent	0.00	4,472	N/A	N/A	0.97	134.2
79-41-4	Methacrylic Acid		$C_4H_6O_2$	Photolithography	100%	22,361	124-38-9	Carbon dioxide	CO2	X	2.04							X			Fab Solvent	0.00	9,145	N/A	N/A	0.00	9,145
74-82-8	Methane		CH_4	Plasma Etch	100%	[illegible]	74-82-8	Methane	CH4		1.00							X			Fab Acid	0.00	3,411	[illegible]	34.1	0.00	34.1
74-82-8	Methane		CH_4	Plasma Etch	100%	3,411	124-38-9	Carbon dioxide	CO2		2.74							X			Fab Acid	0.00	9,358	0	9,358	0.00	9,358
67-56-1	Methanol		CH_4O	Photolithography	100%	167.8	67-56-1	Methanol	C1H4O		1.00	X					X				Fab General	0.00	167.8	N/A	N/A	0.00	167.8
2110-78-3	Methyl 2-hydroxy-2-methylpropionate		[illegible]	Photolithography	100%	6,168	2110-78-3	Methyl 2-hydroxy-2-methylpropionate	C5H10O3		0.20	X									Fab Solvent	0.00	1,234	N/A	N/A	0.97	37.0
2110-78-3	Methyl 2-hydroxy-2-methylpropionate		$C_5H_{10}O_3$	Photolithography	100%	6,168	124-38-9	Carbon dioxide	CO2	X	1.86							X			Fab Solvent	0.00	2,298	N/A	N/A	0.00	2,298
1319-77-3	Mixed cresols		C_7H_8O	Photolithography	100%	31.1	1319-77-3	Mixed cresols	C7H8O		0.20		X				X				Fab Solvent	0.00	6.23	N/A	N/A	0.97	0.19
1319-77-3	Mixed cresols		C_7H_8O	Photolithography	100%	31.1	124-38-9	Carbon dioxide	CO2	X	2.85							X			Fab Solvent	0.00	17.7	N/A	N/A	0.00	17.7
[redacted]				CMP	100%	[redacted]	[redacted]				[redacted]	X									Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]				[redacted]	X									Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	7664-41-7	Ammonia	NH3		[redacted]										Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2		[redacted]			X							Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	74-98-6	Propane	C3H8		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	7631-86-9	Silicon dioxide	SiO2		[redacted]		X								Fab CVD	0.00	[redacted]	N/A	[redacted]	0.82	[redacted]
68-12-2	N,N-Dimethylformamide		C_3H_7NO	Photolithography	100%	0.00	68-12-2	N,N-Dimethylformamide	C3H7NO		1.00	X					X				Fab Solvent	0.00	0.00	N/A	N/A	0.97	0.00
68-12-2	N,N-Dimethylformamide		C_3H_7NO	Photolithography	100%	0.00	124-38-9	Carbon dioxide	CO2	X	1.81							X			Fab Solvent	0.00	0.00	N/A	N/A	0.00	0.00
[illegible]	N,N-Dimethylformamide		C_3H_7NO	Photolithography	[illegible]	[illegible]	[illegible]	Nitrogen dioxide	NO2	X	0.63			X							Fab Solvent	0.00	[illegible]	N/A	N/A	0.00	0.00
91-20-3	Naphthalene		$C_{10}H_8$	Photolithography	100%	13,665	91-20-3	Naphthalene	C10H8		0.20	X					X				Fab Solvent	0.00	2,733	N/A	N/A	0.97	82.0
91-20-3	Naphthalene		$C_{10}H_8$	Photolithography	100%	13,665	124-38-9	Carbon dioxide	CO2	X	[illegible]							X			Fab Solvent	0.00	9,385	N/A	N/A	0.00	9,385

Table 6-1: Process Chemical Emissions Calculations

Primary Chemical							Emission Chemical					Emission Chemical Classifications										Process Emission Quantification					
CAS #	Chemical Name	Common Acronym/Alternate Name	Molecular Formula	Process Category	% of Total Usage	Projected Usage in Process Category (lb/yr)	CAS #	Emission Chemical	Molecular Formula	Emission Chem Formation Depends on Primary Chem EF?	Process Emission Factor (lb emitted / lb used)	VOC	PM	NO_x	CO	SO_2	HAP	GHG	HTAC	Fluorides	Exhaust Type	PEEC Fraction Managed	Pre-Control Process Emissions (lb/yr)	POU or R&S DRE	Post POU Emissions (lb/yr)	Centralized Control DRE	Post-Control Emissions (lb/yr)
123-86-4	n-Butyl acetate		$C_6H_{12}O_2$	Photolithography	100%	1,780,301	123-86-4	n-Butyl acetate	C6H12O2		0.20	X									Fab Solvent	0.00	356,060	N/A	N/A	0.97	10,682
123-86-4	n-Butyl acetate		$C_6H_{12}O_2$	Photolithography	100%	1,780,301	124-38-9	Carbon dioxide	CO2	X	2.27							X			Fab Solvent	0.00	809,412	N/A	N/A	0.00	809,412
7697-37-2	Nitric acid		HNO_3	Wet Etch / Wet Clean	100%	4,483,725	7697-37-2	Nitric acid	HNO3		0.01										Fab Acid	0.00	44,837	N/A	N/A	0.40	26,902
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	7783-54-2	Nitrogen trifluoride	NF3		0.16							X			Fab Acid	0.00	42,634	0.95	2,132	0.00	2,132
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	75-10-5	Difluoromethane	CH2F2		8.60E-04	X						X			Fab Acid	0.00	229.2	0.99	2.29	0.00	2.29
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	593-53-3	Fluoromethane	CH3F		0.01	X						X			Fab Acid	0.00	2,132	0.99	21.3	0.00	21.3
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	76-16-4	Hexafluoroethane	C2F6		0.05							X			Fab Acid	0.00	11,991	0.98	239.8	0.00	239.8
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	7664-39-3	Hydrogen fluoride	HF		0.85						X				Fab Acid	0.00	225,163	0.99	2,25	0.60	900.7
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	10102-44-0	Nitrogen dioxide	NO2	X	0.65			X							Fab Acid	0.00	27,626	0	27,62	0.00	27,626
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	75-73-0	Tetrafluoromethan	CF4		0.05							X			Fab Acid	0.00	11,991	0.89	1,31	0.00	1,319
7783-54-2	Nitrogen trifluoride		NF_3	Plasma Etch	24%	266,465	75-46-7	Trifluoromethane	CHF3		0.03							X			Fab Acid	0.00	6.662	0.98	133.	0.00	133.2
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - In-Situ Clean	1%	5,665	7783-54-2	Nitrogen trifluoride	NF3		0.20							X			Fab CVD	0.95	56.6	N/A	N/A	0.00	56.6
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - In-Situ Clean	1%	5,665	7664-39-3	Hydrogen fluoride	HF		0.85						X				Fab CVD	0.99	47.9	N/A	N/A	0.60	19.1
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - In-Situ Clean	1%	5,665	10102-44-0	Nitrogen dioxide	NO2	X	0.65			X							Fab CVD	0.00	734.1	N/A	N/A	0.90	73.4
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - In-Situ Clean	1%	5,665	75-73-0	Tetrafluoromethane	CF4		0.04							X			Fab CVD	0.89	23.1	N/A	N/A	0.00	23.1
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Remote Clean	76%	866,532	7783-54-2	Nitrogen trifluoride	NF3		0.02							X			Fab CVD	0.95	779.9	N/A	N/A	0.00	779.9
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Remote Clean	76%	866,532	7782-41-4	Fluorine	F2		0.80									X	Fab CVD	1.00	3,479	N/A	N/A	0.00	3,479
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Remote Clean	76%	866,532	7664-39-3	Hydrogen fluoride	HF		0.85						X				Fab CVD	0.99	7,322	N/A	N/A	0.60	2,929
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Remote Clean	76%	866,532	10102-44-0	Nitrogen dioxide	NO2	X	0.65			X							Fab CVD	0.00	10,107	N/A	N/A	0.90	1,011
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Remote Clean	76%	866,532	75-73-0	Tetrafluoromethane	CF4		0.04							X			Fab CVD	0.89	3,622	N/A	N/A	0.00	3,622
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Remote Clean	76%	866,532	75-73-0	Tetrafluoromethane	CF4		0.09							X			Fab CVD	0.00	80,588	N/A	N/A	0.00	80,588
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Thermal Clean	1%	5,665	7783-54-2	Nitrogen trifluoride	NF3		0.28							X			Fab CVD	0.95	79.3	N/A	N/A	0.00	79.3
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Thermal Clean	1%	5,665	7664-39-3	Hydrogen fluoride	HF		0.85						X				Fab CVD	0.99	47.9	N/A	N/A	0.60	19.1
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Thermal Clean	1%	5,665	10102-44-0	Nitrogen dioxide	NO2	X	0.65			X							Fab CVD	0.00	1,028	N/A	N/A	0.90	102.8
7783-54-2	Nitrogen trifluoride		NF_3	Thin Films - Thermal Clean	1%	5,665	75-73-0	Tetrafluoromethane	CF4		0.01							X			Fab CVD	0.00	56.6	N/A	N/A	0.00	56.6
10024-97-2	Nitrous oxide		N_2O	Thin Films / Diffusion Deposition	100%	1,576,605	10024-97-2	Nitrous oxide	N2O		0.50							X			Fab CVD	0.60	315,321	N/A	N/A	0.00	315,321
10024-97-2	Nitrous oxide	*FROM POU*	N_2O	Thin Films / Diffusion Deposition	100%	1,576,605	10102-44-0	Nitrogen dioxide	NO2	X	1.25			X							Fab CVD	0.00	988,787	N/A	N/A	0.90	98,879
10024-97-2	Nitrous oxide	*FROM TOOL*	N_2O	Thin Films / Diffusion Deposition	100%	1,576,605	10102-44-1	Nitrogen dioxide	NO2		0.21			X							Fab CVD	0.00	329,596	N/A	N/A	0.90	32,960
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	115-25-3	Octafluorocyclobutane	C4F8		0.18							X			Fab Acid	0.00	2,091	0.98	41.8	0.00	41.8
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	124-38-9	Carbon dioxide	CO2		0.88							X			Fab Acid	0.00	10,226	0	10,226	0.00	10,226
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	75-10-5	Difluoromethane	CH2F2		1.40E-03	X						X			Fab Acid	0.00	16.3	0.99	0.16	0.00	0.16
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	593-53-3	Fluoromethane	CH3F		2.20E-03	X						X			Fab Acid	0.00	25.6	0.99	0.26	0.00	0.26
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	685-63-2	Hexafluorobutadiene	C4F6		0.01	X						X			Fab Acid	0.00	109.2	0.98	2.18	0.00	2.18
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	76-16-4	Hexafluoroethane	C2F6		0.03							X			Fab Acid	0.00	313.7	0.98	6.27	0.00	6.27
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	7664-39-3	Hydrogen fluoride	HF		0.80						X				Fab Acid	0.00	9,295	0.99	93.0	0.60	37.2
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	75-73-0	Tetrafluoromethane	CF4		0.05							X			Fab Acid	0.00	522.9	0.89	57.5	0.00	57.5
115-25-3	Octafluorocyclobutane		C_4F_8	Plasma Etch	100%	11,619	75-46-7	Trifluoromethane	CHF3		0.03							X			Fab Acid	0.00	337.0	0.98	6.74	0.00	6.74
556-67-2	Octamethylcyclotetrasiloxane	OMCTS / D4	$C_8H_{24}O_4Si_4$	Thin Films / Diffusion Deposition	100%	26,181	556-67-2	Octamethylcyclotetrasiloxane	C8H24O4Si4		0.00										Fab CVD	0.99	0.00	N/A	N/A	0.00	0.00
556-67-2	Octamethylcyclotetrasiloxane	OMCTS / D4	$C_8H_{24}O_4Si_4$	Thin Films / Diffusion Deposition	100%	26,181	124-38-9	Carbon dioxide	CO2		1.19							X			Fab CVD	0.00	31,077	N/A	N/A	0.00	31,077
556-67-2	Octamethylcyclotetrasiloxane	OMCTS / D4	$C_8H_{24}O_4Si_4$	Thin Films / Diffusion Deposition	100%	26,181	67-56-1	Methanol	CH3OH		0.86	X						X			Fab CVD	0.99	226.2	N/A	N/A	0.00	226.2
556-67-2	Octamethylcyclotetrasiloxane	OMCTS / D4	$C_8H_{24}O_4Si_4$	Thin Films / Diffusion Deposition	100%	26,181	7631-86-9	Silicon dioxide	SiO2		0.81		X								Fab CVD	0.00	21,212	N/A	N/A	0.82	3,818
[redacted]				CMP	100%	[redacted]	[redacted]		[redacted]		[redacted]	X	X								Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
7803-51-2	Phosphine		PH_3	Thin Films / Diffusion Deposition	46%	118.9	7803-51-2	Phosphine	PH3		1.00						X				Fab CVD	0.99	1.19	N/A	N/A	0.00	1.19
7803-51-2	Phosphine		PH_3	Thin Films / Diffusion Deposition	46%	118.9	1314-56-3	Phosphorus pentoxide	P2O5	X	2.09			X							Fab CVD	0.00	248.1	N/A	N/A	0.82	44.7
7803-51-2	Phosphine		PH_3	Ion Implant	54%	138.7	7803-51-2	Phosphine	PH3		0.05						X				Fab Acid	0.00	6.93	N/A	N/A	0.00	6.93
7664-38-2	Phosphoric acid		H_3PO_4	Wet Etch / Wet Clean	100%	458,679	7664-38-2	Phosphoric acid	H3PO4		1.00E-03			X							Fab Acid	0.00	458.7	N/A	N/A	0.00	458.7
7783-55-3	Phosphorous Trifluoride		PF_3	Plasma Etch	100%	2,458	7783-55-3	Phosphorous Trifluoride	PF3		0.00										Fab Acid	0.00	0.00	0	0.00	0.00	0.00
7783-55-3	Phosphorous Trifluoride		PF_3	Plasma Etch	100%	2,458	7664-39-3	Hydrogen fluoride	HF		0.68						X				Fab Acid	0.00	1,677	0.99	16.8	0.60	6.71
7783-55-3	Phosphorous Trifluoride		PF_3	Plasma Etch	100%	2,458	1314-56-3	Phosphorus pentoxide	P2O5		0.81			X							Fab Acid	0.00	1,983	0	1,983	0.00	1,983
1310-58-3	Potassium hydroxide		KOH	Wet Etch / Wet Clean	100%	11,874	1310-58-3	Potassium hydroxide	KOH		1.00E-03			X							Fab Acid	0.00	11.9	N/A	N/A	0.00	11.9
52125-53-8	Propanol, 1(or 2)-ethoxy-		$C_5H_{12}O_2$	Photolithography	100%	18,616	52125-53-8	Propanol, 1(or 2)-ethoxy-	C5H12O2		0.20	X									Fab Solvent	0.00	3,723	N/A	N/A	0.97	111.7
52125-53-8	Propanol, 1(or 2)-ethoxy-		$C_5H_{12}O_2$	Photolithography	100%	18,616	124-38-9	Carbon dioxide	CO2	X	2.11							X			Fab Solvent	0.00	7,866	N/A	N/A	0.00	7,866
115-07-1	Propylene		C_3H_6	Thin Films / Diffusion Deposition	100%	7,017	115-07-1	Propylene	C3H6		1.00	X									Fab CVD	0.99	70.2	N/A	N/A	0.00	70.2
115-07-1	Propylene		C_3H_6	Thin Films / Diffusion Deposition	100%	7,017	124-38-9	Carbon dioxide	CO2	X	3.14							X			Fab CVD	0.00	22,017	N/A	N/A	0.00	22,017
108-32-7	Propylene carbonate		$C_4H_6O_3$	None Identified	100%	0.00	108-32-7	Propylene carbonate	C4H6O3		1.00E-03										Fab Acid	0.00	0.00	N/A	N/A	0.00	0.00
110-86-1	Pyridine		C_5H_5N	Photolithography	100%	379.1	110-86-1	Pyridine	C5H5N		0.20	X									Fab Solvent	0.00	75.8	N/A	N/A	0.97	2.27
110-86-1	Pyridine		C_5H_5N	Photolithography	100%	379.1	124-38-9	Carbon dioxide	CO2	X	2.78							X			Fab Solvent	0.00	210.9	N/A	N/A	0.00	210.9
110-86-1	Pyridine		C_5H_5N	Photolithography	100%	379.1	10102-44-0	Nitrogen dioxide	NO2	X	0.58			X							Fab Solvent	0.00	44.1	N/A	N/A	0.00	44.1
[redacted]				Photolithography	100%	[redacted]	[redacted]		[redacted]		[redacted]	X	X								Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2	X	[redacted]			X							Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				CMP	100%	[redacted]	[redacted]		[redacted]		[redacted]	X	X								Fab Ammonia	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
7803-62-5	Silane		SiH_4	Thin Films / Diffusion Deposition	100%	[redacted]	7803-62-5	Silane	SiH4		[redacted]										Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
7803-62-5	Silane		SiH_4	Thin Films / Diffusion Deposition	100%	[redacted]	7631-86-9	Silicon dioxide	SiO2		[redacted]		X								Fab CVD	0.95	[redacted]	N/A	[redacted]	0.82	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]		[redacted]		[redacted]	X									Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	7664-41-7	Ammonia	NH3		[redacted]										Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	109-89-7	Diethylamine	C4H11N		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	74-84-0	Ethane	C2H6		[redacted]										Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2		[redacted]			X							Fab CVD	0.00	[redacted]	N/A	[redacted]	0.90	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	7631-86-9	Silicon dioxide	SiO2		[redacted]		X								Fab CVD	0.00	[redacted]	N/A	[redacted]	0.82	[redacted]
10026-04-7	Silicon tetrachloride		$SiCl_4$	Plasma Etch	100%	46,254	10026-04-7	Silicon tetrachloride	SiCl4		0.00			X							Fab Acid	0.00	0.00	0.95	0.00	0.00	0.00
10026-04-7	Silicon tetrachloride		$SiCl_4$	Plasma Etch	100%	46,254	7647-01-0	Hydrogen chloride	HCl		0.04						X				Fab Acid	0.00	1,984	0.99	19.8	0.60	7.94
[redacted]	Silicon tetrachloride		$SiCl_4$	Plasma Etch	100%	46,254	7631-86-9	Silicon dioxide	SiO2		[redacted]			X							Fab Acid	0.00	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
64742-94-5	Solvent naphtha (petroleum), heavy arom.		Varies	Photolithography	100%	273,307	64742-94-5	Solvent naphtha (petroleum), heavy arom.	Varies		0.20	X									Fab Solvent	0.00	54,661	N/A	N/A	0.97	1,640
64742-94-5	Solvent naphtha (petroleum), heavy arom.		Varies	Photolithography	100%	273,307	124-38-9	Carbon dioxide	CO2	X	3.67							X			Fab Solvent	0.00	200,471	N/A	N/A	0.00	200,471
7446-09-5	Sulfur dioxide		SO_2	Plasma Etch	100%	34,597	7446-09-5	Sulfur dioxide	SO2		1.00					X					Fab Acid	0.00	34,597	0	34,597	0.00	34,597
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	2551-62-4	Sulfur hexafluoride	SF6		0.29							X			Fab Acid	0.00	1,493	0.96	59.7	0.00	59.7
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	75-10-5	Difluoromethane	CH2F2		2.00E-05	X						X			Fab Acid	0.00	0.10	0.99	1.03E-03	0.00	1.03E-03

Table 6-1: Process Chemical Emissions Calculations

Primary Chemical							Emission Chemical					Emission Chemical Classifications									Exhaust Type	Process Emission Quantification					
CAS #	Chemical Name	Common Acronym/Alternate Name	Molecular Formula	Process Category	% of Total Usage	Projected Usage in Process Category (lb/yr)	CAS #	Emission Chemical	Molecular Formula	Emission Chem Formation Depends on Primary Chem EF?	Process Emission Factor (lb emitted / lb used)	VOC	PM	NO_x	CO	SO_2	HAP	GHG	HTAC	Fluorides		PEEC Fraction Managed	Pre-Control Process Emissions (lb/yr)	POU or RDS DRE	Post POU Emissions (lb/yr)	Centralized Control DRE	Post-Control Emissions (lb/yr)
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	593-53-3	Fluoromethane	CH3F		0.01	X						X			Fab Acid	0.00	42.2	0.99	0.42	0.00	0.42
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	76-16-4	Hexafluoroethane	C2F6		0.04							X			Fab Acid	0.00	211.1	0.98	4.22	0.00	4.22
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	7664-39-3	Hydrogen fluoride	HF		0.82						X				Fab Acid	0.00	4,233	0.99	42.3	0.60	16.9
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	7446-09-5	Sulfur dioxide	SO2		0.44					X					Fab Acid	0.00	2,259	0	2,259	0.00	2,259
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	75-73-0	Tetrafluoromethane	CF4		0.03							X			Fab Acid	0.00	175.1	0.89	19.3	0.00	19.3
2551-62-4	Sulfur hexafluoride		SF_6	Plasma Etch	100%	5,149	75-46-7	Trifluoromethane	CHF3		3.90E-03							X			Fab Acid	0.00	20.1	0.98	0.40	0.00	0.40
7664-93-9	Sulfuric acid		H_2SO_4	Wet Etch / Wet Clean	100%	23,673,997	7664-93-9	Sulfuric acid	H2SO4		1.00E-03		X								Fab Acid	0.00	23,674	N/A	N/A	0.75	5,918
78-10-4	Tetraethyl orthosilicate	TEOS	$SiC_8H_{20}O_4$	Thin Films / Diffusion Deposition	100%	[redacted]	78-10-4	Tetraethyl orthosilicate	SiC8H2004		[redacted]	X									Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
78-10-4	Tetraethyl orthosilicate	TEOS	$SiC_8H_{20}O_4$	Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
78-10-4	Tetraethyl orthosilicate	TEOS	$SiC_8H_{20}O_4$	Thin Films / Diffusion Deposition	100%	[redacted]	64-17-5	Ethanol	C2H5OH		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
78-10-4	Tetraethyl orthosilicate	TEOS	$SiC_8H_{20}O_4$	Thin Films / Diffusion Deposition	100%	[redacted]	7631-86-9	Silicon dioxide	SiO2		[redacted]		X								Fab CVD	0.00	[redacted]	N/A	[redacted]	0.82	[redacted]
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	75-73-0	Tetrafluoromethane	CF4		0.65							X			Fab Acid	0.00	255,157	0.89	28,067	0.00	28,067
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	124-38-9	Carbon dioxide	CO2		0.50							X			Fab Acid	0.00	196,309	0	196,309	0.00	196,309
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	75-10-5	Difluoromethane	CH2F2		0.01	X						X			Fab Acid	0.00	5,496	0.99	55.0	0.00	55.0
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	593-53-3	Fluoromethane	CH3F		0.01	X						X			Fab Acid	0.00	2,081	0.99	20.8	0.00	20.8
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	685-63-2	Hexafluorobutadiene	C4F6		1.50E-03	X						X			Fab Acid	0.00	588.8	0.98	11.8	0.00	11.8
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	76-16-4	Hexafluoroethane	C2F6		0.06							X			Fab Acid	0.00	23,94	0.98	478.	0.00	478.
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	7664-39-3	Hydrogen fluoride	HF		0.91						X				Fab Acid	0.00	357.0	0.99	3.57	0.60	1.42
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	75-46-7	Trifluoromethane	CHF3		0.01							X			Fab Acid	0.00	5,103	0.98	102.1	0.00	102.
75-73-0	Tetrafluoromethane	Tetrafluoromethane	CF_4	Plasma Etch	100%	392,549	115-25-3	Octafluorocyclobutane	C4F8		3.30E-03							X			Fab Acid	0.00	1,295	0.98	25.9	0.00	25.!
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]		[redacted]		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
97-99-4	Tetrahydrofurfuryl Alcohol		$C_5H_{10}O_2$	Photolithography	100%	3,571	97-99-4	Tetrahydrofurfuryl Alcohc	C5H10O2		0.20	X									Fab Solvent	0.00	714.1	N/A	N/A	0.97	21.4
97-99-4	Tetrahydrofurfuryl Alcohol		$C_5H_{10}O_2$	Photolithography	100%	3,571	124-38-9	Carbon dioxide	CO2	X	2.15							X			Fab Solvent	0.00	1,539	N/A	N/A	0.00	1,539
[redacted]				Photolithography	100%	[redacted]	[redacted]		[redacted]		0.01	X	X								Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.97	[redacted]
[redacted]				Photolithography	100%	[redacted]	124-38-9	Carbon Dioxide	CO2	X	[redacted]							X			Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Photolithography	100%	[redacted]	10102-44-0	Nitrogen Dioxide	NO2	X	[redacted]			X							Fab Solvent	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Wet Etch / Wet Clean	100%	[redacted]	[redacted]		[redacted]		[redacted]	X	X							X	Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
75-59-2	Tetramethylammonium hydroxide	TMAH	$C_4H_{13}NO$	Photolithography	100%	934,483	75-59-2	Tetramethylammonium hydroxide	C4H13NO		1.00E-03	X	X								Fab Ammonia	0.00	934.5	N/A	N/A	0.00	934.5
7550-45-0	Titanium tetrachloride		$TiCl_4$	Thin Films / Diffusion Deposition	100%	30,122	7550-45-0	Titanium tetrachloride	TiCl4		0.00		X				X		X		Fab CVD	0.00	0.00	N/A	N/A	0.82	0.00
7550-45-0	Titanium tetrachloride		$TiCl_4$	Thin Films / Diffusion Deposition	100%	30,122	7647-01-0	Hydrogen chloride	HCl		0.77						X				Fab CVD	0.99	231.6	N/A	N/A	0.60	92.7
7550-45-0	Titanium tetrachloride		$TiCl_4$	Thin Films / Diffusion Deposition	100%	30,122	13463-67-7	Titanium dioxide	TiO2		0.42		X								Fab CVD	0.00	12,683	N/A	N/A	0.82	2,283
[redacted]				Wet Etch / Wet Clean	100%	[redacted]	[redacted]		[redacted]		[redacted]	X	X								Fab Acid	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
150-46-9	Triethyl borate	TEB	$C_6H_{15}BO_3$	Thin Films / Diffusion Deposition	100%	0.00	124-38-9	Carbon dioxide	CO2		1.81							X			Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
150-46-9	Triethyl borate	TEB	$C_6H_{15}BO_3$	Thin Films / Diffusion Deposition	100%	0.00	1303-86-2	Boron trioxide	B2O3		0.24		X								Fab CVD	0.00	0.00	N/A	N/A	0.82	0.00
150-46-9	Triethyl borate	TEB	$C_6H_{15}BO_3$	Thin Films / Diffusion Deposition	100%	0.00	124-38-9	Carbon dioxide	CO2		1.81							X			Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
150-46-9	Triethyl borate	TEB	$C_6H_{15}BO_3$	Thin Films / Diffusion Deposition	100%	0.00	64-17-5	Ethanol	C2H5OH		0.95	X									Fab CVD	0.99	0.00	N/A	N/A	0.00	0.00
78-40-0	Triethyl phosphate	TEPO	$C_6H_{15}O_4P$	Thin Films / Diffusion Deposition	100%	0.00	78-40-0	Triethyl phosphate	C6H15O4P		0.00	X									Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
78-40-0	Triethyl phosphate	TEPO	$C_6H_{15}O_4P$	Thin Films / Diffusion Deposition	100%	0.00	124-38-9	Carbon dioxide	CO2		1.45							X			Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
78-40-0	Triethyl phosphate	TEPO	$C_6H_{15}O_4P$	Thin Films / Diffusion Deposition	100%	0.00	64-17-5	Ethanol	C2H5OH		0.76	X									Fab CVD	0.99	0.00	N/A	N/A	0.00	0.00
78-40-0	Triethyl phosphate	TEPO	$C_6H_{15}O_4P$	Thin Films / Diffusion Deposition	100%	0.00	1314-56-3	Phosphorus pentoxide	P2O5		0.39		X								Fab CVD	0.00	0.00	N/A	N/A	0.82	0.00
121-44-8	Triethylamine		$C_6H_{15}N$	Wet Etch / Wet Clean	100%	196.3	121-44-8	Triethylamine	C6H15N		0.05	X					X				Fab Acid	0.00	9.82	N/A	N/A	0.00	9.82
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	75-46-7	Trifluoromethane	CHF3		0.38							X			Fab Acid	0.00	12,042	0.98	240.8	0.00	240.8
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	124-38-9	Carbon dioxide	CO2		0.63							X			Fab Acid	0.00	19,920	0	19,920	0.00	19,920
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	75-10-5	Difluoromethane	CH2F2		2.60E-03	X						X			Fab Acid	0.00	82.4	0.99	0.82	0.00	0.82
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	593-53-3	Fluoromethane	CH3F		0.04	X						X			Fab Acid	0.00	1,173	0.99	11.7	0.00	11.7
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	685-63-2	Hexafluorobutadiene	C4F6		1.00E-04	X						X			Fab Acid	0.00	3.17	0.98	0.06	0.00	0.06
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	76-16-4	Hexafluoroethane	C2F6		0.06							X			Fab Acid	0.00	1,965	0.98	39.3	0.00	39.3
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	7664-39-3	Hydrogen fluoride	HF		0.86						X				Fab Acid	0.00	27,172	0.99	271.7	0.60	108.7
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	75-73-0	Tetrafluoromethane	CF4		0.08							X			Fab Acid	0.00	2,408	0.89	264.9	0.00	264.9
75-46-7	Trifluoromethane		CHF_3	Plasma Etch	100%	31,689	115-25-3	Octafluorocyclobutane	C4F8		6.70E-04							X			Fab Acid	0.00	21.2	0.98	0.42	0.00	0.42
75-24-1	Trimethylaluminium	TMAl	C_3H_9Al	Thin Films / Diffusion Deposition	100%	1,182	75-24-1	Trimethylaluminium	C3H9Al		0.00	X									Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
75-24-1	Trimethylaluminium	TMAl	C_3H_9Al	Thin Films / Diffusion Deposition	100%	1,182	1344-28-1	Aluminum oxide	Al2O3		0.71		X								Fab CVD	0.00	835.8	N/A	N/A	0.82	150.4
75-24-1	Trimethylaluminium	TMAl	C_3H_9Al	Thin Films / Diffusion Deposition	100%	1,182	124-38-9	Carbon dioxide	CO2		1.83							X			Fab CVD	0.00	2,165	N/A	N/A	0.00	2,165
75-24-1	Trimethylaluminium	TMAl	C_3H_9Al	Thin Films / Diffusion Deposition	100%	1,182	50-00-0	Formaldehyde	CH2O		1.25	X					X		X		Fab CVD	0.99	14.8	N/A	N/A	0.00	14.8
75-24-1	Trimethylaluminium	TMAl	C_3H_9Al	Thin Films / Diffusion Deposition	100%	1,182	67-56-1	Methanol	CH3OH		1.33	X					X				Fab CVD	0.99	15.7	N/A	N/A	0.00	15.7
993-07-7	Trimethylsilane		$C_3H_{10}Si$	Thin Films / Diffusion Deposition	100%	5,853	993-07-7	Trimethylsilane	C3H10Si		0.00	X									Fab CVD	0.00	0.00	N/A	N/A	0.00	0.00
993-07-7	Trimethylsilane		$C_3H_{10}Si$	Thin Films / Diffusion Deposition	100%	5,853	74-82-8	Methane	CH4		0.65							X			Fab CVD	0.99	38.0	N/A	N/A	0.00	38.0
993-07-7	Trimethylsilane		$C_3H_{10}Si$	Thin Films / Diffusion Deposition	100%	5,853	124-38-9	Carbon dioxide	CO2		1.78							X			Fab CVD	0.00	10,414	N/A	N/A	0.00	10,414
993-07-7	Trimethylsilane		$C_3H_{10}Si$	Thin Films / Diffusion Deposition	100%	5,853	7631-86-9	Silicon dioxide	SiO2		0.81		X								Fab CVD	0.00	4,739	N/A	N/A	0.82	853.0
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]		[redacted]		[redacted]										Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-38-9	Carbon dioxide	CO2		[redacted]							X			Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]		[redacted]		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	124-40-3	Dimethylamine	C2H7N		[redacted]	X									Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	67-56-1	Methanol	CH3OH		[redacted]	X					X				Fab CVD	0.99	[redacted]	N/A	[redacted]	0.00	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	10102-44-0	Nitrogen dioxide	NO2		[redacted]			X							Fab CVD	0.00	[redacted]	N/A	[redacted]	0.90	[redacted]
[redacted]				Thin Films / Diffusion Deposition	100%	[redacted]	[redacted]		[redacted]		[redacted]		X								Fab CVD	0.00	[redacted]	N/A	[redacted]	0.00	[redacted]
7783-82-6	Tungsten hexafluoride		WF_6	Thin Films / Diffusion Deposition	100%	119,647	7783-82-6	Tungsten hexafluoride	WF6		0.00		X							X	Fab CVD	0.95	0.00	N/A	N/A	0.82	0.00
7783-82-6	Tungsten hexafluoride		WF_6	Thin Films / Diffusion Deposition	100%	119,647	7664-39-3	Hydrogen fluoride	HF		0.02						X				Fab CVD	0.99	24.1	N/A	N/A	0.60	9.64
7783-82-6	Tungsten hexafluoride		WF_6	Thin Films / Diffusion Deposition	100%	119,647	1314-35-8	Tungsten trioxide	WO3		0.04		X								Fab CVD	0.00	4,657	N/A	N/A	0.82	838.2

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Process Chemical Emissions Summary

Table 7-1: Process Chemical Emissions Per Stack Type

CAS	Emission Chemical Name	Stack Type	Annual Pre-Control Emissions	Average Hourly Pre-Control Emissions	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[1]	POU or RCS DRE	Centralized Control DRE	Annual Potential Emissions	Number of Operational Stacks	Maximum Hourly Emissions Per Stack	Average Hourly Emissions Per Stack	Env. Rating[2,3,4]	SGC	AGC
			(lb/yr)	(lb/hr)		(lb/hr)			(lb/yr)		(lb/hr/stack)	(lb/hr/stack)		(ug/m3)	(ug/m3)
288-88-0	1,2,4-Triazole	Fab Ammonia	867.7	0.10	25%	0.03	N/A	0.00	868	24	5.16E-03	4.13E-03	INT-B	-	0.48
95-63-6	1,2,4-Trimethylbenzene	Fab Solvent	5,466	0.62	25%	0.19	N/A	0.97	164	64	3.66E-04	2.92E-04	B	-	60.0
1436-34-6	1,2-Epoxyhexane	Fab Solvent	3.93	4.49E-04	25%	1.40E-04	N/A	0.97	0.12	64	2.63E-07	2.11E-07	INT-B	-	-
[redacted]	[redacted]	Fab Acid	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	72	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
123-91-1	1,4-Dioxane	Fab Solvent	6.23	7.11E-04	25%	2.22E-04	N/A	0.97	0.19	64	4.16E-07	3.33E-07	B	3,000	0.20
872-50-4	1-Methyl-2-pyrrolidone	Fab Solvent	110,657	12.6	25%	3.95	N/A	0.97	3,320	64	7.40E-03	5.92E-03	B	-	100
929-06-6	2-(2-aminoethoxy)ethanol	Fab Solvent	2,169	0.25	25%	0.08	N/A	0.97	65.1	64	1.45E-04	1.16E-04	INT-B	1,500	18.0
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Ammonia	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	B*	[redacted]	[redacted]
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B*	[redacted]	[redacted]
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
108-65-6	2-Methoxy-1-methylethyl acetate	Fab Solvent	2,912,639	332.5	25%	103.9	N/A	0.97	87,379	64	1.95E-01	1.56E-01	B	36,850	2,000
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Ammonia	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	INT-A	[redacted]	[redacted]
75-65-0	2-Methylpropan-2-ol	Fab Solvent	0.28	3.17E-05	25%	9.91E-06	N/A	0.97	0.01	64	1.86E-08	1.49E-08	B*	-	720
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
123-42-2	4-Hydroxy-4-methylpentan-2-one	Fab Solvent	0.79	8.98E-05	25%	2.81E-05	N/A	0.97	0.02	64	5.26E-08	4.21E-08	B	-	570
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
1344-28-1	Aluminum oxide	Fab Acid	270.1	0.03	25%	0.01	0.00	0.00	270	72	5.35E-04	4.28E-04	B*	-	2.40
1344-28-1	Aluminum oxide	Fab CVD	835.8	0.10	25%	0.03	N/A	0.82	150	24	8.94E-04	7.16E-04	B*	-	2.40
7784-42-1	Arsine	Fab Acid	4.15	4.73E-04	25%	1.48E-04	N/A	0.00	4.15	72	8.22E-06	6.58E-06	A	0.20	0.05
1303-86-2	Boron trioxide	Fab Acid	1,045	0.12	25%	0.04	0.00	0.00	1,045	72	2.07E-03	1.66E-03	B*	-	24.0
1303-86-2	Boron trioxide	Fab CVD	494.6	0.06	25%	0.02	N/A	0.82	89.0	24	5.29E-04	4.24E-04	B*	-	24.0
7726-95-6	Bromine	Fab Acid	52,206	5.96	25%	1.86	0.50	0.00	26,103	72	5.17E-02	4.14E-02	B	130	1.60
124-38-9	Carbon dioxide	Fab CVD	505,318	57.7	25%	18.0	N/A	0.00	505,318	24	3.00E+00	2.40E+00	D	-	21,000
124-38-9	Carbon dioxide	Fab Solvent	58,538,662	6,682	25%	2,088	N/A	0.00	58,538,662	64	1.31E+02	1.04E+02	D	-	21,000
124-38-9	Carbon dioxide	Fab Acid	4,312,977	492.3	25%	153.9	0.00	0.00	4,312,977	72	8.55E+00	6.84E+00	D	-	21,000
463-58-1	Carbonyl sulfide	Fab Acid	1,442	0.16	25%	0.05	0.99	0.00	14.4	72	2.86E-05	2.29E-05	B	250	28.0
7782-50-5	Chlorine	Fab Acid	79,183	9.04	25%	2.82	0.00	0.00	79,183	72	1.57E-01	1.26E-01	B	116	0.20
77-92-9	Citric acid	Fab Acid	166.5	0.02	25%	0.01	N/A	0.00	167	72	3.30E-04	2.64E-04	INT-B	2,100	20.0
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
108-94-1	Cyclohexanone	Fab Solvent	52,173	5.96	25%	1.86	N/A	0.97	1,565	64	3.49E-03	2.79E-03	B	20,000	190
[redacted]	[redacted]	Fab CVD	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	B	[redacted]	[redacted]
120-92-3	Cyclopentanone	Fab Solvent	32.8	3.75E-03	25%	1.17E-03	N/A	0.97	0.98	64	2.20E-06	1.76E-06	INT-B	4,000	30.0
19287-45-7	Diborane	Fab CVD	1.97	2.24E-04	25%	7.01E-05	N/A	0.00	1.97	24	1.17E-05	9.35E-06	B*	-	0.26
142-96-1	Dibutyl ether	Fab Solvent	4,853	0.55	25%	0.17	N/A	0.97	146	64	3.25E-04	2.60E-04	INT-C	15,000	2,887
109-89-7	Diethylamine	Fab CVD	227.2	0.03	25%	0.01	N/A	0.00	227	24	1.35E-03	1.08E-03	B*	4,500	36.0
[redacted]	[redacted]	Fab Ammonia	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	B	[redacted]	[redacted]

Table 7-1: Process Chemical Emissions Per Stack Type

CAS	Emission Chemical Name	Stack Type	Annual Pre-Control Emissions	Average Hourly Pre-Control Emissions	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[1]	POU or RCS DRE	Centralized Control DRE	Annual Potential Emissions	Number of Operational Stacks	Maximum Hourly Emissions Per Stack	Average Hourly Emissions Per Stack	Env. Rating[2,3,4]	SGC	AGC
			(lb/yr)	(lb/hr)		(lb/hr)			(lb/yr)		(lb/hr/stack)	(lb/hr/stack)		(ug/m3)	(ug/m3)
124-40-3	Dimethylamine	Fab CVD	78.5	0.01	25%	2.80E-03	N/A	0.00	78.5	24	4.67E-04	3.73E-04	B*	2,800	22.0
[redacted]	[redacted]	Fab Acid	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	72	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
74-84-0	Ethane	Fab CVD	186.9	0.02	25%	0.01	N/A	0.00	187	24	1.11E-03	8.89E-04	N/A	N/A	N/A
107-21-1	Ethanediol	Fab Ammonia	173.5	0.02	25%	0.01	N/A	0.00	174	24	1.03E-03	8.25E-04	B*	1,000	400
64-17-5	Ethanol	Fab CVD	551.1	0.06	25%	0.02	N/A	0.00	551	24	3.28E-03	2.62E-03	C	-	45,000
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	B	[redacted]	[redacted]
97-64-3	Ethyl lactate	Fab Solvent	6,362	0.73	25%	0.23	N/A	0.97	191	64	4.26E-04	3.40E-04	INT-B	370	71.0
7782-41-4	Fluorine	Fab CVD	3,488	0.40	25%	0.12	N/A	0.00	3,488	24	2.07E-02	1.66E-02	B	5.30	0.07
50-00-0	Formaldehyde	Fab CVD	14.8	1.69E-03	25%	5.27E-04	N/A	0.00	14.8	24	8.78E-05	7.03E-05	A	30.0	6.0E-02
96-48-0	Gamma-butyrolactone	Fab Solvent	2,753	0.31	25%	0.10	N/A	0.97	82.6	64	1.84E-04	1.47E-04	B	-	3.60
1310-53-8	Germanium dioxide	Fab CVD	189.2	0.02	25%	0.01	N/A	0.82	34.1	24	2.02E-04	1.62E-04	INT-B	-	12.9
[redacted]	[redacted]	Fab CVD	[redacted]	[redacted]	25%	[redacted]	N/A	0.82	[redacted]	24	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
110-43-0	Heptan-2-one	Fab Solvent	473.1	0.05	25%	0.02	N/A	0.97	14.2	64	3.16E-05	2.53E-05	B*	-	550
685-63-2	Hexafluorobutadiene	Fab Acid	2,468	0.28	25%	0.09	0.98	0.00	49.4	72	9.78E-05	7.83E-05	INT-A	7.50	0.10
999-97-3	Hexamethyldisilazane	Fab Solvent	43,928	5.01	25%	1.57	N/A	0.97	1,318	64	2.94E-03	2.35E-03	INT-B	-	36.0
10035-10-6	Hydrogen bromide	Fab Acid	52,840	6.03	25%	1.88	0.99	0.00	528	72	1.05E-03	8.38E-04	C	680	-
7647-01-0	Hydrogen chloride	Fab Acid	153,006	17.5	25%	5.46	0.99	0.60	59,141	72	1.17E-01	9.38E-02	B	2,100	20.0
7647-01-0	Hydrogen chloride	Fab CVD	2,115	0.24	25%	0.08	N/A	0.60	846	24	5.03E-03	4.02E-03	B	2,100	20.0
7664-39-3	Hydrogen fluoride	Fab Acid	692,941	79.1	25%	24.7	0.99	0.60	21,372	72	4.24E-02	3.39E-02	B	5.60	0.07
7664-39-3	Hydrogen fluoride	Fab CVD	7,627	0.87	25%	0.27	N/A	0.60	3,051	24	1.81E-02	1.45E-02	B	5.60	0.07
7722-84-1	Hydrogen peroxide	Fab Acid	17,069	1.95	25%	0.61	N/A	0.00	17,069	72	3.38E-02	2.71E-02	B*	-	3.30
13966-94-4	Indium iodide	Fab Acid	0.01	9.97E-07	25%	3.12E-07	N/A	0.00	0.01	72	1.73E-08	1.39E-08	INT-A	100	0.24
67-63-0	Isopropanol	Fab Solvent	4,647,421	530.5	25%	165.8	N/A	0.97	139,423	64	3.11E-01	2.49E-01	B	98,000	7,000
[redacted]	[redacted]	Fab Ammonia	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Ammonia	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Acid	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	72	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
[redacted]	[redacted]	Fab Solvent	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]	INT-B	[redacted]	[redacted]
79-41-4	Methacrylic Acid	Fab Solvent	4,472	0.51	25%	0.16	N/A	0.97	134	64	2.99E-04	2.39E-04	B*	Not in DAR-1	170.0
74-82-8	Methane	Fab CVD	53.1	0.01	25%	1.89E-03	N/A	0.00	53.1	24	3.16E-04	2.53E-04	N/A	N/A	N/A
74-82-8	Methane	Fab Acid	3,411	0.39	25%	0.12	0.99	0.00	34.1	72	6.76E-05	5.41E-05	N/A	N/A	N/A
67-56-1	Methanol	Fab CVD	408.1	0.05	25%	0.01	N/A	0.00	408	24	2.43E-03	1.94E-03	B	33,000	4,000
67-56-1	Methanol	Fab General	167.8	0.02	25%	0.01	N/A	0.00	168	70	3.42E-04	2.74E-04	B	33,000	4,000
1319-77-3	Mixed cresols	Fab Solvent	6.23	7.11E-04	25%	2.22E-04	N/A	0.97	0.19	64	4.16E-07	3.33E-07	B	-	180
150-77-6	N,N,N',N'-Tetraethylethylenediamine	Fab Ammonia	273.2	0.03	25%	0.01	N/A	0.00	273	24	1.62E-03	1.30E-03	INT-B	2,800	7.00
91-20-3	Naphthalene	Fab Solvent	2,733	0.31	25%	0.10	N/A	0.97	82.0	64	1.83E-04	1.46E-04	B	7,900	3.00
123-86-4	n-Butyl acetate	Fab Solvent	356,060	40.6	25%	12.7	N/A	0.97	10,682	64	2.38E-02	1.91E-02	C	71,300	565
7697-37-2	Nitric acid	Fab Acid	44,837	5.12	25%	1.60	N/A	0.40	26,902	72	5.33E-02	4.27E-02	B	86.0	12.3
7783-54-2	Nitrogen trifluoride	Fab Acid	42,634	4.87	25%	1.52	0.95	0.00	2,132	72	4.22E-03	3.38E-03	B*	6.60	0.08
7783-54-2	Nitrogen trifluoride	Fab CVD	915.8	0.10	25%	0.03	N/A	0.00	916	24	5.45E-03	4.36E-03	B*	6.60	0.08
10024-97-2	Nitrous oxide	Fab CVD	315,321	36.0	25%	11.2	N/A	0.00	315,321	24	1.87E+00	1.50E+00	B*	-	210
[redacted]	[redacted]	Fab Ammonia	[redacted]	[redacted]	25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]	[redacted]	B	[redacted]	[redacted]
7803-51-2	Phosphine	Fab CVD	1.19	1.36E-04	25%	4.24E-05	N/A	0.00	1.19	24	7.07E-06	5.65E-06	B	21.0	0.30
7803-51-2	Phosphine	Fab Acid	6.93	7.92E-04	25%	2.47E-04	N/A	0.00	6.93	72	1.37E-05	1.10E-05	B	21.0	0.30
7664-38-2	Phosphoric acid	Fab Acid	458.7	0.05	25%	0.02	N/A	0.00	459	72	9.09E-04	7.27E-04	B	300	10.0

Table 7-1: Process Chemical Emissions Per Stack Type

CAS	Emission Chemical Name	Stack Type	Annual Pre-Control Emissions	Average Hourly Pre-Control Emissions	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[1]	POU or RCS DRE	Centralized Control DRE	Annual Potential Emissions	Number of Operational Stacks	Maximum Hourly Emissions Per Stack	Average Hourly Emissions Per Stack	Env. Rating[2,3,4]	SGC	AGC
			(lb/yr)	(lb/hr)		(lb/hr)			(lb/yr)		(lb/hr/stack)	(lb/hr/stack)		(ug/m3)	(ug/m3)
1314-56-3	Phosphorus pentoxide	Fab CVD	248.1	0.03	25%	0.01	N/A	0.82	44.7	24	2.66E-04	2.12E-04	INT-B	300	4.80
1314-56-3	Phosphorus pentoxide	Fab Acid	1,983	0.23	25%	0.07	0.00	0.00	1,983	72	3.93E-03	3.14E-03	INT-B	300	4.80
1310-58-3	Potassium hydroxide	Fab Acid	11.9	1.36E-03	25%	4.24E-04	N/A	0.00	11.9	72	2.35E-05	1.88E-05	B*	200	-
74-98-6	Propane	Fab CVD	2.32	2.64E-04	25%	8.26E-05	N/A	0.00	2.32	24	1.38E-05	1.10E-05	N/A	N/A	N/A
52125-53-8	Propanol, 1(or 2)-ethoxy-	Fab Solvent	3,723	0.43	25%	0.13	N/A	0.97	112	64	2.49E-04	1.99E-04	INT-B	36,850	2,000
115-07-1	Propylene	Fab CVD	70.2	0.01	25%	2.50E-03	N/A	0.00	70.2	24	4.17E-04	3.34E-04	B*	-	3,000
110-86-1	Pyridine	Fab Solvent	75.8	0.01	25%	2.71E-03	N/A	0.97	2.27	64	5.07E-06	4.06E-06	C	-	74.3
[redacted]		Fab Ammonia	[redacted]		25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]		INT-C*	[redacted]	
7631-86-9	Silicon dioxide	Fab CVD	92,902	10.6	25%	3.31	N/A	0.82	16,722	24	9.94E-02	7.95E-02	INT-B	-	2.00
7631-86-9	Silicon dioxide	Fab Solvent	32,706	3.73	25%	1.17	N/A	0.00	32,706	64	7.29E-02	5.83E-02	INT-B	-	2.00
7631-86-9	Silicon dioxide	Fab Acid	817.8	0.09	25%	0.03	0.00	0.00	818	72	1.62E-03	1.30E-03	INT-B	-	2.00
64742-94-5	Solvent naphtha (petroleum), heavy arom.	Fab Solvent	54,661	6.24	25%	1.95	N/A	0.97	1,640	64	3.66E-03	2.92E-03	B	-	100
7446-09-5	Sulfur dioxide	Fab Solvent	21.5	2.45E-03	25%	7.66E-04	N/A	0.00	21.5	64	4.79E-05	3.83E-05	B*	196	80.0
7446-09-5	Sulfur dioxide	Fab Acid	38,393	4.38	25%	1.37	0.00	0.00	38,393	72	7.61E-02	6.09E-02	B*	196	80.0
2551-62-4	Sulfur hexafluoride	Fab Acid	1,493	0.17	25%	0.05	0.96	0.00	59.7	72	1.18E-04	9.47E-05	B*	6.80	0.09
75-73-0	Tetrafluoromethane	Fab Acid	271,890	31.0	25%	9.70	0.89	0.00	29,908	72	5.93E-02	4.74E-02	INT-B	-	300
75-73-0	Tetrafluoromethane	Fab CVD	84,498	9.65	25%	3.01	N/A	0.00	84,498	24	5.02E-01	4.02E-01	INT-B	-	300
[redacted]		Fab CVD	[redacted]		25%	[redacted]	N/A	0.00	[redacted]	24	[redacted]		B	[redacted]	
97-99-4	Tetrahydrofurfuryl Alcohol	Fab Solvent	714.1	0.08	25%	0.03	N/A	0.97	21.4	64	4.78E-05	3.82E-05	INT-B*	TBD	TBD
[redacted]		Fab Solvent	1.77	2.02E-04	25%	6.30E-05	N/A	0.97	0.05	64	1.18E-07	9.46E-08	INT-B	-	2,850
		Fab Acid	1,475	0.17	25%	0.05	N/A	0.00	1,475	72	2.92E-03	2.34E-03	INT-B	26.0	0.33
75-59-2	Tetramethylammonium hydroxide	Fab Ammonia	934.5	0.11	25%	0.03	N/A	0.00	934	24	5.56E-03	4.44E-03	INT-B	3,600	29.0
13463-67-7	Titanium dioxide	Fab Acid	35.2	4.02E-03	25%	1.26E-03	0.00	0.00	35.2	72	6.97E-05	5.58E-05	B*	-	24
13463-67-7	Titanium dioxide	Fab CVD	12,683	1.45	25%	0.45	N/A	0.82	2,283	24	1.36E-02	1.09E-02	B*	-	24
121-44-8	Triethylamine	Fab Acid	9.82	1.12E-03	25%	3.50E-04	N/A	0.00	9.82	72	1.95E-05	1.56E-05	B*	2800	7
1314-35-8	Tungsten trioxide	Fab CVD	4,657	0.53	25%	0.17	N/A	0.82	838	24	4.98E-03	3.99E-03	INT-B	-	7.1
1314-23-4	Zirconium oxide	Fab CVD	4,354	0.50	25%	0.16	N/A	0.82	784	24	4.66E-03	3.73E-03	INT-B	380	12
[redacted]		Fab Ammonia	[redacted]		25%	[redacted]	N/A	0	[redacted]	24	[redacted]		INT-B	[redacted]	
107-98-2	1-Methoxy-2-propanol Group	Fab Ammonia	4,222	0.48	25%	0.15	N/A	0	4,222	24	2.51E-02	2.01E-02	B	36850	2000
107-98-2	1-Methoxy-2-propanol Group	Fab Solvent	7,163	0.82	25%	0.26	N/A	0.97	215	64	4.79E-04	3.83E-04	B	36850	2000
64-19-7	Acetic Acid Group	Fab Solvent	0.00	0.00	25%	0.00	N/A	0.97	0.00	64	0.00E+00	0.00E+00	B*	3700	60
64-19-7	Acetic Acid Group	Fab Acid	419.4	0.05	25%	0.01	N/A	0	419	72	8.31E-04	6.65E-04	B*	3700	60
7664-41-7	Ammonia Group	Fab CVD	20,526	2.34	25%	0.73	N/A	0	20,526	24	1.22E-01	9.76E-02	C	2400	500
7664-41-7	Ammonia Group	Fab Ammonia	1,149,077	131.2	25%	41.0	N/A	0.98	22,982	24	1.37E-01	1.09E-01	C	2400	500
7664-41-7	Ammonia Group	Fab Acid	13,207	1.51	25%	0.47	N/A	0	13,207	72	2.62E-02	2.09E-02	C	2400	500
138-22-7	Butyl Lactate Group	Fab Solvent	8,423	0.96	25%	0.30	N/A	0.97	253	64	5.63E-04	4.51E-04	B*	-	-
75-10-5	Difluoromethane Group	Fab Acid	15,191	1.73	25%	0.54	0.99	0	152	72	3.01E-04	2.41E-04	INT-C	-	50600
[redacted]		Fab Acid	[redacted]		25%	[redacted]	N/A	0	[redacted]	72	[redacted]		INT-C	[redacted]	
76-16-4	Hexafluoroethane Group	Fab Acid	44,312	5.06	25%	1.58	0.98	0	886	72	1.76E-03	1.41E-03	INT-C*	-	50400
7664-93-9	Sulfuric Acid Group	Fab Acid	23,674	2.70	25%	0.84	N/A	0, 0.75	5,918	72	1.17E-02	9.38E-03	B	120	1
7803-62-5	Silane Group	Fab CVD	[redacted]		25%	[redacted]	N/A	0	[redacted]	24	[redacted]		B	[redacted]	
7803-62-5	Silane Group	Fab Ammonia			25%		N/A	0		24			B		

1. The Proposed Air Permit Project is divided into two fabs each of which is divided into two halves with similar operations and stack design.
2. B* indicates that a compound listed in DAR-1 with no toxicity rating assigned.
3. INT - (X) indicates an environmental rating was assigned by NYSDEC for chemicals not listed in DAR-1.
4. INT - (X*) indicates an environmental rating assigned pending review by NYSDEC not listed in DAR-1

Table 7-2: Process Chemical Criteria Pollutant Emissions per Stack Type

Criteria Pollutant	Stack Type1	Annual Pre-Control Emissions (lb/yr)	Average Hourly Pre-Control Emissions (lb/hr)	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[2] (lb/hr)	Centralized Control DRE	Annual Potential Emissions (lb/yr)	Number of Operational Stacks	Maximum Hourly Emissions Per Stack (lb/hr/stack)	Average Hourly Emissions Per Stack (lb/hr/stack)
PM-10	Fab Acid	29,859	3.41	25%	1.07	Process Category/Emission Chemical Specific - Refer to Table 6-1	12,103	72	0.02	0.02
PM-2.5	Fab Acid	29,859	3.41	25%	1.07		12,103	72	0.02	0.02
NOx	Fab Acid	27,626	3.15	25%	0.99		27,626	72	0.05	0.04
SO2	Fab Acid	38,393	4.38	25%	1.37		38,393	72	0.08	0.06
PM-10	Fab Ammonia	2,308	0.26	25%	0.08		2,308	24	0.01	0.01
PM-2.5	Fab Ammonia	2,308	0.26	25%	0.08		2,308	24	0.01	0.01
NOx	Fab Ammonia	0.00	0.00	25%	0.00		0.00	24	0.00	0.00
PM-10	Fab CVD	118,495	13.5	25%	4.23		21,329	24	0.13	0.10
PM-2.5	Fab CVD	118,495	13.5	25%	4.23		21,329	24	0.13	0.10
NOx	Fab CVD	1,835,087	209.5	25%	65.5		183,509	24	1.09	0.87
PM-10	Fab Solvent	32,715	3.73	25%	1.17		32,706	64	0.07	0.06
PM-2.5	Fab Solvent	32,715	3.73	25%	1.17		32,706	64	0.07	0.06
NOx	Fab Solvent	66,695	7.61	25%	2.38		66,695	64	0.15	0.12
SO2	Fab Solvent	21.5	2.45E-03	25%	7.66E-04		21.5	64	4.79E-05	3.83E-05

1. PM, NOx, and SO2 emitted from the Fab Solvent exhaust will be created in and emitted from the RCTO burner, not the zeolite rotor exhaust.

2. The Proposed Air Permit Project is divided into two fabs each of which is divided into two halves with similar operations and stack design.

Table 7-3: Solvent Exhaust Emissions per Exhaust Type

CAS	Emission Chemical Name	Exhaust Type[1,2]	Annual Pre-Control Emissions (lb/yr)	Average Hourly Pre-Control Emissions (lb/hr)	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[3] (lb/hr)	POU DRE	Centralized Control DRE	Annual Potential Emissions (lb/yr)	Number of Operational Stacks	Maximum Hourly Emissions Per Stack (lb/hr/stack)	Average Hourly Emissions Per Stack (lb/hr/stack)
95-63-6	1,2,4-Trimethylbenzene	Solvent Exhaust	5,193	0.59	25%	0.19	N/A	0.97	155.8	64	3.47E-04	2.78E-04
95-63-6	1,2,4-Trimethylbenzene	RCTO Burner Exhaust	273.3	0.03	25%	0.01	N/A	0.97	8.20	64	1.83E-05	1.46E-05
1436-34-6	1,2-Epoxyhexane	Solvent Exhaust	3.74	4.27E-04	25%	1.33E-04	N/A	0.97	0.11	64	2.50E-07	2.00E-07
1436-34-6	1,2-Epoxyhexane	RCTO Burner Exhaust	0.20	2.25E-05	25%	7.02E-06	N/A	0.97	0.01	64	1.32E-08	1.05E-08
123-91-1	1,4-Dioxane	Solvent Exhaust	5.91	6.75E-04	25%	2.11E-04	N/A	0.97	0.18	64	3.96E-07	3.16E-07
123-91-1	1,4-Dioxane	RCTO Burner Exhaust	0.31	3.55E-05	25%	1.11E-05	N/A	0.97	0.01	64	2.08E-08	1.67E-08
872-50-4	1-Methyl-2-pyrrolidone	Solvent Exhaust	105,124	12.0	25%	3.75	N/A	0.97	3,154	64	7.03E-03	5.63E-03
872-50-4	1-Methyl-2-pyrrolidone	RCTO Burner Exhaust	5,533	0.63	25%	0.20	N/A	0.97	166.0	64	3.70E-04	2.96E-04
929-06-6	2-(2-aminoethoxy)ethanol	Solvent Exhaust	2,061	0.24	25%	0.07	N/A	0.97	61.8	64	1.38E-04	1.10E-04
929-06-6	2-(2-aminoethoxy)ethanol	RCTO Burner Exhaust	108.4	0.01	25%	3.87E-03	N/A	0.97	3.25	64	7.25E-06	5.80E-06
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
108-65-6	2-Methoxy-1-methylethyl acetate	Solvent Exhaust	2,767,007	315.9	25%	98.7	N/A	0.97	83,010	64	1.85E-01	1.48E-01
108-65-6	2-Methoxy-1-methylethyl acetate	RCTO Burner Exhaust	145,632	16.6	25%	5.20	N/A	0.97	4,369	64	9.74E-03	7.79E-03
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
75-65-0	2-Methylpropan-2-ol	Solvent Exhaust	0.26	3.01E-05	25%	9.41E-06	N/A	0.97	0.01	64	1.76E-08	1.41E-08
75-65-0	2-Methylpropan-2-ol	RCTO Burner Exhaust	0.01	1.59E-06	25%	4.95E-07	N/A	0.97	4.17E-04	64	9.29E-10	7.43E-10
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
123-42-2	4-Hydroxy-4-methylpentan-2-one	Solvent Exhaust	0.75	8.53E-05	25%	2.67E-05	N/A	0.97	0.02	64	5.00E-08	4.00E-08
123-42-2	4-Hydroxy-4-methylpentan-2-one	RCTO Burner Exhaust	0.04	4.49E-06	25%	1.40E-06	N/A	0.97	1.18E-03	64	2.63E-09	2.11E-09
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
124-38-9	Carbon dioxide	Solvent Exhaust	55,611,729	6,348	25%	1,984	N/A	0.00	55,611,729	64	1.24E+02	9.92E+01
124-38-9	Carbon dioxide	RCTO Burner Exhaust	2,926,933	334.1	25%	104.4	N/A	0.00	2,926,933	64	6.53E+00	5.22E+00
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	RCTO Burner Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]
[redacted]	[redacted]	Solvent Exhaust	49,564	5.66	25%	1.77	N/A	0.97	1,487	64	3.32E-03	2.65E-03
108-94-1	Cyclohexanone	RCTO Burner Exhaust	2,609	0.30	25%	0.09	N/A	0.97	78.3	64	1.74E-04	1.40E-04
120-92-3	Cyclopentanone	Solvent Exhaust	31.2	3.56E-03	25%	1.11E-03	N/A	0.97	0.94	64	2.09E-06	1.67E-06
120-92-3	Cyclopentanone	RCTO Burner Exhaust	1.64	1.87E-04	25%	5.85E-05	N/A	0.97	0.05	64	1.10E-07	8.78E-08
142-96-1	Dibutyl ether	Solvent Exhaust	4,610	0.53	25%	0.16	N/A	0.97	138.3	64	3.08E-04	2.47E-04
142-96-1	Dibutyl ether	RCTO Burner Exhaust	242.6	0.03	25%	0.01	N/A	0.97	7.28	64	1.62E-05	1.30E-05
[redacted]	[redacted]	Solvent Exhaust	[redacted]	[redacted]	25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	[redacted]

Table 7-3: Solvent Exhaust Emissions per Exhaust Type

CAS	Emission Chemical Name	Exhaust Type[1,2]	Annual Pre-Control Emissions (lb/yr)	Average Hourly Pre-Control Emissions (lb/hr)	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[3] (lb/hr)	POU DRE	Centralized Control DRE	Annual Potential Emissions (lb/yr)	Number of Operational Stacks	Maximum Hourly Emissions Per Stack (lb/hr/stack)	Average Hourly Emissions Per Stack (lb/hr/stack)
[redacted]		RCTO Burner Exhaust	[redacted]		25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	
97-64-3	Ethyl lactate	Solvent Exhaust	6,044	0.69	25%	0.22	N/A	0.97	181.3	64	4.04E-04	3.23E-04
97-64-3	Ethyl lactate	RCTO Burner Exhaust	318.1	0.04	25%	0.01	N/A	0.97	9.54	64	2.13E-05	1.70E-05
96-48-0	Gamma-butyrolactone	Solvent Exhaust	2,615	0.30	25%	0.09	N/A	0.97	78.5	64	1.75E-04	1.40E-04
96-48-0	Gamma-butyrolactone	RCTO Burner Exhaust	137.7	0.02	25%	4.91E-03	N/A	0.97	4.13	64	9.21E-06	7.37E-06
110-43-0	Heptan-2-one	Solvent Exhaust	449.5	0.05	25%	0.02	N/A	0.97	13.5	64	3.01E-05	2.41E-05
110-43-0	Heptan-2-one	RCTO Burner Exhaust	23.7	2.70E-03	25%	8.44E-04	N/A	0.97	0.71	64	1.58E-06	1.27E-06
999-97-3	Hexamethyldisilazane	Solvent Exhaust	41,732	4.76	25%	1.49	N/A	0.97	1,252	64	2.79E-03	2.23E-03
999-97-3	Hexamethyldisilazane	RCTO Burner Exhaust	2,196	0.25	25%	0.08	N/A	0.97	65.9	64	1.47E-04	1.18E-04
67-63-0	Isopropanol	Solvent Exhaust	4,415,050	504.0	25%	157.5	N/A	0.97	132,451	64	0.30	0.24
67-63-0	Isopropanol	RCTO Burner Exhaust	232,371	26.5	25%	8.29	N/A	0.97	6,971	64	0.02	0.01
[redacted]		Solvent Exhaust	[redacted]		25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	
		RCTO Burner Exhaust			25%		N/A	0.97		64		
79-41-4	Methacrylic Acid	Solvent Exhaust	4,249	0.48	25%	0.15	N/A	0.97	127.5	64	2.84E-04	2.27E-04
79-41-4	Methacrylic Acid	RCTO Burner Exhaust	223.6	0.03	25%	0.01	N/A	0.97	6.71	64	1.50E-05	1.20E-05
1319-77-3	Mixed cresols	Solvent Exhaust	5.91	6.75E-04	25%	2.11E-04	N/A	0.97	0.18	64	3.96E-07	3.16E-07
1319-77-3	Mixed cresols	RCTO Burner Exhaust	0.31	3.55E-05	25%	1.11E-05	N/A	0.97	0.01	64	2.08E-08	1.67E-08
91-20-3	Naphthalene	Solvent Exhaust	2,596	0.30	25%	0.09	N/A	0.97	77.9	64	1.74E-04	1.39E-04
91-20-3	Naphthalene	RCTO Burner Exhaust	136.7	0.02	25%	4.87E-03	N/A	0.97	4.10	64	9.14E-06	7.31E-06
123-86-4	n-Butyl acetate	Solvent Exhaust	338,257	38.6	25%	12.1	N/A	0.97	10,148	64	2.26E-02	1.81E-02
123-86-4	n-Butyl acetate	RCTO Burner Exhaust	17,803	2.03	25%	0.64	N/A	0.97	534.1	64	1.19E-03	9.53E-04
52125-53-8	Propanol, 1(or 2)-ethoxy-	Solvent Exhaust	3,537	0.40	25%	0.13	N/A	0.97	106.1	64	2.37E-04	1.89E-04
52125-53-8	Propanol, 1(or 2)-ethoxy-	RCTO Burner Exhaust	186.2	0.02	25%	0.01	N/A	0.97	5.58	64	1.25E-05	9.96E-06
110-86-1	Pyridine	Solvent Exhaust	72.0	0.01	25%	2.57E-03	N/A	0.97	2.16	64	4.82E-06	3.85E-06
110-86-1	Pyridine	RCTO Burner Exhaust	3.79	4.33E-04	25%	1.35E-04	N/A	0.97	0.11	64	2.54E-07	2.03E-07
7631-86-9	Silicon dioxide	Solvent Exhaust	31,071	3.55	25%	1.11	N/A	0.00	31,071	64	6.93E-02	5.54E-02
7631-86-9	Silicon dioxide	RCTO Burner Exhaust	1,635	0.19	25%	0.06	N/A	0.00	1,635	64	3.65E-03	2.92E-03
64742-94-5	Solvent naphtha (petroleum), heavy arom.	Solvent Exhaust	51,928	5.93	25%	1.85	N/A	0.97	1,558	64	3.47E-03	2.78E-03
64742-94-5	Solvent naphtha (petroleum), heavy arom.	RCTO Burner Exhaust	2,733	0.31	25%	0.10	N/A	0.97	82.0	64	1.83E-04	1.46E-04
97-99-4	Tetrahydrofurfuryl Alcohol	Solvent Exhaust	678.4	0.08	25%	0.02	N/A	0.97	20.4	64	4.54E-05	3.63E-05
97-99-4	Tetrahydrofurfuryl Alcohol	RCTO Burner Exhaust	35.7	4.08E-03	25%	1.27E-03	N/A	0.97	1.07	64	2.39E-06	1.91E-06
[redacted]		Solvent Exhaust	[redacted]		25%	[redacted]	N/A	0.97	[redacted]	64	[redacted]	
		RCTO Burner Exhaust			25%		N/A	0.97		64		
107-98-2	1-Methoxy-2-propanol Group	Solvent Exhaust	6,805	0.78	25%	0.24	N/A	0.97	204.2	64	4.55E-04	3.64E-04
107-98-2	1-Methoxy-2-propanol Group	RCTO Burner Exhaust	358.2	0.04	25%	0.01	N/A	0.97	10.7	64	2.40E-05	1.92E-05
64-19-7	Acetic Acid Group	Solvent Exhaust	0.00	0.00	25%	0.00	N/A	0.97	0.00	64	0.00E+00	0.00E+00
64-19-7	Acetic Acid Group	RCTO Burner Exhaust	0.00	0.00	25%	0.00	N/A	0.97	0.00	64	0.00E+00	0.00E+00
138-22-7	Butyl Lactate Group	Solvent Exhaust	8,002	0.91	25%	0.29	N/A	0.97	240.1	64	5.35E-04	4.28E-04
138-22-7	Butyl Lactate Group	RCTO Burner Exhaust	421.2	0.05	25%	0.02	N/A	0.97	12.6	64	2.82E-05	2.25E-05

1. 95% of total emissions are emitted through the Solvent Exhaust
2. 5% of total emissions are emitted through the RCTO Burner Exhaust
3. The Proposed Air Permit Project is divided into two fabs each of which is divided into two halves with similar operations and stack design.

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Photoresist Ashing Emissions

Table 8-1: Photoresist Ashing Process Usage and Specifications

Annual Photoresist Usage[1] (lb/yr)	[redacted]
Percentage of Photoresist Remaining on Wafer Post-Application	5%
Percentage of Solids in Photoresist Material[2]	30%
Percentage of Solids Oxidized to CO	50%
Percentage of Solids Oxidized to CO_2	50%

1. To calculate emissions of CO_2 and CO from the ashing process, the total photoresist usage in pounds per year (lb/year) for the Proposed Air Permit Project was estimated based on usage at an existing Micron facility.

2. Some photoresist material contains solids that will remain on a wafer post-application and later be combusted in other processes. The weight of photoresist solids remaining on the wafer is assumed to be oxidized into 50% CO and 50% CO_2 on a molar basis.

3. Weight of organic compounds in photoresist solids assumed to be 100% carbon for the purpose of potential emission calculations.

4. Carbon from photoresist material may react with etch gases to form additional byproducts covered in process chemical emissions calculations. This calculation covers all CO and CO_2 expected to be generated from photoresist carbon.

Table 8-2: Photoresist Ashing Potential to Emit

Pollutant	Molar Weight	Emissions from Photoresist Ashing	
	lb/lb-mol	lb/yr	tpy
CO	28.01	[redacted]	
CO_2	44.01		

Conversions

1 ton =	2,000	lbs
Carbon MW =	12	lb/lb-mol

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Heat Transfer Fluid Emissions

Note:
Various semiconductor manufacturing processes require the use of heat transfer fluids (HTFs) to maintain equipment or component temperatures. These HTFs can leak and evaporate from the manufacturing process, resulting in VOC and GHG emissions to the atmosphere. HTF emissions are estimated below.

Table 9-1. Heat Transfer Fluid Specifications

Chemical Product	Chemical	CAS #	VOC/HAP?[1]	20-yr Global Warming Potential (GWP)[2]	100-yr Global Warming Potential (GWP)[3]	Projected Annual Usage	Fab 1 and Fab 2 Total Emissions[4]	
				(kg CO_2e/kg)	(kg CO_2e/kg)	(lb/yr)	(lb/hr)	(tpy)
[redacted]			Neither			15,589	1.78	7.7[illegible]
			VOC			2,339.8	0.27	1.17
			Neither			2,012	0.23	1.01
			Neither			2,534	0.29	1.27
			Neither			238.5	0.03	0.12
			Neither			1,445.6	0.17	0.72
			VOC			1,147.6	0.1[illegible]	0.57
[redacted]								

2. 20-yr Global warming potentials are assumed to be equal to 100-yr GWP.
3. 100-yr Global warming potentials per IPCC 2019 Refinement (Volume 3, Chapter 6, Table 6.5).
4. Annual usage based on similar processes at other Micron facilities. Annual usage (i.e., adding fluid to chillers) is assumed to equal annual emissions (i.e., annual leaks from chillers).

Table 9-2. Heat Transfer Fluid GHG Emissions

Pollutant	Emissions (Per CAS #)				Emissions (All Fluids)
	[redacted]				
	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
VOC	0.00	1.17	0.00	0.57	**1.74**
HAP	0.00	0.00	0.00	0.00	**0.00**
CO_2e - 20-yr	[redacted]				
CO_2e - 100-yr					

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Isopropanol Cleaning Emissions

Table 10-1: Isopropanol Cleaning Emissions Data

Chemical Name	CAS	Total Usage	Emission Factor	Total Emissions	Molecular Weight
		(lb/yr)	(lb/lb)	(lb/yr)	(lb/lb-mol)
Isopropanol	67-63-0	187,396	1.00	187,396	60.1

Table 10-2: Isopropanol Cleaning Emission Rates and Stack Concentrations

Stack Type	Number of Operational Stacks	Exhaust Rate	Annual Emissions per Stack Type	Annual Emissions per Stack	Average Hourly Emissions per Stack Type	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[3]	Maximum Hourly Emissions per Stack	Average Hourly Emissions per Stack	Avg. IPA Conc. per Stack
		(scfm)	(lb/yr)	(lb/yr)	(lb/hr)		(lb/hr)	(lb/hr/stack)	(lb/hr/stack)	(ppmv)
Fab Acid[1]	72	80,000	74,104	1,029.2	8.46	25%	2.64	0.15	0.12	0.16
Fab CVD[1]	24	26,500	8,182	340.9	0.93	25%	0.29	0.05	0.04	0.16
Fab Ammonia[1]	24	40,000	12,351	514.6	1.41	25%	0.44	0.07	0.06	0.16
Fab General[1]	70	55,000	49,351	707.6	5.65	25%	1.77	0.10	0.08	0.16
Fab Solvent[1]	64	52,500	43,227	675.4	4.93	25%	1.54	0.10	0.08	0.16
Fab General[1]	70	55,000	187,396	2,677	21.4	25%	6.69	0.38	0.31	0.59

1. Emission rates calculated assuming Isopropanol is disperesed and vented through all stacks.
2. Emission rates calculated assuming Isopropanol is vented exclusively through General Exhaust.
3. The Proposed Air Permit Project includes two fabs, each of which is divided into two halves with similar operations and stack design.

Conversions

1 year =	525,600	minutes
1 lb-mole of gas (@ 20C) =	385.3	Cubic feet

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Ozone Emissions

Table 11-1: Ozone Emissions Data

Chemical Name	CAS	Total Generated[1] (lb/yr)	PEEC Fraction Managed[2]	Total Emissions (lb/yr)
Ozone	10028-15-6	1,000,000	0.999	1,000

1. Total generated value is a conservative estimate based on generation quantities at other similar manufacturing facilties.
2. PEEC Managed Fraction is based on Micron's experience operating similar equipment.

Table 11-2: Ozone Emission Rates

Stack Type	Number of Operational Stacks	Exhaust Rate (scfm)	Annual Emissions per Stack Type (lb/yr)	Annual Emissions per Stack (lb/yr)	Average Hourly Emissions per Stack Type (lb/hr)	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential per Half[1] (lb/hr)
Fab Acid	72	80,000	901	12.5	0.10	25%	0.03
Fab CVD	24	26,500	99	4.1	0.01	25%	3.55E-03

1. The Proposed Air Permit Project includes two fabs, each of which is divided into two halves with similar operations and stack design.

Micron - Clay, NY Fabs 1 & 2
1-WWBIO and 2-WWBIO
Wastewater Treatment Process Emissions

Table 12-1: Toxchem Estimated Wastewater Treatment Potential Emissions

Emission Chemical		Total Emissions from Wastewater[1]		VOC	HAP	PM	Percent Emitted in WWT Bldg	Percent Emitted in BIO Bldg
CAS No.	Name	(lb/yr)	(tpy)					
7664-41-7	Ammonia	52,865	26.4				100%	0%
124-38-9	Carbon dioxide	5,745,799	2,873				0%	100%
74-82-8	Methane	1,396,964	698				0%	100%
7783-06-4	Hydrogen sulfide	186.4	0.09				0%	100%
75-59-2	Tetramethylammonium hydroxide	29.3	0.01	X		X	2%	98%
67-63-0	Isopropanol	54,752	27.4	X			65%	35%
872-50-4	1-Methyl-2-pyrrolidone	1,697	0.85	X			42%	58%
[redacted]				X			35%	65%
[redacted]				X			5%	4%
[redacted]				X			5%	4%
[redacted]				X			1%	8%
288-88-0	1,2,4-Triazole	6,431	3.22	X			0%	6%
929-06-6	2-(2-aminoethoxy)ethanol	2.93E-06	1.47E-09	X			19%	81%
[redacted]				X			N/A	N/A
[redacted]				X		X	N/A	N/A
[redacted]				X			24%	76%
77-92-9	Citric acid	0.00	0.00	X			N/A	N/A
[redacted]				X		X	43%	57%
[redacted]				X		X	N/A	N/A
[redacted]				X			84%	16%
64-19-7	Acetic acid	5.76E-04	2.88E-07	X			19%	81%
[redacted]				X			N/A	N/A
107-21-1	Ethanediol	1.19E-03	5.93E-07	X	X		16%	84%
67-56-1	Methanol	0.04	2.25E-05	X	X		66%	34%
	Total VOC	63,917	32.0					
	Total PM	29.3	0.01					
	Total HAP	0.05	2.31E-05					
	Total CO_2e - 20-yr[2]	123,090,770	61,545					
	Total CO_2e - 100-yr[3]	44,860,789	22,430					

1. Emissions estimated using Toxchem modeling software, supplemented by degredation byproduct calculations below. PTE totals assume 98% control of ammonia in the WWT ammonia scrubber.
2. 20-yr Global warming potentials per 6 NYCRR Part 496.
3. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (Global Warming Potentials).

Conversions

1 ton =	2,000	lbs

Table 12-2: Calculation of Secondary Generation of CO_2 in Aerobic Zones

Emission Chemical		MW	Carbon	Mass Degraded in Aerobic Zone	CO_2 from Aerobic Zone	Mass Degraded in Aeration Zone	CO_2 from Aeration Zone	Mass Degraded in MBR	CO_2 from MBR	Total CO_2
CAS No.	Name	(lb/lbmol)	Count	(lb/day)	(lb/day)	(lb/day)	(lb/day)	(lb/day)	(lb/day)	(lb/day)
75-59-2	Tetramethylammonium hydroxide	91.2	4.00	59.5	114.8	0.05	0.10	1.24E-03	2.40E-03	114.9
67-63-0	Isopropanol	60.1	3.00	2,821	6,198	1,333	2,929	233.8	513.5	9,640
872-50-4	1-Methyl-2-pyrrolidone	99.1	5.00	735.1	1,632	123.0	273.0	20.0	44.3	1,949
[redacted]										
288-88-0	1,2,4-Triazole	69.1	2.00	0.52	0.66	0.02	0.03	3.10E-04	3.95E-04	0.69
929-06-6	2-(2-aminoethoxy)ethanol	105.1	4.00	2.99	5.01	1.37	2.29	0.23	0.38	7.68
[redacted]										
77-92-9	Citric acid	192.1	6.00	1.82	2.51	0.72	0.99	0.12	0.16	3.66
[redacted]										
64-19-7	Acetic acid	60.1	2.00	1.49	2.19	0.03	0.04	2.52E-03	3.69E-03	2.23
[redacted]										
107-21-1	Ethanediol	62.1	2.00	0.88	1.24	0.45	0.64	0.08	0.11	2.00
67-56-1	Methanol	32.0	1.00	4.66E-03	0.01	3.87E-06	5.31E-06	8.96E-08	1.23E-07	0.01

Table 12-3: Calculation of Secondary Generation of CH_4 and CO_2 from Anaerobically Digested COD

Stream	Flow (gpm)	Flow (m^3/week)	COD (mg/L)	COD (kg/m^3)	Influent COD (kg/week)
Stream 1	1,285	49,019	200.0	0.20	9,804
Stream 2	264.7	10,101	90.0	0.09	909.0
Stream 3	328.3	12,528	15.0	0.02	187.9
Stream 4	406.8	15,520	10.00	0.01	155.2
Stream 5	262.8	10,027	4,800	4.80	48,127
Stream 6	426.7	16,281	90.0	0.09	1,465
Stream 7	98.5	3,757	30.0	0.03	112.7

Total Influent COD	60,761.17	kg/week	
B_0	0.25	kg-CH_4/kg-COD	*Table II-1 to Subpart II of 40 CFR 98*
MCF - Anaerobic Reactor	0.8		*Table II-1 to Subpart II of 40 CFR 98*
CH_4 Emission Rate from Anaerobic Zones	3,827.30	lb/day	*Eq. II-1 in Subpart II of 40 CFR 98*
CO_2 Emission Rate from Anaerobic Zones	3,827.30	lb/day	*COD is typically converted equally to CH_4 and CO_2 in anaerobic zones*

Table 12-4: Calculation of H_2S Emissions from Scrubber Specifications

Parameter	Value	Units
Scrubber Inlet Flow Rate	50,894.0	scfm
Inlet H2S Concentration	7.9	ppm
Standard Temperature	68.0	F
Standard Pressure	1.0	atm
Gas Constant	0.7	atm-ft^3/lbmol/R
Molecular Weight of H_2S	34.1	lb/lbmol
Uncontrolled H_2S Emissions	51.1	lb/day
Scrubber H_2S Removal Efficiency	99%	
Controlled H_2S Emissions	0.51	lb/day

Table 12-5: WWT Emissions per Stack Type

Emission Chemical		Stack Type	Annual Pre-Control Emissions	Variance Factor to Account for Hourly Operational Differences	Emission Rate Potential	Control (%)	Annual Potential Emissions	Number of Operational Stacks	Maximum Hourly Emissions Per Stack	Average Hourly Emissions Per Stac
CAS No.	Name		(lb/yr)		(lb/hr)		(lb/yr)		(lb/hr/stack)	(lb/hr/stack)
7664-41-7	Ammonia	WWT Ammonia	2,638,606	25%	376.5	98%	52,72	4	1.88	1.51
124-38-9	Carbon dioxide	BIO General	5,745,799	25%	819.9	0%	5,745,99	2	409.9	328.0
74-82-8	Methane	BIO General	1,396,964	25%	199.3	0%	1,396,964	2	99.7	79.7
7783-06-4	Hydrogen sulfide	BIO General	18,643	25%	2.66	99%	186.4	2	1.33E-02	1.06E-02
75-59-2	Tetramethylammonium hydroxide	WWT Solvent	6.59E-01	25%	9.40E-05	0%	6.59E-01	4	2.35E-05	1.88E-05
75-59-2	Tetramethylammonium hydroxide	BIO General	28.6	25%	4.09E-03	0%	28.6	2	2.04E-03	1.63E-03
67-63-0	Isopropanol	WWT Solvent	35,831	25%	5.11	0%	35,831	4	1.28	1.02
67-63-0	Isopropanol	BIO General	18,921	25%	2.70	0%	18,921	2	1.35	1.08
872-50-4	1-Methyl-2-pyrrolidone	WWT Solvent	706.2	25%	1.01E-01	0%	706.2	4	2.52E-02	2.02E-02
872-50-4	1-Methyl-2-pyrrolidone	BIO General	991.1	25%	1.41E-01	0%	991.1	2	7.07E-02	5.66E-02
[redacted]		WWT Solvent	[redacted]	25%	[redacted]	0%	[redacted]	4	[redacted]	
		BIO General		25%		0%		2		
		WWT Solvent		25%		0%		4		
		BIO General		25%		0%		2		
		WWT Solvent		25%		0%		4		
		BIO General		25%		0%		2		
		WWT Solvent		25%		0%		4		
		BIO General		25%		0%		2		
288-88-0	1,2,4-Triazole	WWT Solvent	2,561	25%	3.65E-01	0%	2,561	4	9.13E-02	7.31E-02
288-88-0	1,2,4-Triazole	BIO General	3,870	25%	5.52E-01	0%	3,870	2	2.76E-01	2.21E-01
929-06-6	2-(2-aminoethoxy)ethanol	WWT Solvent	5.52E-07	25%	7.87E-11	0%	5.52E-0	4	1.97E-11	1.57E-11
929-06-6	2-(2-aminoethoxy)ethanol	BIO General	2.38E-06	25%	3.40E-10	0%	2.38E-0	2	1.70E-10	1.36E-10
150-77-6	N,N,N',N'-Tetraethylethylenediamine	WWT Solvent	1.27	25%	1.82E-04	0%	1.27	4	4.54E-05	3.63E-05
150-77-6	N,N,N',N'-Tetraethylethylenediamine	BIO General	4.14	25%	5.91E-04	0%	4.14	2	2.95E-04	2.36E-04
[redacted]		WWT Solvent	[redacted]	25%	[redacted]	0%	[redacted]	4	[redacted]	
		BIO General		25%		0%		2		
		WWT Solvent		25%		0%		4		
		BIO General		25%		0%		2		
64-19-7	Acetic acid	WWT Solvent	1.12E-04	25%	1.59E-08	0%	1.12E-04	4	3.98E-09	3.19E-09
64-19-7	Acetic acid	BIO General	4.64E-04	25%	6.63E-08	0%	4.64E-0	2	3.31E-08	2.65E-08
107-21-1	Ethanediol	WWT Solvent	1.91E-04	25%	2.73E-08	0%	1.91E-0	4	6.82E-09	5.46E-09
107-21-1	Ethanediol	BIO General	9.94E-04	25%	1.42E-07	0%	9.94E-0	2	7.09E-08	5.67E-08
67-56-1	Methanol	WWT Solvent	2.95E-02	25%	4.21E-06	0%	2.95E-0	4	1.05E-06	8.41E-07
67-56-1	Methanol	BIO General	1.54E-02	25%	2.20E-06	0%	1.54E-0	2	1.10E-06	8.82E-07

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Tool-Level Thermal Oxidation System Combustion Emissions

Table 13-1. Tool-Level Thermal Oxidation System Specifications and Inventory

Exhaust Type	Number of Operational Exhaust Stacks	Total Natural Gas Usage (MMscf/year)[1,2]
Metal Etch POUs - Process FA1 and FA2	72	650
Thin Films PEECs - Process FC1 and FC2	24	2,300
	Total NG Flow Rate	2,950

1. Total natural gas usage by thermal oxidation systems provided by Micron and scaled accordingly for Fab 1 and Fab 2.
2. Emissions from GHG thermal oxidation system natural gas combustion will pass through acid exhausts.

Table 13-2. Tool-Level Thermal Oxidation System Criteria Pollutant and GHG Potential to Emit

Pollutant	Emission Factor[1,2,3] (lb/MMscf)	Potential to Emit (per Stack)[4,5]				Potential to Emit (Total per Stack Type)	
		Metal Etch POUs - FA1 and FA2		Thin Films PEECs - FC1 and FC2		FA1 and FA2	FC1 and FC2
		(lb/hr)	(tpy)	(lb/hr)	(tpy)	(tpy)	(tpy)
PM (Total)	7.6	0.01	0.03	0.01	0.07	2.47	1.57
PM_{10}	7.6	0.01	0.03	0.01	0.07	2.47	1.57
$PM_{2.5}$	7.6	0.01	0.03	0.01	0.07	2.47	1.57
SO_2	0.6	6.18E-04	2.71E-03	0.01	0.03	0.20	0.69
CO	420	0.43	1.90	4.59	20.1	136.5	483.0
NO_x	100	0.10	0.45	0.11	0.48	32.5	11.5
VOC	5.5	0.01	0.02	0.06	0.26	1.79	6.33
Lead	0.0005	5.15E-07	2.26E-06	5.47E-06	2.40E-05	1.63E-04	5.75E-04
CO_2	120,000	123.7	541.7	1,313	5,750	39,000	138,000
CH_4	2.3	2.37E-03	0.01	0.03	0.11	0.75	2.65
N_2O	2.2	2.27E-03	0.01	0.02	0.11	0.72	2.53
CO_2e - 20-yr[6]	-	124.5	545.2	1,321	5,787	39,252	138,890
CO_2e - 100-yr[7]	-	124.3	544.6	1,320	5,781	39,210	138,745
Upstream CO_2e[8]	91,921	94.7	414.9	1,006	4,405	29,874	105,709

1. Emission Factors from AP-42 Section 1.4 Table 1.4-1 and 1.4-2 for Small Boilers.
2. Per AP-42 Section 1.4 Table 1.4-2, PM (total) = PM_{10} = $PM_{2.5}$.
3. AP-42 emission factor for CO from NG combustion multiplied by safety factor of 5 to account for emissions as a result of partial oxidation of process chemicals.
4. The CVD exhaust ionizing wet scrubbers (IWS) will provide the following destruction and removal efficiencies:
   $PM/PM_{10}/PM_{2.5}$: 82%
   NO_X: 90%
5. 20-yr Global warming potentials per 6 NYCRR Part 496.
6. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials*).
7. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 40,877 g/MMBtu

Table 13-3. Tool-Level Thermal Oxidation System HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1]	Potential to Emit (per Stack)				Potential to Emit (Total per Stack Type)	
			Metal Etch POUs - FA1 and FA2		Thin Films PEECs - FC1 and FC2		FA1 and FA2	FC1 and FC2
		(lb/MMscf)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(tpy)	(tpy)
Benzene	Yes	2.10E-03	2.16E-06	9.48E-06	2.30E-05	1.01E-04	6.83E-04	2.42E-03
Formaldehyde	Yes	7.50E-02	7.73E-05	3.39E-04	8.20E-04	3.59E-03	0.02	0.09
Toluene	Yes	3.40E-03	3.50E-06	1.53E-05	3.72E-05	1.63E-04	1.11E-03	3.91E-03
2-Methylnaphthalene	Yes	2.40E-05	2.47E-08	1.08E-07	2.63E-07	1.15E-06	7.80E-06	2.76E-05
3-Methylchloranthrene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
7,12-Dimethylbenz(a)anthracene	Yes	1.60E-05	1.65E-08	7.22E-08	1.75E-07	7.67E-07	5.20E-06	1.84E-05
Acenaphthylene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Benzo(a)pyrene	Yes	1.20E-06	1.24E-09	5.42E-09	1.31E-08	5.75E-08	3.90E-07	1.38E-06
Benzo(b)fluoranthene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Benzo(k)fluoranthene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Dibenzo(a,h)anthracene	Yes	1.20E-06	1.24E-09	5.42E-09	1.31E-08	5.75E-08	3.90E-07	1.38E-06
Dichlorobenzene	Yes	1.20E-03	1.24E-06	5.42E-06	1.31E-05	5.75E-05	3.90E-04	1.38E-03
Hexane	Yes	1.80E+00	1.86E-03	0.01	0.02	0.09	0.59	2.07
Naphthalene	Yes	6.10E-04	6.29E-07	2.75E-06	6.67E-06	2.92E-05	1.98E-04	7.02E-04
Acenaphthene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Anthracene	Yes	2.40E-06	2.47E-09	1.08E-08	2.63E-08	1.15E-07	7.80E-07	2.76E-06
Benzo(a)anthracene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Benzo(g,h,i)perylene	Yes	1.20E-06	1.24E-09	5.42E-09	1.31E-08	5.75E-08	3.90E-07	1.38E-06
Chrysene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Fluoranthene	Yes	3.00E-06	3.09E-09	1.35E-08	3.28E-08	1.44E-07	9.75E-07	3.45E-06
Fluorene	Yes	2.80E-06	2.89E-09	1.26E-08	3.06E-08	1.34E-07	9.10E-07	3.22E-06
Indeno(1,2,3-cd)pyrene	Yes	1.80E-06	1.86E-09	8.13E-09	1.97E-08	8.63E-08	5.85E-07	2.07E-06
Phenanthrene	Yes	1.70E-05	1.75E-08	7.67E-08	1.86E-07	8.15E-07	5.53E-06	1.96E-05
Pyrene	Yes	5.00E-06	5.15E-09	2.26E-08	5.47E-08	2.40E-07	1.63E-06	5.75E-06
Arsenic	Yes	2.00E-04	2.06E-07	9.03E-07	2.19E-06	9.58E-06	6.50E-05	2.30E-04
Beryllium	Yes	1.20E-05	1.24E-08	5.42E-08	1.31E-07	5.75E-07	3.90E-06	1.38E-05
Cadmium	Yes	1.10E-03	1.13E-06	4.97E-06	1.20E-05	5.27E-05	3.58E-04	1.27E-03
Chromium	Yes	1.40E-03	1.44E-06	6.32E-06	1.53E-05	6.71E-05	4.55E-04	1.61E-03
Cobalt	Yes	8.40E-05	8.66E-08	3.79E-07	9.19E-07	4.03E-06	2.73E-05	9.66E-05
Lead	Yes	5.00E-04	5.15E-07	2.26E-06	5.47E-06	2.40E-05	1.63E-04	5.75E-04
Manganese	Yes	3.80E-04	3.92E-07	1.72E-06	4.16E-06	1.82E-05	1.24E-04	4.37E-04
Mercury	Yes	2.60E-04	2.68E-07	1.17E-06	2.84E-06	1.25E-05	8.45E-05	2.99E-04
Nickel	Yes	2.10E-03	2.16E-06	9.48E-06	2.30E-05	1.01E-04	6.83E-04	2.42E-03
Selenium	Yes	2.40E-05	2.47E-08	1.08E-07	2.63E-07	1.15E-06	7.80E-06	2.76E-05
		Total HAP PTE	**1.95E-03**	**8.52E-03**	**0.02**	**0.09**	**0.61**	**2.17**

1. Emission factors are from AP-42, Section 1.4, Tables 1.4-3 and 1.4-4.

Conversions

1 lb =	453.59 g
1 scf NG =	1,020 BTU - Average heat content of NG from AP-42 1.4.1.
1 year =	8,760 hours

Micron - Clay, NY Fabs 1 & 2
1-FABOP, 2-FABOP, 1-HPMCU, 2-HPMCU
RCTO Combustion Emissions

Table 14-1. RCTO Specifications and Inventory

Description	Operating Status	Equipment Count	Burner Rating (Each) (MMBtu/hr)	Natural Gas Flow (scfh)
Fab RCTOs - Process FS1 and FS2	Active	64	4.00	3,922
Fab RCTOs - Process FS1 and FS2	Redundant	8	4.00	3,922
HPM RCTOs - Process HS1 and HS2	Active	12	1.00	980.4
HPM RCTOs - Process HS1 and HS2	Redundant	4	1.00	980.4
			Total NG Flow Rate (scfh)	**298,039**

Table 14-2. RCTO Criteria Pollutant and GHG Potential to Emit

Pollutant	Emission Factor[1,2,3] (lb/MMscf)	Potential to Emit (per RCTO)				Potential to Emit (RCTO Totals)
		Fab RCTOs - FS1 and FS2		HPM RCTOs - HS1 and HS2		
		(lb/hr)	(tpy)	(lb/hr)	(tpy)	(tpy)
PM (Total)	7.6	0.03	0.13	0.01	0.03	9.92
PM_{10}	7.6	0.03	0.13	0.01	0.03	9.92
$PM_{2.5}$	7.6	0.03	0.13	0.01	0.03	9.92
SO_2	0.6	2.35E-03	0.01	5.88E-04	2.58E-03	0.78
CO[2]	420	1.65	7.21	0.41	1.80	548.3
NO_x	100	0.39	1.72	0.10	0.43	130.5
VOC	5.5	0.02	0.09	0.01	0.02	7.18
Lead	0.0005	1.96E-06	8.59E-06	4.90E-07	2.15E-06	6.53E-04
CO_2	120,000	470.6	2,061	117.6	515.3	156,649
CH_4	2.3	0.01	0.04	2.25E-03	0.01	3.00
N_2O	2.2	0.01	0.04	2.16E-03	0.01	2.87
CO_2e - 20-yr[4]	-	473.6	2,074	118.4	518.6	157,660
CO_2e - 100-yr[5]	-	473.1	2,072	118.3	518.1	157,495
Upstream CO_2e[6]	91,921	360.5	1,579	90.1	394.7	119,994

1. Emission factors are from AP-42, Section 1.4, Tables 1.4-1 and 1.4-2.
2. Per AP-42 Section 1.4 Table 1.4-2, PM (total) = PM_{10} = $PM_{2.5}$.
3. AP-42 emission factor for CO from NG combustion multiplied by safety factor of 5 to account for emissions as a result of partial oxidation of process chemicals.
4. 20-yr Global warming potentials per 6 NYCRR Part 496.
5. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials*).
6. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 40,877 g/MMBtu

Table 14-3. RCTO HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1]	Potential to Emit (per RCTO)				Potential to Emit (RCTO Totals)
			Fab RCTOs - FS1 and FS2		HPM RCTOs - HS1 and HS2		
		(lb/MMscf)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(tpy)
Benzene	Yes	2.10E-03	8.24E-06	3.61E-05	2.06E-06	9.02E-06	2.74E-03
Formaldehyde	Yes	0.08	2.94E-04	1.29E-03	7.35E-05	3.22E-04	0.10
Toluene	Yes	3.40E-03	1.33E-05	5.84E-05	3.33E-06	1.46E-05	4.44E-03
2-Methylnaphthalene	Yes	2.40E-05	9.41E-08	4.12E-07	2.35E-08	1.03E-07	3.13E-05
3-Methylchloranthrene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
7,12-Dimethylbenz(a)anthracene	Yes	1.60E-05	6.27E-08	2.75E-07	1.57E-08	6.87E-08	2.09E-05
Acenaphthylene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Benzo(a)pyrene	Yes	1.20E-06	4.71E-09	2.06E-08	1.18E-09	5.15E-09	1.57E-06
Benzo(b)fluoranthene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Benzo(k)fluoranthene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Dibenzo(a,h)anthracene	Yes	1.20E-06	4.71E-09	2.06E-08	1.18E-09	5.15E-09	1.57E-06
Dichlorobenzene	Yes	1.20E-03	4.71E-06	2.06E-05	1.18E-06	5.15E-06	1.57E-03
Hexane	Yes	1.80	0.01	0.03	1.76E-03	0.01	2.35
Naphthalene	Yes	6.10E-04	2.39E-06	1.05E-05	5.98E-07	2.62E-06	7.96E-04
Acenaphthene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Anthracene	Yes	2.40E-06	9.41E-09	4.12E-08	2.35E-09	1.03E-08	3.13E-06
Benzo(a)anthracene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Benzo(g,h,i)perylene	Yes	1.20E-06	4.71E-09	2.06E-08	1.18E-09	5.15E-09	1.57E-06
Chrysene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Fluoranthene	Yes	3.00E-06	1.18E-08	5.15E-08	2.94E-09	1.29E-08	3.92E-06
Fluorene	Yes	2.80E-06	1.10E-08	4.81E-08	2.75E-09	1.20E-08	3.66E-06
Indeno(1,2,3-cd)pyrene	Yes	1.80E-06	7.06E-09	3.09E-08	1.76E-09	7.73E-09	2.35E-06
Phenanthrene	Yes	1.70E-05	6.67E-08	2.92E-07	1.67E-08	7.30E-08	2.22E-05
Pyrene	Yes	5.00E-06	1.96E-08	8.59E-08	4.90E-09	2.15E-08	6.53E-06
Arsenic	Yes	2.00E-04	7.84E-07	3.44E-06	1.96E-07	8.59E-07	2.61E-04
Beryllium	Yes	1.20E-05	4.71E-08	2.06E-07	1.18E-08	5.15E-08	1.57E-05
Cadmium	Yes	1.10E-03	4.31E-06	1.89E-05	1.08E-06	4.72E-06	1.44E-03
Chromium	Yes	1.40E-03	5.49E-06	2.40E-05	1.37E-06	6.01E-06	1.83E-03
Cobalt	Yes	8.40E-05	3.29E-07	1.44E-06	8.24E-08	3.61E-07	1.10E-04
Lead	Yes	5.00E-04	1.96E-06	8.59E-06	4.90E-07	2.15E-06	6.53E-04
Manganese	Yes	3.80E-04	1.49E-06	6.53E-06	3.73E-07	1.63E-06	4.96E-04
Mercury	Yes	2.60E-04	1.02E-06	4.47E-06	2.55E-07	1.12E-06	3.39E-04
Nickel	Yes	2.10E-03	8.24E-06	3.61E-05	2.06E-06	9.02E-06	2.74E-03
Selenium	Yes	2.40E-05	9.41E-08	4.12E-07	2.35E-08	1.03E-07	3.13E-05
		Total HAP PTE	**1.76E-02**	**0.03**	**1.85E-03**	**8.11E-03**	**2.47**

1. HAP emission factors are from AP-42, Section 1.4, Tables 1.4-3 and 1.4-4.

Conversions

1 lb =	453.59	g
1 year =	8,760	hr
1 scf NG =	1,020	BTU - Average heat content of NG from AP-42 1.4.1.

Micron - Clay, NY Fabs 1 & 2
1-CMBOP and 2-CMBOP
Water Bath Vaporizer Combustion Emissions

Table 15-1. Water Bath Vaporizer Inventory

Equipment Description	Operating Status	Equipment Count	Operating Hours Limit (hrs)[1]	Burner Rating (Each)	Natural Gas Flow Rate[2]	Maximum Stack Flow Rate
				(MMBtu/hr)	(scfh)	(scfm)
Water Bath Vaporizers - Process WBV	Active	4	2,000	42.8	42,000	22,500
Water Bath Vaporizers - Process WBV	Redundant	4	0	42.8	0	0
				Total	**168,000**	**90,000**

1. Micron proposes a permit condition limiting total hours of WBV operation to 8,000 per year and specifying that no more than 4 WBV are operated at any given time. Therefore, the PTE is calculated assuming that redundant units do not operate.
2. Natural gas flow rate to the vaporizer based on manufacturer specifications.

Table 15-2. Water Bath Vaporizer Criteria Pollutant and GHG Potential to Emit

Pollutant	Molecular Weight	Emission Factor[1,2] (lb/MMscf)	BACT/LAER Limits		Potential to Emit (Per Unit)		Potential to Emit (All Units)	
	(lb/lb-mole)		Value	Unit	(lb/hr)	(tpy)	(lb/hr)	(tpy)
PM (Total)		7.6			0.32	0.32	1.28	1.28
PM_{10}		7.6			0.32	0.32	1.28	1.28
$PM_{2.5}$		7.6			0.32	0.32	1.28	1.28
SO_2		0.6			0.03	0.03	0.10	0.10
CO			84	lb/MMscf	3.53	3.53	14.1	14.1
NO_x	46.01		9	ppmvd @3% O2	1.45	1.45	5.80	5.80
VOC			0.0054	lb/MMBtu	0.23	0.23	0.92	0.92
Lead		0.0005			2.10E-05	2.10E-05	8.40E-05	8.40E-05
CO_2		120,000			5,040	5,040	20,160	20,160
CH_4		2.3			0.10	0.10	0.39	0.39
N_2O		0.64			0.03	0.03	0.11	0.11
CO_2e - 20-yr[3]		-			5,055	5,055	40,442	40,442
CO_2e - 100-yr[4]		-			5,050	5,050	40,399	40,399
Upstream CO_2e[5]		91,921			3,861	3,861	30,885	30,885

1. Emission Factors from AP-42 Section 1.4 Tables 1.4-1 and 1.4-2 for Small Boilers. Assuming low NO_x burners.
2. Per AP-42 Section 1.4 Table 1.4-2, PM (total) = PM_{10} = $PM_{2.5}$.
3. 20-yr Global warming potentials per 6 NYCRR Part 496.
4. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials*).
5. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 40,877 g/MMBtu

Table 15-3. Water Bath Vaporizer HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1]	Potential to Emit (All Units)	
		(lb/MMscf)	(lb/hr)	(tpy)
Benzene	Yes	2.10E-03	3.53E-04	3.53E-04
Formaldehyde	Yes	7.50E-02	0.01	0.01
Toluene	Yes	3.40E-03	5.71E-04	5.71E-04
2-Methylnaphthalene	Yes	2.40E-05	4.03E-06	4.03E-06
3-Methylchloranthrene	Yes	1.80E-06	3.02E-07	3.02E-07
7,12-Dimethylbenz(a)anthracene	Yes	1.60E-05	2.69E-06	2.69E-06
Acenaphthylene	Yes	1.80E-06	3.02E-07	3.02E-07
Benzo(a)pyrene	Yes	1.20E-06	2.02E-07	2.02E-07
Benzo(b)fluoranthene	Yes	1.80E-06	3.02E-07	3.02E-07
Benzo(k)fluoranthene	Yes	1.80E-06	3.02E-07	3.02E-07
Dibenzo(a,h)anthracene	Yes	1.20E-06	2.02E-07	2.02E-07
Dichlorobenzene	Yes	1.20E-03	2.02E-04	2.02E-04
Hexane	Yes	1.80E+00	0.30	0.30
Naphthalene	Yes	6.10E-04	1.02E-04	1.02E-04
Acenaphthene	Yes	1.80E-06	3.02E-07	3.02E-07
Anthracene	Yes	2.40E-06	4.03E-07	4.03E-07
Benzo(a)anthracene	Yes	1.80E-06	3.02E-07	3.02E-07
Benzo(g,h,i)perylene	Yes	1.20E-06	2.02E-07	2.02E-07
Chrysene	Yes	1.80E-06	3.02E-07	3.02E-07
Fluoranthene	Yes	3.00E-06	5.04E-07	5.04E-07
Fluorene	Yes	2.80E-06	4.70E-07	4.70E-07
Indeno(1,2,3-cd)pyrene	Yes	1.80E-06	3.02E-07	3.02E-07
Phenanthrene	Yes	1.70E-05	2.86E-06	2.86E-06
Pyrene	Yes	5.00E-06	8.40E-07	8.40E-07
Arsenic	Yes	2.00E-04	3.36E-05	3.36E-05
Beryllium	Yes	1.20E-05	2.02E-06	2.02E-06
Cadmium	Yes	1.10E-03	1.85E-04	1.85E-04
Chromium	Yes	1.40E-03	2.35E-04	2.35E-04
Cobalt	Yes	8.40E-05	1.41E-05	1.41E-05
Lead	Yes	5.00E-04	8.40E-05	8.40E-05
Manganese	Yes	3.80E-04	6.38E-05	6.38E-05
Mercury	Yes	2.60E-04	4.37E-05	4.37E-05
Nickel	Yes	2.10E-03	3.53E-04	3.53E-04
Selenium	Yes	2.40E-05	4.03E-06	4.03E-06
		Total HAP PTE	**0.32**	**0.32**

1. HAP emission factors are from AP-42, Section 1.4, Tables 1.4-3 and 1.4-4.

Conversions

1 lb =	453.59	g
1 year =	8,760	hr
1 scf NG =	1,020	BTU - Average heat content of NG from AP-42 1.4.1.
1 year =	525,600	minutes
1 lb-mole of gas (@ 20C) =	385.3	Cubic feet
1 hr=	60	minutes

Micron - Clay, NY Fabs 1 & 2
1-CMBOP and 2-CMBOP
Natural Gas Boiler Combustion Emissions

Table 16-1. Total Boiler Burner Rating

Equipment Description	Equipment Count	Operating Hours Limit[1] (hrs/yr)	Burner Rating (MMBtu/hr)	Maximum Outlet Flow (scfm)
Natural Gas Boilers - Process BLR	6	6,000	32.7	22,500
		Total	196.2	135,000

1. Micron proposes a permit condition limiting each boiler to 6,000 hours of operation per year.

Table 16-2. Boiler Criteria Pollutant/GHG Potential to Emit

Pollutant	Molecular Weight (lb/lb-mole)	Emission Factor[1,2] (lb/MMscf)	BACT/LAER Limits		Potential to Emit (Per Unit)		Potential to Emit (All Units)	
			Value	Unit	(lb/hr)	(tpy)	(lb/hr)	(tpy)
PM (Total)		7.6			0.24	0.73	1.46	4.39
PM_{10}		7.6			0.24	0.73	1.46	4.39
$PM_{2.5}$		7.6			0.24	0.73	1.46	4.39
SO_2		0.6			0.02	0.06	0.12	0.35
CO	28.01		50	ppmvd @3% O2	4.91	14.7	29.4	88.3
NO_X	46.01		9	ppmvd @3% O2	1.45	4.35	8.71	26.1
VOC			0.0017	lb/MMBtu	0.06	0.17	0.33	1.00
Lead		0.0005			1.60E-05	4.81E-05	9.62E-05	2.89E-04
CO_2		120,000			3,847	11,541	23,082	69,247
CH_4		2.3			0.07	0.22	0.44	1.33
N_2O		0.64			0.02	0.06	0.12	0.37
CO_2e - 20-yr[3]		-			3,859	11,576	23,152	69,456
CO_2e - 100-yr[4]		-			3,855	11,564	23,127	69,382
Upstream CO_2e[5]		91,921			2,947	8,841	17,681	53,044

1. Criteria pollutant emission factors are from AP-42, Section 1.4, Tables 1.4-1 and 1.4-2. Assuming low-NO_x burners and flue gas recirculation.
2. Per AP-42 Section 1.4 Table 1.4-2, PM (total) = PM_{10} = $PM_{2.5}$.
3. 20-yr Global warming potentials per 6 NYCRR Part 496.
4. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials).*
5. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 40,877 g/MMBtu

Table 16-3. Boiler HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1]	Potential to Emit (All Units)	
		(lb/MMscf)	(lb/hr)	(tpy)
Benzene	Yes	2.10E-03	4.04E-04	1.21E-03
Formaldehyde	Yes	7.50E-02	0.01	0.04
Toluene	Yes	3.40E-03	6.54E-04	1.96E-03
2-Methylnaphthalene	Yes	2.40E-05	4.62E-06	1.38E-05
3-Methylchloranthrene	Yes	1.80E-06	3.46E-07	1.04E-06
7,12-Dimethylbenz(a)anthracene	Yes	1.60E-05	3.08E-06	9.23E-06
Acenaphthylene	Yes	1.80E-06	3.46E-07	1.04E-06
Benzo(a)pyrene	Yes	1.20E-06	2.31E-07	6.92E-07
Benzo(b)fluoranthene	Yes	1.80E-06	3.46E-07	1.04E-06
Benzo(k)fluoranthene	Yes	1.80E-06	3.46E-07	1.04E-06
Dibenzo(a,h)anthracene	Yes	1.20E-06	2.31E-07	6.92E-07
Dichlorobenzene	Yes	1.20E-03	2.31E-04	6.92E-04
Hexane	Yes	1.80E+00	0.35	1.04
Naphthalene	Yes	6.10E-04	1.17E-04	3.52E-04
Acenaphthene	Yes	1.80E-06	3.46E-07	1.04E-06
Anthracene	Yes	2.40E-06	4.62E-07	1.38E-06
Benzo(a)anthracene	Yes	1.80E-06	3.46E-07	1.04E-06
Benzo(g,h,i)perylene	Yes	1.20E-06	2.31E-07	6.92E-07
Chrysene	Yes	1.80E-06	3.46E-07	1.04E-06
Fluoranthene	Yes	3.00E-06	5.77E-07	1.73E-06
Fluorene	Yes	2.80E-06	5.39E-07	1.62E-06
Indeno(1,2,3-cd)pyrene	Yes	1.80E-06	3.46E-07	1.04E-06
Phenanthrene	Yes	1.70E-05	3.27E-06	9.81E-06
Pyrene	Yes	5.00E-06	9.62E-07	2.89E-06
Arsenic	Yes	2.00E-04	3.85E-05	1.15E-04
Beryllium	Yes	1.20E-05	2.31E-06	6.92E-06
Cadmium	Yes	1.10E-03	2.12E-04	6.35E-04
Chromium	Yes	1.40E-03	2.69E-04	8.08E-04
Cobalt	Yes	8.40E-05	1.62E-05	4.85E-05
Lead	Yes	5.00E-04	9.62E-05	2.89E-04
Manganese	Yes	3.80E-04	7.31E-05	2.19E-04
Mercury	Yes	2.60E-04	5.00E-05	1.50E-04
Nickel	Yes	2.10E-03	4.04E-04	1.21E-03
Selenium	Yes	2.40E-05	4.62E-06	1.38E-05
		Total HAP PTE	**0.36**	**1.09E+00**

1. Emission factors are from AP-42, Section 1.4, Tables 1.4-3 and 1.4-4. Emissions factors corrected for actual heating value from standard of 1020 BTU/ft^3.

Conversions

1 lb =	453.59	g
1 year =	8,760	hr
1 scf NG =	1,020	BTU - Average heat content of NG from AP-42 1.4.1.
1 kW =	3,413	BTU - AP-42 appendix A pg. 15
	0.85	kW out/kW in
1 year =	525,600	minutes
1 lb-mole of gas (@ 20C) =	385.3	Cubic feet
1 hr=	60	minutes

Micron - Clay, NY Fabs 1 & 2
1-CMBOP and 2-CMBOP
Diesel Emergency Generator Combustion Emissions

Table 17-1. Diesel Generator Inventory

Equipment Description	Equipment Count	Annual Operating Hours Limit (hrs/yr/engine)	Engine Full Load	Engine Power
			HP	kW
CUB 1 Diesel Emergency Generators - Process EMD	60	100	3,350	2,498
CUB 2 Diesel Emergency Generators - Process EMD	58			
Total Load (All Units)	118	--	**395,300**	**8,367,272**

1. Emergency generators are limited to the following 24-hour operation during emergencies: 38 engines limited to 4 hours of operation, 34 engines limited to 8 hours of operation, and the remaining 46 engines are unlimited in a 24-hour period.

Table 17-2. Diesel Emergency Generators Criteria Pollutant and GHG Potential to Emit

Pollutant	Tier 4 Exhaust Emission Standards[1,2]	AP-42 Emission Factors[3]	GHG Emission Factors[4]	Potential to Emit (Per Unit)		Potential to Emit (All Diesel Generators)
	(g/kW-hr)	(lb/HP-hr)	(kg/MMBtu)	(lb/hr)	(tpy)	(tpy)
PM (Total)	0.008	-	-	0.05	2.29E-03	0.27
PM_{10}	0.008	-	-	0.04	2.20E-03	0.26
$PM_{2.5}$	0.008	-	-	0.04	2.20E-03	0.26
SO_2	-	1.21E-05	-	0.04	2.03E-03	0.24
CO	3.5	-	-	19.3	0.96	114
NO_x	0.67	-	-	3.69	0.18	21.77
VOC	0.19	-	-	1.05	0.05	6.17
CO_2	-	-	73.96	1,391	69.5	8,206
CH_4	-	-	0.0030	0.06	2.82E-03	0.33
N_2O	-	-	0.00060	0.01	5.64E-04	0.07
CO_2e - 20-yr[5]	-	-	-	1,399	69.9	8,251
CO_2e - 100-yr[6]	-	-	-	1,395	69.8	8,233
Upstream CO_2e[7]	-	-	23.54	442.7	22.1	2,612

1. PM Emissions factors are based on manufacturer gaurantee. Tier 4 emission factors for balance of the pollutants are from Table 1 of 40 CFR Part 1039 Subpart B - Emission Standards and Related Requirements.
2. $PM_{2.5}$ and PM_{10} emission factors conservatively assumed to be equal to that of PM (total).
3. AP-42 Section 3.4 SO_2 emission factor based on ULSD which contains 15 ppm sulfur content.
4. CO_2, N_2O and CH_4 emission factors based on 40 CFR Part 98 Table C-1 and C-2 Default diesel emissions factors.
5. 20-yr Global warming potentials per 6 NYCRR Part 496.
6. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials*).
7. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 23,540 g/MMBtu

Table 17-3. Diesel Emergency Generators HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1] (lb/MMBtu)	Potential to Emit (lb/hr)	Potential to Emit (tpy)
Benzene	Yes	7.76E-04	0.78	0.04
Toluene	Yes	2.81E-04	0.28	0.01
Xylenes	Yes	1.93E-04	0.19	0.01
Formaldehyde	Yes	7.89E-05	0.08	3.97E-03
Acetaldehyde	Yes	2.52E-05	0.03	1.27E-03
Acrolein	Yes	7.88E-06	0.01	3.97E-04
Total PAH	Yes	2.12E-04	0.21	0.01
		Total HAP PTE	**1.58**	**0.08**

1. Emissions are calculated based on emission factors for diesel engines per AP-42 Section 3.4, Table 3.4-3 and 3.4-4.

2. Emergency generators covered by NSPS Subpart IIII.

Conversions

1 lb =	453.59	g
1 year (Emergency Operation) =	500	hr
Energy Conversion Factor:	392.75	bhp-hr/MMBtu (mechanical) in AP-42 Appendix A
15 ppm S =	0.0015	wt% S
Hoursepower (mechanical) =	0.74558	Kilowatts
Diesel Usage Conversion Factor:	0.138	MMBtu/gal

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Micron - Clay, NY Fabs 1 & 2
1-HPMCU and 2-HPMCU
Induced Draft Cooling Tower PM Emissions

Table 19-1. Drift Data Constants

Drift (% of water flow)	**0.0005**
TDS (ppmw)	**1200**
NaCl Specific Gravity	**2.2**

Table 19-2. Drift Data From Old Wood Herringbone Mist Eliminators (0.01% Drift)

CTI 0.01% Drift Data			Particulate Emissions		
Droplet	**Fraction**	**Calculated residue**	**TPM**	**Interpolated PM_{10}**	**Interpolated $PM_{2.5}$**
Ø (µm)	**% smaller**	**Ø (µm)**	**mg/m^3H_2O**	**mg/m^3H_2O**	**mg/m^3H_2O**
15	0.15	1.23	0.90		
25	0.29	2.04	1.74		4.09
35	0.99	2.86	5.94		
45	2.22	3.68	13.32		
55	3.79	4.49	22.74		
65	5.54	5.31	33.24		
80	9.25	6.54	55.50		
100	13.52	8.17	81.12		
120	18.15	9.80	108.90	112.36	
140	22.97	11.44	137.82		
165	32.07	13.48	192.42		
195	42.56	15.93	255.36		
225	53.43	18.38	320.58		
255	63.24	20.84	379.44		
285	71.38	23.29	428.28		
325	80.88	26.55	485.28		
375	87.36	30.64	524.16		
425	90.89	34.73	545.34		
475	94.04	38.81	564.24		
550	97.54	44.94	585.24		
650	99.52	53.11	597.12		
750	99.52	61.28	597.12		
850	99.52	69.45	597.12		
950	100.00	77.62	600.00		
mg/m^3H_2O			**600.00**	**112.36**	**4.09**
%			**100.0%**	**18.7%**	**0.7%**

SOURCE: J. Missimer, D. Wheeler, and K. Hennon, The relationship between SP and HGBIK Drift Measurement Results, CTI paper TP98-16, 1998

Table 19-3. Interpolated Drift Data for the Intermediate Drift Eliminators (0.0005% Drift) Representing the Averages of Table 19-2 and Table 19-4

Interpolated Data, 0.005% Drift			Particulate Emissions		
Droplet	Fraction	Calculated residue	TPM	Interpolated PM_{10}	Interpolated $PM_{2.5}$
Ø (µm)	% smaller	Ø (µm)	mg/m^3H_2O	mg/m^3H_2O	mg/m^3H_2O
13	0.08	1.02	0.45		
23	0.24	1.84	1.46		3.23
33	0.61	2.66	3.65		
43	1.37	3.47	8.20		
53	2.80	4.29	16.82		
63	5.62	5.11	33.73		
75	15.30	6.13	91.79		
95	31.67	7.76	190.00		
115	44.33	9.40	265.98	284.08	
135	52.50	11.03	314.98		
158	60.04	12.87	360.25		
188	66.80	15.32	400.78		
218	72.95	17.77	437.69		
248	78.67	20.22	471.99		
278	83.03	22.67	498.21		
313	88.58	25.53	531.50		
363	92.19	29.62	553.11		
413	94.62	33.70	567.69		
463	96.56	37.79	579.33		
525	98.31	42.90	589.83		
625	99.76	51.07	598.56		
mg/m^3H_2O			**598.56**	**284.08**	**3.23**
%			**100.0%**	**47.5%**	**0.54%**

Table 19-4. Drift Data From New Cellular Drift Eliminators (0.0003% Drift)

EPRI 0.0003% Drift Data			Particulate Emissions		
Droplet	Fraction	Calculated residue	TPM	Interpolated PM_{10}	Interpolated $PM_{2.5}$
Ø (µm)	% smaller	Ø (µm)	mg/m^3H_2O	mg/m^3H_2O	mg/m^3H_2O
10	0.00	0.82	0.00		
20	0.20	1.63	1.18		
30	0.23	2.45	1.36		1.46
40	0.51	3.27	3.08		
50	1.82	4.09	10.90		
60	5.70	4.90	34.21		
70	21.35	5.72	128.09		
90	49.81	7.35	298.87		
110	70.51	8.99	423.05	465.85	
130	82.02	10.62	492.14		
150	88.01	12.26	528.07		
180	91.03	14.71	546.19		
210	92.47	17.16	554.81		
240	94.09	19.61	564.55		
270	94.69	22.06	568.13		
300	96.29	24.51	577.73		
350	97.01	28.60	582.07		
400	98.34	32.68	590.04		
450	99.07	36.77	594.43		
500	99.07	40.85	594.43		
600	100.00	49.02	600.00		
mg/m^3H_2O			**600.00**	**465.85**	**1.46**
%			**100.0%**	**77.6%**	**0.2%**

SOURCE: J. Reisman and G. Frisbie, Calculating Realistic PM_{10} Emissions from Cooling Towers AWMA, Proceedings Florida Conference 2001, Session No. AM-1b

Micron - Clay, NY Fabs 1 & 2
1-HPMCU and 2-HPMCU
Cooling Tower Particulate Matter Emissions

Table 20-1. Percent of PM Emissions Based on Drift

Drift[1]	PM_{10}[1]	$PM_{2.5}$[1]
0.01%	18.7%	0.68%
0.005%	47.5%	0.54%
0.0005%	**76.4%**	**0.26%**
0.0003%	77.6%	0.24%

1. Bold values were interpolated from calculated data.

Table 20-2. Cooling Tower Inventory and Specifications

Description	Equipment Count	Drift Loss[1]	Flow Rate[2]	Total Annual Flow Rate	
		(%)	(gpm)	(gal/yr)	(lb/yr)
CUB Cooling Tower - Process CT1 and CT2	210	0.0005%	5,300	5.85E+11	4.88E+12
Gas Yard Cooling Tower - Process CT1 and CT2	12	0.0005%	5,330	3.36E+10	2.80E+11
		Total	10,630	6.19E+11	5.16E+12

1. The drift loss is based on BACT determinations.
2. Flow rate for each new cooling tower is based on manufacturer's specifications.

Table 20-3. Cooling Tower Speciated Particulate Matter Speciated Potential to Emit

Additive Mixture	CAS #	Chemical Name	Density	Annual Usage of Mixture	Weight Percent in Mixture	Concentration in Cooling Water	Total PM Emissions[2]
			(lb/gal)	lb/yr	(%)	(ppmw)	tpy
Sodium Hypochlorite, 12%	7681-52-9	Sodium hypochlorite	9.76	204,133	12.5	0.49	6.38E-03
	1310-73-2	Sodium hydroxide	9.76	204,133	5.0	0.20	2.55E-03
Sulfuric Acid, 70%	7664-93-9	Sulfuric acid	15.35	1,600,853	100	31.03	4.00E-01
Biocide (NALCO 77352NA)	10377-60-3	Magnesium Nitrate	8.50	298,520	5.0	2.89E-01	3.73E-03
	2682-20-4	2-Methyl-4-Isothiazolin-3-one	8.50	298,520	1.0	5.79E-02	7.46E-04
	26172-55-4	5-Chloro-2-Methyl-4-Isothiazolin-3-one	8.50	298,520	5.0	0.29	3.73E-03
Corrosion Inhibitor	37971-36-1	2-Phosphonobutane-1,2,4-tricarboxylic acid	9.76	670,556	10.00	1.30	1.68E-02
	29329-71-3	Phosphonic acid, (1-hydroxyethylidene)bis-, sodium salt	9.76	670,556	5.00	0.65	8.38E-03
Antiscalant and Biocide (NALCO Trasar Trac101)	7632-00-0	Sodium nitrite	10.76	44,756	30.0	0.26	3.36E-03
	7631-95-0	Sodium molybdate	10.76	44,756	5.0	0.04	5.59E-04
	Proprietary[1]	Substiituted triazole	-	-	1.0	-	-

1. CAS not listed on manufacturer SDS.
2. Total PM emissions as a result of each additive are estimated by multiplying the ratio of the additive concentration to the total TDS concentration by the total estimated TDS emissions.
3. TDS is speciated to the extent possible based on known additives. Constituents present in municipal water resulting in TDS emissions are unknown.

Table 20-4. Cooling Tower Particulate Matter Potential to Emit

Pollutant	Emissions (Per Unit)				Total Emissions
	CUB Cooling Tower		Gas Yard Cooling Tower		
	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(tpy)
TDS[1]	0.02	0.07	0.02	0.07	15.48
PM_{10}[2]	0.01	0.05	0.01	0.05	10.11
$PM_{2.5}$[2]	7.24E-05	3.17E-04	4.09E-05	1.79E-04	0.07

1. Estimated Solids in Cooling Water, TDS = 1200 ppm

Water Density = 8.34 lb/gal

2. The percentage of PM_{10} and $PM_{2.5}$ emissions of TDS is based on cooling tower data compiled by Environmental Canada: https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions/wet-cooling-tower-particulate-guide.html

Conversions

1 year = 8,760 hours

Micron - Clay, NY Fabs 1 & 2
Various Emission Units
Storage Tanks Specs

Table 21-1. Tank Information & Turnover Calculation

Tank ID	Product/Purpose	Total Tank Count - Fab 1 & Fab 2	Single Tank Capacity (gal)	Total Annual Throughput (gal/yr)	Total Daily Throughput (gal/day)	Tank Building	Exhaust Stack	Emission Units	Part 212 Applicability	Part 229 Applicability
HPM/FAB Building Storage										
1	Hydrogen Peroxide 31%	24	10,000	9,102,370	24,938	HPM	HPM Acid	1-HPMCU, 2-HPMCU	Subject to 212-2	N/A - not VOC
2	Sulfuric Acid 96%	16	10,000	5,307,830	14,542	HPM	HPM Acid	1-HPMCU, 2-HPMCU	Subject to 212-2	N/A - not VOC
3	Hydrofluoric Acid 49%	8	10,000	2,909,050	7,970	HPM	HPM Acid	1-HPMCU, 2-HPMCU	Subject to 212-2	N/A - not VOC
4	Hydrofluoric Acid 100:1	8	6,500	8,760,000	24,000	HPM	HPM Acid	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
5	Aqueous Ammonia 29%	16	6,500	1,543,220	4,228	HPM	HPM Ammonia	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
6	Tetramethyl Ammonium Hydroxide (TMAH) 25%	8	5,000	1,165,810	3,194	HPM	HPM Ammonia	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
7	[redacted]	8	6,500	110,230	302	HPM	HPM Ammonia	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
8	Tetramethyl Ammonium Hydroxide Dilute (0.063%)	8	6,500	4,182,900	11,460	HPM	HPM Ammonia	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
9	Isopropyl Alcohol	16	10,000	6,729,870	18,438	HPM	HPM Solvent	1-HPMCU, 2-HPMCU	N/A - 212-1.4(f)	Subject to 229.3(e)(2)(iv
10	Propylene Glycol Methyl Ether Acetate	8	6,500	1,503,800	4,120	HPM	HPM Solvent	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
11	Industrial Grade Sulfuric Acid 93%	8	7,600	3,854	11	HPM	HPM Acid	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
12	NaOH 50%	12	5,400	10,409,480	28,519	Fab	Fab Ammonia	1-FABOP, 2-FABOP	N/A - 212-1.4(a)	N/A - not VOC
Waste Material Storage										
13	Waste Sulfuric Acid (W-H2SO4), up to 98%	12	13,209	4,051,500	11,100	HPM	HPM Acid	1-HPMCU, 2-HPMCU	Subject to 212-2	N/A - not VOC
14	Waste Phosphoric Acid (W-H3PO4), up to 85%	8	13,209	518,300	1,420	WWT	WWT Acid	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
15	Waste Concentrated HF (W-CHF), up to 49%	8	13,209	3,438,300	9,420	WWT	WWT Acid	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
16	Waste Nitric Acid (W-HNO3), up to 30%	8	13,209	547,500	1,500	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - No emissions	N/A - not VOC
17	Waste Copper Sulfate (W-CuSO4), up to 15%	8	2,642	65,700	180	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	N/A - not VOC
18	Waste Dilute Sulfuric Peroxide (W-DSP), 9% H2SO4	8	13,209	328,500	900	WWT	WWT Acid	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
19	Waste Concentrated IPA (W-IPA)	24	12,000	4,781,500	13,100	Outdoors	Fab Solvent	1-FABOP, 2-FABOP	N/A - 212-1.4(f)	Subject to 229.3(e)(2)(iv
20	Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	24	12,000	3,452,900	9,460	Outdoors	Fab Solvent	1-FABOP, 2-FABOP	N/A - 212-1.4(f)	Subject to 229.3(e)(2)(iv
21	Waste Photo Solvent 2 (W-PS2) - Photoresist	12	7,000	277,400	760	Outdoors	Fab Solvent	1-FABOP, 2-FABOP	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
WWT Building Storage										
22	Sodium Hydroxide, 50%	10	21,000	416,100	1,140	WWT	WWT Ammonia	1-WWBIO, 2-WWBIO	N/A - No emissions	N/A - not VOC
23	Hydrochloric Acid, 36%	4	10,000	824,900	2,260	WWT	WWT Acid	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
24	Sodium Hypochlorite, 12%	4	8,000	500,050	1,370	WWT	WWT Ammonia	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	N/A - not VOC
25	Sodium Bisulphite	4	5,000	36,500	100	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	N/A - not VOC
26	Calcium Chloride 35%	8	16,000	6,946,940	19,033	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - No emissions	N/A - not VOC
27	Aluminium Sulfate, 8%	4	16,000	461,360	1,264	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - No emissions	N/A - not VOC
28	Aluminium Chlorohydrate, 23%	4	5,300	422,949	1,159	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	N/A - not VOC
29	Catalase	4	2,600	175,200	480	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
30	Sulfuric acid	4	15,000	5,653,880	15,490	WWT	WWT Acid	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
31	Ferric Chloride	4	16,500	657,000	1,800	WWT	WWT Acid	1-WWBIO, 2-WWBIO	N/A - No emissions	N/A - not VOC
BIO Building Storage										
32	Sodium Hydroxide, 50%	2	18,000	1,010,769	2,769	BIO	BIO General	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
33	Sulfuric Acid, 70%	4	6,500	15,442	42	BIO	BIO General	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	N/A - not VOC
34	Sodium Bisulphite, 25%	2	10,000	10,038	28	BIO	Atmosphere Venting	1-WWBIO, 2-WWBIO	N/A - No emissions	N/A - not VOC
35	Phosphoric Acid, 85%	4	10,000	73,000	200	BIO	Atmosphere Venting	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
36	Citric Acid, 50%	2	5,000	26,642	73	BIO	Atmosphere Venting	1-WWBIO, 2-WWBIO	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
37	Sodium Hypochlorite, 12%	2	20,000	730,014	2,000	BIO	Atmosphere Venting	1-WWBIO, 2-WWBIO	Subject to 212-2	N/A - not VOC
CUB Building Storage										
38	Sodium Hypochlorite, 12%	2	7,000	20,920	57	CUB	Atmosphere Venting	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
39	Sulfuric Acid, 70%	2	4,000	104,320	286	CUB	CUB Acid	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
40	Biocide	2	2,000	35,120	96	CUB	Atmosphere Venting	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
41	Corrosion Inhibitor	2	2,000	68,720	188	CUB	Atmosphere Venting	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	Subject to 229.3(e)(2)(v)
42	Antiscalant and Biocide	2	2,000	4,160	11	CUB	Atmosphere Venting	1-HPMCU, 2-HPMCU	N/A - 212-1.4(a)	N/A - not VOC
Diesel Storage										
43	Ultra-Low Sulfur Diesel	8	25,000	729,343	1,998	Outdoors	Atmosphere Venting	1-HPMCU, 2-HPMCU	Subject to 212-2	N/A - TVP < 4 psia

Table 21-2. Tank Hourly Filling Rate

Tanker Truck Volume (Assumed) (gal)	Time to Fill (Assumed) (hr)
5,000	2.00

1. Fill time assumed based on estimated tanker truck volume and practical filling time.

Micron - Clay, NY Fabs 1 & 2
Various Emission Units
Storage Tank Chemical Properties

Table 22-1. Chemical Properties Reference Table

CAS #	Chemical	VOC/HAP	Molecular Weight (lb/lbmol)	Vapor Pressure (mmHg)	Vapor Pressure (psia)	Notes	Reference
7732-18-5	Water	NEITHER	18.02	-	0.339	Vapor pressure at 20 degrees Celsius. Converted from Perry's Handbook (0.0023393 MPa).	Perry's Chemical Engineers' Handbook, 8th Edition. Table 2-5, "Vapor Pressure (MPa) of Liquid Water from 0 to 100°C."
7722-84-1	Hydrogen Peroxide	NEITHER	34.02	1.97	0.038		Hydrogen Peroxide | H2O2 | CID 784 - PubChem (nih.gov) https://pubchem.ncbi.nlm.nih.gov/compound/Hydrogen-peroxide#section=Vapor-Pressure
7664-93-9	Sulfuric Acid	NEITHER	98.08	-	3.25E-07	Vapor pressure at 20 degrees Celsius. Use rounded vapor pressure of 98% H_2SO_4 aqueous solution as conservative estimate. Converted from Perry's Handbook (.224E-07 bar).	Perry's Chemical Engineers' Handbook, 8th Edition. Table 2-16, "Sulfuric Acid Partial Pressure, bar, over Aqueous Sulfuric Acid."
7664-39-3	Hydrofluoric Acid	HAP	20.01	0.23	0.004	Vapor pressure is that of HBr in a 49% aqueous solution at 20°C (see Tank 3 composition). Based on HBr data as a surrogate for HF vapor pressure data. Use vapor pressure of 50% aqueous solution as conservative estimate.	Perry's Chemical Engineers' Handbook, 8th Edition. Table 2-19, "Partial Pressures of H_2O and HBr over Aqueous Solutions of HBr at 20 to 55°C."
7664-41-7	Ammonia	NEITHER	17.03	-	12.65	Vapor pressure is that of a 29% aqueous solution at 27 degrees Celsius.	Perry's Chemical Engineers' Handbook, 8th Edition. Table 2-25, "Partial Pressures of NH_3 over Aqueous Solutions of NH_3."
75-59-2	Tetramethyl Ammonium Hydroxide	VOC	91.15	-	1.00E-02	Aqueous salt expected to have negligble vapor pressure. Conservative estimate of 0.01 psia.	--
67-63-0	Isopropyl Alcohol	VOC	60.10	33.00	0.638		CDC - NIOSH Pocket Guide to Chemical Hazards - Isopropyl alcohol https://www.cdc.gov/niosh/npg/npgd0359.html
108-65-6	Propylene Glycol Methyl Ether Acetate	VOC	132.16	5.05	0.098	Vapor pressure at 25 degrees Celsius from predicted EPISuite data, U.S. EPA.	PGMEA | C6H12O3 | ChemSpider https://www.chemspider.com/Chemical-Structure.7658.html
[redacted]							
1310-73-2	Sodium Hydroxide	NEITHER	40.00	0.00	0.00E+00	Confirmed to have 0 vapor pressure according to NIOSH	https://www.cdc.gov/niosh/npg/npgd0565.html
7681-52-9	Sodium Hypochlorite	NEITHER	74.44	16.00	0.309		Sodium hypochlorite | ClNaO | ChemSpider http://www.chemspider.com/Chemical-Structure.22756.html?rid=584224e1-cb7e-45f0-b413-b6c8c36eb9c0
7647-01-0	Hydrochloric Acid	HAP	36.46	68.50	1.325	Vapor pressure is that of a 34% aqueous solution at 25 degrees Celsius (see Tank 15 composition).	Perry's Chemical Engineers' Handbook, 8th Edition. Table 2-12, "Partial Pressures of HCl over Aqueous Solutions of HCl."
7631-90-5	Sodium Bisulfite	NEITHER	104.06	0.00	0.00E+00	White crystals or powder	Sodium bisulfite | HNaO3S | ChemSpider http://www.chemspider.com/Chemical-Structure.571016.html?rid=2bc61aa7-722a-4dce-a218-cd29a8f8643c
7664-38-2	Phosphoric Acid (Orthophosphoric Acid)	NEITHER	98.00	0.03	5.80E-04		CDC - NIOSH Pocket Guide to Chemical Hazards - Phosphoric acid https://www.cdc.gov/niosh/npg/npgd0506.html
7697-37-2	Nitric Acid	NEITHER	63.01	0.00	0.00E+00	Vapor pressure is that of a 30% solution at 25 degrees Celsius (see Tank 24 composition).	Perry's Chemical Engineers' Handbook, 8th Edition. Table 2-18, "Partial Pressures of HNO_3 and H_2O over Aqueous Solutions of HNO_3.*."
7758-99-8	Copper (II) Sulfate	NEITHER	159.61	0.00	0.00E+00	Hydrated blue solid	Copper(II) sulfate | CuO4S | ChemSpider http://www.chemspider.com/Chemical-Structure.22870.html?rid=4323f1cd-5ac2-40bb-b7aa-c03e9c485ed7&page_num=0
10043-52-4	Calcium Chloride	NEITHER	110.98	0.00	0.00E+00	White solid beads/powder	Calcium chloride | CaCl2 | ChemSpider http://www.chemspider.com/Chemical-Structure.23237.html?rid=ec9482a2-4ae2-45c6-bceb-20a3c57db99a
7446-70-0	Aluminum Chloride	NEITHER	133.34	0.00	0.00E+00	Colorless crystal solid	Aluminium chloride | AlCl3 | ChemSpider http://www.chemspider.com/Chemical-Structure.22445.html?rid=1e52448f-9b22-4c63-9a9e-2bfce0e94316#acdLabsTab
12125-01-8	Ammonium Fluoride	NEITHER	37.04	0.00	0.00E+00	White crystalline solid	Ammonium fluoride | H4FN | ChemSpider http://www.chemspider.com/Chemical-Structure.23806.html?rid=301ba886-d38a-46ec-adaa-ae478d977f4e
1341-49-7	Ammonium Bifluoride	NEITHER	57.04	0.00	0.00E+00	White crystalline solid	Ammonium bifluoride | H5F2N | ChemSpider http://www.chemspider.com/Chemical-Structure.14229.html?rid=449fe527-5fe5-4a90-8538-9a6d5c9d0c7a&page_num=0
[redacted]							
68334-30-5	Ultra-Low Sulfur Diesel	VOC	130.00	-	6.00E-03	Vapor pressure of fuel at 16 degrees Celsius. Vapor molecular weight taken from AP-42 Table 7.1-2.	AP 42 Chapter 7: Liquid Storage Tanks (epa.gov)
10043-01-3	Aluminum Sulfate	NEITHER	342.20	0.00	0.00E+00	White crystalline solid	https://pubchem.ncbi.nlm.nih.gov/compound/Aluminum-Sulfate#section=Computed-Properties
12359-72-7	Aluminum Chlorohydrate	NEITHER	210.48	0.00	0.00E+00	Crystalline Solid	https://www.chemicalbook.com/ChemicalProductProperty_EN_CB4396251.htm
9001-05-2	Catalase	VOC	166.17	0.00	0.00E+00	Enzyme	https://www.chemicalbook.com/ProductChemicalPropertiesCB9273573_EN.htm
[redacted]							
497-19-8	Sodium Carbonate	VOC	105.99	0.00E+00	0.00E+00	Colorless crystal solid	https://pubchem.ncbi.nlm.nih.gov/compound/Sodium-Carbonate#section=Computed-Properties
7632-00-0	Sodium Nitrite	NEITHER	69.00	0.00E+00	0.00E+00	White crystalline solid	https://pubchem.ncbi.nlm.nih.gov/compound/23668193#section=Chemical-Classes https://pubchem.ncbi.nlm.nih.gov/compound/Sodium-Nitrate
7631-95-0	Sodium Molybdate	NEITHER	205.93	0.00E+00	0.00E+00	White crystalline solid	https://pubchem.ncbi.nlm.nih.gov/compound/Sodium-molybdate#section=Experimental-Properties
7705-08-0	Ferric Chloride	NEITHER	162.20	0.00E+00	0.00E+00	Brown-black solid	https://pubchem.ncbi.nlm.nih.gov/compound/Ferric-Chloride
29329-71-3	Phosphonic acid, (1-hydroxyethylidene)bis-, sodium salt	VOC	228.01	0.00E+00	0.00E+00	Forms large crystals	https://pubchem.ncbi.nlm.nih.gov/compound/23687324#section=Experimental-Properties
[redacted]							
[redacted]							
Proprietary[1]	Polyalkylene glycol	No CAS listed on manufacturer SDS, properties unknown					
Proprietary[1]	Substituted Triazole	No CAS listed on manufacturer SDS, properties unknown					

Micron - Clay, NY Fabs 1 & 2
Various Emission Units
Storage Tank Working and Breathing Loss Emissions

Table 23-1. Working Loss Emission Factors for Fixed Roof Tanks

Emission Factors calculated using:					
AP-42 Section 7.1, Subsection 7.1.3.1.2			Stock Vapor Density Equation 1-22		$W_v = (M*P)/(R*T)$
Working Loss Equation 1-35		$L_W = V_Q K_N K_P W_V K_B$	W_v	Stock Vapor Density, lb/gal	See Table
L_W	Hourly or Annual Emissions, lb/hr or lb/yr	See Table	P	Vapor Pressure of liquid loaded, psia	See Table
V_Q	Hourly or Annual Throughput, gal/hr or gal/yr	See Table	M	Molecular Weight of Vapors, lb/lb-mol	See Table
K_N	Working Loss Turnover Factor	See Below	T	Temperature of bulk liquid loaded, °R	539.67
K_P	Working Loss Product Factor	1	R	Ideal Gas Constant, psia*ft^3/lb-mole*°R	10.731
W_V	Stock Vapor Density, lb/gal	See Table			
K_B	Vent Setting Correction Factor, See Footnote 1	1	Working Loss Turnover Factor Equation		$K_N = (180+N)/(6N)$
			K_N	Working Loss Turnover Factor	See Table
			N	Annual Turnovers	See Table
				Conversion Factor, ft^3/gal	0.134

Table 23-2. Working Loss Tank Emissions

Tank S/N	Chemical Product	Raw Material Index	Raw Material Chemical Index	CAS #	Chemical	Chemical wt% in Raw Material	Molecular Weight (lb/lbmol)	Vapor Pressure	lbmol of Chemical per lb Raw Material	Mol%	VOC/HAP?	Vapor Partial Pressure[1]	Vapor Mol. %	Partial Vapor Molecular Weight	Vapor Molecular Weight	Vapor Density	Vapor Wt.%	Tank Count	Single Tank Capacity	Total Tank Capacity	Daily Total Tank Throughput	Annual Turnovers	K_N	Hourly Filling Rate (per tank)
												pp	y = pp/TP	MWi x Vap.Mol%i	M_v	W_v								V_Q (hourly)
								(psia)	(Wt%i/Mwi)			(psia)	(mol%)	(lb/lbmol)	(lb/lbmol)	(lb/gal)			(gal)	(gal)	(gal/day)	N		(gal/hr)
HPM/FAB Building Storage																								
1	Hydrogen Peroxide 31%	1	1	7722-84-1	Hydrogen Peroxide	31.0%	34.0	0.04	9.11E-03	19.2%		7.32E-03	2.60%	0.89	18.4	1.20E-04	4.80%	24	10,000	240,000	24,938	38	0.96	2,500
		1	2	7732-18-5	Water	69.0%	18.0	0.34	0.04	80.8%		0.27	97.40%	17.6	18.4	1.20E-04	95.2%	24	10,000	240,000	24,938	38	0.96	2,500
2	Sulfuric Acid 96%	2	3	7664-93-9	Sulfuric Acid	96.0%	98.1	3.25E-07	9.79E-03	81.5%		2.65E-07	0.00%	4.14E-04	18.0	2.61E-05	0.00%	16	10,000	160,000	14,542	33	1.00	2,500
		2	4	7732-18-5	Water	4.00%	18.0	0.34	2.22E-03	18.5%		0.06	100.00%	18.0	18.0	2.61E-05	100.0%	16	10,000	160,000	14,542	33	1.00	2,500
3	Hydrofluoric Acid 49%	3	5	7664-39-3	Hydrofluoric Acid	49.0%	20.0	4.45E-03	0.02	46.4%	HAP	2.06E-03	1.12%	0.22	18.0	7.66E-05	1.24%	8	10,000	80,000	7,970	36	0.99	2,500
		3	6	7732-18-5	Water	51.0%	18.0	0.34	0.03	53.6%		0.18	98.88%	17.8	18.0	7.66E-05	98.8%	8	10,000	80,000	7,970	36	0.99	2,500
4	Hydrofluoric Acid 100:1	4	7	7664-39-3	Hydrofluoric Acid	0.67%	20.0	4.45E-03	3.33E-04	0.60%	HAP	2.67E-05	0.01%	1.58E-03	18.0	1.40E-04	0.01%	8	6,500	52,000	24,000	168	0.34	2,500
		4	8	7732-18-5	Water	99.3%	18.0	0.34	0.06	99.4%		0.34	99.99%	18.0	18.0	1.40E-04	100.0%	8	6,500	52,000	24,000	168	0.34	2,500
5	Aqueous Ammonia 29%	5	9	7664-41-7	Ammonia	29.0%	17.0	12.6	0.02	30.2%		3.82	94.15%	16.0	17.1	1.60E-03	93.8%	16	6,500	104,000	4,228	15	1.00	2,500
		5	10	7732-18-5	Water	71.0%	18.0	0.34	0.04	69.8%		0.24	5.85%	1.05	17.1	1.60E-03	6.16%	16	6,500	104,000	4,228	15	1.00	2,500
6	Tetramethyl Ammonium Hydroxide (TMAH) 25%	6	11	75-59-2	Tetramethyl Ammonium Hydroxide	25.0%	91.2	1.00E-02	2.74E-03	6.18%	VOC	6.18E-04	0.19%	0.18	18.2	1.34E-04	0.97%	8	5,000	40,000	3,194	29	1.00	2,500
		6	12	7732-18-5	Water	75.0%	18.0	0.34	0.04	93.8%		0.32	99.81%	18.0	18.2	1.34E-04	99.0%	8	5,000	40,000	3,194	29	1.00	2,500
7	[redacted]	7	13	75-59-2	Tetramethyl Ammonium Hydroxide	2.38%	91.2	1.00E-02	2.61E-04	0.48%	VOC	4.80E-05	0.01%	0.01	18.0	1.41E-04	0.07%	8	6,500	52,000	302	2	1.00	2,500
		7	14	[redacted]														8	6,500	52,000	302	2	1.00	2,500
		7	15	7732-18-5	Water	97.5%	18.0	0.34	0.05	99.5%		0.34	99.99%	18.0	18.0	1.41E-04	99.9%	8	6,500	52,000	302	2	1.00	2,500
8	Tetramethyl Ammonium Hydroxide Dilute (0.063%)	8	16	75-59-2	Tetramethyl Ammonium Hydroxide	0.06%	91.2	1.00E-02	6.91E-06	0.01%	VOC	1.25E-06	0.00%	3.35E-04	18.0	1.41E-04	0.00%	8	6,500	52,000	11,460	80	0.54	2,500
		8	17	7732-18-5	Water	99.9%	18.0	0.34	0.06	100.0%		0.34	100.00%	18.0	18.0	1.41E-04	100.0%	8	6,500	52,000	11,460	80	0.54	2,500
9	Isopropyl Alcohol	9	18	67-63-0	Isopropyl Alcohol	100.0%	60.1	0.64	0.02	100.0%	VOC	0.64	100.00%	60.1	60.1	8.85E-04	100.0%	16	10,000	160,000	18,438	42	0.88	2,500
10	Propylene Glycol Methyl Ether Acetate	10	19	108-65-6	Propylene Glycol Methyl Ether Acetate	100.0%	132.2	0.10	7.57E-03	100.0%	VOC	0.10	100.00%	132.2	132.2	2.98E-04	100.0%	8	6,500	52,000	4,120	29	1.00	2,500
11	Industrial Grade Sulfuric Acid 93%	11	20	7664-93-9	Sulfuric Acid	93.0%	98.1	3.25E-07	9.48E-03	70.9%		2.30E-07	0.00%	2.29E-04	18.0	4.10E-05	0.00%	8	7,600	60,800	11	0	1.00	2,500
		11	21	7732-18-5	Water	7.00%	18.0	0.34	3.88E-03	29.1%		0.10	100.00%	18.0	18.0	4.10E-05	100.0%	8	7,600	60,800	11	0	1.00	2,500
12	NaOH 50%	12	22	1310-73-2	Sodium Hydroxide	50.0%	40.0	0.00	0.01	31.1%		0.00	0.00%	0.00	18.0	9.73E-05	0.00%	12	5,400	64,800	28,519	161	0.35	2,500
		12	23	7732-18-5	Water	50.0%	18.0	0.34	0.03	68.9%		0.23	100.00%	18.0	18.0	9.73E-05	100.0%	12	5,400	64,800	28,519	161	0.35	2,500
Waste Material Storage																								
13	Waste Sulfuric Acid (W-H2SO4), up to 98%	13	24	7664-93-9	Sulfuric Acid	98.0%	98.1	3.25E-07	9.99E-03	90.0%		2.92E-07	0.00%	8.45E-04	18.0	1.41E-05	0.00%	12	13,209	158,503	11,100	26	1.00	463
		13	25	7732-18-5	Water	2.00%	18.0	0.34	1.11E-03	10.0%		0.03	100.00%	18.0	18.0	1.41E-05	100.0%	12	13,209	158,503	11,100	26	1.00	463
14	Waste Phosphoric Acid (W-H3PO4), up to 85%	14	26	7664-38-2	Phosphoric Acid (Orthophosphoric Acid)	85.0%	98.0	5.80E-04	8.67E-03	51.0%		2.96E-04	0.18%	0.17	18.2	6.98E-05	0.96%	8	13,209	105,669	1,420	5	1.00	59
		14	27	7732-18-5	Water	15.0%	18.0	0.34	8.32E-03	49.0%		0.17	99.82%	18.0	18.2	6.98E-05	99.0%	8	13,209	105,669	1,420	5	1.00	59
15	Waste Concentrated HF (W-CHF), up to 49%	15	28	7664-39-3	Hydrofluoric Acid	49.0%	20.0	4.45E-03	0.02	46.4%	HAP	2.06E-03	1.12%	0.22	18.0	7.66E-05	1.24%	8	13,209	105,669	9,420	33	1.00	393
		15	29	7732-18-5	Water	51.0%	18.0	0.34	0.03	53.6%		0.18	98.88%	17.8	18.0	7.66E-05	98.8%	8	13,209	105,669	9,420	33	1.00	393
16	Waste Nitric Acid (W-HNO3), up to 30%	16	30	7697-37-2	Nitric Acid	30.0%	63.0	0.00	4.76E-03	10.9%		0.00	0.00%	0.00	18.0	1.26E-04	0.00%	8	13,209	105,669	1,500	5	1.00	63
		16	31	7732-18-5	Water	70.0%	18.0	0.34	0.04	89.1%		0.30	100.00%	18.0	18.0	1.26E-04	100.0%	8	13,209	105,669	1,500	5	1.00	63
17	Waste Copper Sulfate (W-CuSO4), up to 15%	17	32	7758-99-8	Copper (II) Sulfate	15.0%	159.6	0.00	9.40E-04	1.95%		0.00	0.00%	0.00	18.0	1.38E-04	0.00%	8	2,642	21,134	180	3	1.00	8
		17	33	7732-18-5	Water	85.0%	18.0	0.34	0.05	98.0%		0.33	100.00%	18.0	18.0	1.38E-04	100.0%	8	2,642	21,134	180	3	1.00	8
18	Waste Dilute Sulfuric Peroxide (W-DSP), 9% H2SO4	18	34	7664-93-9	Sulfuric Acid	9.00%	98.1	3.25E-07	9.18E-04	2.08%		6.77E-09	0.00%	2.41E-06	18.4	1.17E-04	0.00%	8	13,209	105,669	900	3	1.00	38
		18	35	7722-84-1	Hydrogen Peroxide	28.2%	34.0	0.04	8.29E-03	18.8%		7.17E-03	2.60%	0.89	18.4	1.17E-04	4.80%	8	13,209	105,669	900	3	1.00	38
		18	36	7732-18-5	Water	62.8%	18.0	0.34	0.03	79.1%		0.27	97.40%	17.6	18.4	1.17E-04	95.2%	8	13,209	105,669	900	3	1.00	38
19	Waste Concentrated IPA (W-IPA)	19	37	67-63-0	Isopropyl Alcohol	100.0%	60.1	0.64	0.02	100.0%	VOC	0.64	100.00%	60.1	60.1	8.85E-04	100.0%	24	12,000	288,000	13,100	17	1.00	546
		19	38	7732-18-5	Water	0.00%	18.0	0.34	0.00	0.00%		0.00	0.00%	0.00	60.1	8.85E-04	0.00%	24	12,000	288,000	13,100	17	1.00	546

Table 23-2. Working Loss Tank Emissions

Tank S/N	Chemical Product	Raw Material Index	Raw Material Chemical Index	CAS #	Total Tank Annual Throughput	Max Emission Rate (per tank)	Pre-Control Total Tank Emissions	Tank Building	Exhaust Stack	Control Efficiency	Total Tank Emissions			Annual VOC Emissions	Annual HAP Emissions
					V_Q (annual)	L_W (hourly)	L_W (annual)				(lb/hr)	(lb/yr)	(tpy)	(tpy)	(tpy)
					(gal/yr)	(lb/hr)	(lb/yr)								
HPM/FAB Building Storage															
1	Hydrogen Peroxide 31%	1	1	7722-84-1	9,102,370	0.01	50.1	HPM	HPM Acid Exhaust	0%	0.01	50.1	0.03	**0.00**	**0.00**
		1	2	7732-18-5	9,102,370	0.27	993.8			0%	N/A	N/A	N/A	**0.00**	**0.00**
2	Sulfuric Acid 96%	2	3	7664-93-9	5,307,830	1.50E-06	3.18E-03	HPM	HPM Acid Exhaust	75%	3.75E-07	7.96E-04	3.98E-07	**0.00**	**0.00**
		2	4	7732-18-5	5,307,830	0.07	138.5			0%	N/A	N/A	N/A	**0.00**	**0.00**
3	Hydrofluoric Acid 49%	3	5	7664-39-3	2,909,050	2.36E-03	2.75	HPM	HPM Acid Exhaust	98%	4.72E-05	0.05	2.75E-05	**0.00**	**2.75E-05**
		3	6	7732-18-5	2,909,050	0.19	218.3			0%	N/A	N/A	N/A	**0.00**	**0.00**
4	Hydrofluoric Acid 100:1	4	7	7664-39-3	8,760,000	1.06E-05	0.04	HPM	HPM Acid Exhaust	98%	2.12E-07	7.44E-04	3.72E-07	**0.00**	**3.72E-07**
		4	8	7732-18-5	8,760,000	0.12	423.7			0%	N/A	N/A	N/A	**0.00**	**0.00**
5	Aqueous Ammonia 29%	5	9	7664-41-7	1,543,220	3.75	2,314.93	HPM	HPM Ammonia Exhaust	98%	0.08	46.3	0.02	**0.00**	**0.00**
		5	10	7732-18-5	1,543,220	0.25	152.1			0%	N/A	N/A	N/A	**0.00**	**0.00**
6	Tetramethyl Ammonium Hydroxide (TMAH) 25%	6	11	75-59-2	1,165,810	3.25E-03	1.52	HPM	HPM Ammonia Exhaust	0%	3.25E-03	1.52	7.58E-04	**7.58E-04**	**0.00**
		6	12	7732-18-5	1,165,810	0.33	154.4			0%	N/A	N/A	N/A	**0.00**	**0.00**
[redacted]		7	13	75-59-2	110,230	2.53E-04	0.01	HPM	HPM Ammonia Exhaust	0%	2.53E-04	0.01	5.57E-06	**5.57E-06**	**0.00**
		7	14	[redacted]						0%					
		7	15	7732-18-5	110,230	0.35	15.5			0%	N/A	N/A	N/A	**0.00**	**0.00**
8	Tetramethyl Ammonium Hydroxide Dilute (0.063%)	8	16	75-59-2	4,182,900	3.54E-06	5.92E-03	HPM	HPM Ammonia Exhaust	0%	3.54E-06	5.92E-03	2.96E-06	**2.96E-06**	**0.00**
		8	17	7732-18-5	4,182,900	0.19	318.5			0%	N/A	N/A	N/A	**0.00**	**0.00**
9	Isopropyl Alcohol	9	18	67-63-0	6,729,870	1.95	5,242.20	HPM	HPM Solvent Exhaust	90%	0.19	524.2	0.26	**0.26**	**0.00**
10	Propylene Glycol Methyl Ether Acetate	10	19	108-65-6	1,503,800	0.74	448.0	HPM	HPM Solvent Exhaust	90%	0.07	44.8	0.02	**0.02**	**0.00**
11	Industrial Grade Sulfuric Acid 93%	11	20	7664-93-9	4,015	1.30E-06	2.09E-06	HPM	HPM Acid Exhaust	75%	3.26E-07	5.24E-07	2.62E-10	**0.00**	**0.00**
		11	21	7732-18-5	4,015	0.10	0.16			0%	N/A	N/A	N/A	**0.00**	**0.00**
12	NaOH 50%	12	22	1310-73-2	10,409,435	0.00	0.00	Fab	Fab Ammonia Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		12	23	7732-18-5	10,409,435	0.09	357.9			0%	N/A	N/A	N/A	**0.00**	**0.00**
Waste Material Storage															
13	Waste Sulfuric Acid (W-H2SO4), up to 98%	13	24	7664-93-9	4,051,500	3.06E-07	2.68E-03	HPM	HPM Acid Exhaust	75%	7.65E-08	6.71E-04	3.35E-07	**0.00**	**0.00**
		13	25	7732-18-5	4,051,500	6.53E-03	57.2			0%	N/A	N/A	N/A	**0.00**	**0.00**
14	Waste Phosphoric Acid (W-H3PO4), up to 85%	14	26	7664-38-2	518,300	3.96E-05	0.35	WWT	WWT Acid Exhaust	40%	2.38E-05	0.21	1.04E-04	**0.00**	**0.00**
		14	27	7732-18-5	518,300	4.09E-03	35.8			0%	N/A	N/A	N/A	**0.00**	**0.00**
15	Waste Concentrated HF (W-CHF), up to 49%	15	28	7664-39-3	3,438,300	3.74E-04	3.28	WWT	WWT Acid Exhaust	98%	7.48E-06	0.07	3.28E-05	**0.00**	**3.28E-05**
		15	29	7732-18-5	3,438,300	0.03	260.2			0%	N/A	N/A	N/A	**0.00**	**0.00**
16	Waste Nitric Acid (W-HNO3), up to 30%	16	30	7697-37-2	547,500	0.00	0.00	WWT	WWT Acid Exhaust	40%	0.00	0.00	0.00	**0.00**	**0.00**
		16	31	7732-18-5	547,500	7.86E-03	68.8			0%	N/A	N/A	N/A	**0.00**	**0.00**
17	Waste Copper Sulfate (W-CuSO4), up to 15%	17	32	7758-99-8	65,700	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		17	33	7732-18-5	65,700	1.04E-03	9.09			0%	N/A	N/A	N/A	**0.00**	**0.00**
18	Waste Dilute Sulfuric Peroxide (W-DSP), 9% H2SO4	18	34	7664-93-9	328,500	5.75E-10	5.03E-06	WWT	WWT Acid Exhaust	75%	1.44E-10	1.26E-06	6.29E-10	**0.00**	**0.00**
		18	35	7722-84-1	328,500	2.11E-04	1.85			0%	2.11E-04	1.85	9.25E-04	**0.00**	**0.00**
		18	36	7732-18-5	328,500	4.19E-03	36.7			0%	N/A	N/A	N/A	**0.00**	**0.00**
19	Waste Concentrated IPA (W-IPA)	19	37	67-63-0	4,781,500	0.48	4,232.87	Outdoors	Fab Solvent Exhaust	97%	0.01	127.0	0.06	**0.06**	**0.00**
		19	38	7732-18-5	4,781,500	0.00	0.00			0%	N/A	N/A	N/A	**0.00**	**0.00**

Table 23-2. Working Loss Tank Emissions

Tank S/N	Chemical Product	Raw Material Index	Raw Material Chemical Index	CAS #	Chemical	Chemical wt% in Raw Material	Molecular Weight (lb/lbmol)	Vapor Pressure (psia)	lbmol of Chemical per lb Raw Material (Wt%i/Mwi)	Mol%	VOC/HAP?	Vapor Partial Pressure[1] pp (psia)	Vapor Mol. % y = pp/TP (mol%)	Partial Vapor Molecular Weight MWi x Vap.Mol%i (lb/lbmol)	Vapor Molecular Weight M_v (lb/lbmol)	Vapor Density W_v (lb/gal)	Vapor Wt.%	Tank Count	Single Tank Capacity (gal)	Total Tank Capacity (gal)	Daily Total Tank Throughput (gal/day)	Annual Turnovers N	K_N	Hourly Filling Rate (per tank) V_Q (hourly) (gal/hr)
20	Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	20	39	108-65-6	Propylene Glycol Methyl Ether Acetate	99.7%	132.2	0.10	7.54E-03	99.7%	VOC	0.10	99.54%	131.55	132.16	2.98E-04	99.5%	24	12,000	288,000	9,460	12	1.00	394
		20	40	[redacted]														24	12,000	288,000	9,460	12	1.00	394
21	Waste Photo Solvent 2 (W-PS2) - Photoresist	21	41	108-65-6	Propylene Glycol Methyl Ether Acetate	99.7%	132.2	0.10	7.54E-03	99.7%	VOC	0.10	99.54%	131.55	132.16	2.98E-04	99.5%	12	7,000	84,000	760	3	1.00	32
		21	42	[redacted]														12	7,000	84,000	760	3	1.00	32
WWT Building Storage																								
22	Sodium Hydroxide 50%	22	43	1310-73-2	Sodium Hydroxide	50.0%	40.0	0.00	0.01	31.1%		0.00	0.00%	0.00	18.0	9.73E-05	0.00%	10	21,000	210,000	1,140	2	1.00	2,500
		22	44	7732-18-5	Water	50.0%	18.0	0.34	0.03	68.9%		0.23	100.00%	18.0	18.0	9.73E-05	100.0%	10	21,000	210,000	1,140	2	1.00	2,500
23	Hydrochloric Acid, 36%	23	45	7647-01-0	Hydrochloric Acid	36.0%	36.5	1.32	9.87E-03	21.8%	HAP	0.29	52.05%	19.0	27.6	3.53E-04	68.7%	4	10,000	40,000	2,260	21	1.00	2,500
		23	46	7732-18-5	Water	64.0%	18.0	0.34	0.04	78.2%		0.27	47.95%	8.64	27.6	3.53E-04	31.29%	4	10,000	40,000	2,260	21	1.00	2,500
24	Sodium Hypochlorite, 12%	24	47	7681-52-9	Sodium Hypochlorite	12.5%	74.4	0.31	1.68E-03	3.4%		0.01	3.24%	2.41	19.8	1.51E-04	12.14%	4	8,000	32,000	1,370	16	1.00	2,500
		24	48	1310-73-2	Sodium Hydroxide	5.0%	40.0	0.00	1.25E-03	2.6%		0.00	0.00%	0.00	19.8	1.51E-04	0.00%	4	8,000	32,000	1,370	16	1.00	2,500
		24	49	7732-18-5	Water	82.5%	18.0	0.34	0.05	94.0%		0.32	96.76%	17.4	19.8	1.51E-04	87.9%	4	8,000	32,000	1,370	16	1.00	2,500
25	Sodium Bisulfite	25	50	7631-90-5	Sodium Bisulfite	60.0%	104.1	0.00	5.77E-03	20.6%		0.00	0.00%	0.00	18.0	1.12E-04	0.00%	4	5,000	20,000	100	2	1.00	2,500
		25	51	7732-18-5	Water	40.0%	18.0	0.34	0.02	79.4%		0.27	100.00%	18.0	18.0	1.12E-04	100.0%	4	5,000	20,000	100	2	1.00	2,500
26	Calcium Chloride 35%	26	52	10043-52-4	Calcium Chloride	35.0%	111.0	0.00	3.15E-03	8.04%		0.00	0.00%	0.00	18.0	1.30E-04	0.00%	8	16,000	128,000	19,033	54	0.72	2,500
		26	53	7732-18-5	Water	65.0%	18.0	0.34	0.04	92.0%		0.31	100.00%	18.0	18.0	1.30E-04	100.0%	8	16,000	128,000	19,033	54	0.72	2,500
27	Aluminium Sulfate, 8%	27	54	10043-01-3	Aluminum Sulfate	8.00%	342.2	0.00	2.34E-04	0.46%		0.00	0.00%	0.00	18.0	1.40E-04	0.00%	4	16,000	64,000	1,264	7	1.00	2,500
		27	55	7732-18-5	Water	92.0%	18.0	0.34	0.05	99.54%		0.34	100.00%	18.0	18.0	1.40E-04	100.00%	4	16,000	64,000	1,264	7	1.00	2,500
28	Aluminium Chlorohydrate, 23%	28	56	12359-72-7	Aluminum Chlorohydrate	23.0%	210.5	0.00	1.09E-03	2.5%		0.00	0.00%	0.00	18.0	1.38E-04	0.0%	4	5,300	21,200	1,159	20	1.00	2,500
		28	57	7732-18-5	Water	77.0%	18.0	0.34	0.04	97.51%		0.33	100.00%	18.0	18.0	1.38E-04	100.00%	4	5,300	21,200	1,159	20	1.00	2,500
29	Catalase	29	58	9001-05-2	Catalase	100.0%	166.2	0.00	6.02E-03	100.0%	VOC	0.00	0.00%	0.00	0.00	0.00	0.0%	4	2,600	10,400	480	17	1.00	2,500
		29	59	7732-18-5	Water	0.0%	18.0	0.34	0.00	0.0%		0.00	0.00%	0.00	0.00	0.00	0.0%	4	2,600	10,400	480	17	1.00	2,500
30	Sulfuric acid	30	60	7664-93-9	Sulfuric Acid	93.0%	98.1	3.25E-07	9.48E-03	70.9%		2.30E-07	0.00%	2.29E-04	18.0	4.10E-05	0.0%	4	15,000	60,000	15,490	94	0.49	2,500
		30	61	7732-18-5	Water	7.0%	18.0	0.34	3.88E-03	29.06%		0.10	100.00%	18.0	18.0	4.10E-05	100.00%	4	15,000	60,000	15,490	94	0.49	2,500
31	FeCl3	31	62	7705-08-0	Ferric Chloride	40.0%	162.2	0.00	2.47E-03	6.9%		0.00	0.00%	0.00	18.0	1.31E-04	0.0%	4	16,500	66,000	1,800	10	1.00	2,500
		31	63	7732-18-5	Water	60.0%	18.0	0.34	0.03	93.1%		0.32	100.00%	18.0	18.0	1.31E-04	100.0%	4	16,500	66,000	1,800	10	1.00	2,500
BIO Building Storage																								
32	Sodium Hydroxide 50%	32	64	1310-73-2	Sodium Hydroxide	50.0%	40.0	0.00	0.01	31.1%		0.00	0.00%	0.00	18.0	9.73E-05	0.00%	2	18,000	36,000	2,769	28	1.00	2,500
		32	65	7732-18-5	Water	50.0%	18.0	0.34	0.03	68.9%		0.23	100.00%	18.0	18.0	9.73E-05	100.0%	2	18,000	36,000	2,769	28	1.00	2,500
33	Sulfuric Acid, 70%	33	66	7664-93-9	Sulfuric Acid	70.0%	98.1	3.25E-07	7.14E-03	30.0%		9.75E-08	0.00%	4.03E-05	18.0	9.88E-05	0.0%	4	6,500	26,000	42	1	1.00	2,500
		33	67	7732-18-5	Water	30.0%	18.0	0.34	0.02	70.0%		0.24	100.00%	18.0	18.0	9.88E-05	100.00%	4	6,500	26,000	42	1	1.00	2,500
34	Sodium Bisulfite, 25%	34	68	7631-90-5	Sodium Bisulfite	25.0%	104.1	0.00	2.40E-03	5.5%		0.00	0.00%	0.00	18.0	1.33E-04	0.00%	2	10,000	20,000	28	1	1.00	2,500
		34	69	7732-18-5	Water	75.0%	18.0	0.34	0.04	94.5%		0.32	100.00%	18.0	18.0	1.33E-04	100.0%	2	10,000	20,000	28	1	1.00	2,500
35	Phosphoric Acid, 85%	35	70	7664-38-2	Phosphoric Acid (Orthophosphoric Acid)	85.0%	98.0	5.80E-04	8.67E-03	51.03%		2.96E-04	0.18%	0.17	18.2	6.98E-05	0.96%	4	10,000	40,000	200	2	1.00	2,500
		35	71	7732-18-5	Water	15.0%	18.0	0.34	8.32E-03	49.0%		0.17	99.82%	18.0	18.2	6.98E-05	99.0%	4	10,000	40,000	200	2	1.00	2,500
36	Citric Acid, 50%	36	72	77-92-9	Citric Acid	50.0%	192.1	3.21E-10	2.60E-03	8.6%	VOC	2.75E-11	0.00%	0.00	18.0	1.29E-04	0.00%	2	5,000	10,000	73	3	1.00	2,500
		36	73	7732-18-5	Water	50.0%	18.0	0.34	0.03	91.4%		0.31	100.00%	18.0	18.0	1.29E-04	100.0%	2	5,000	10,000	73	3	1.00	2,500
37	Sodium Hypochlorite, 12%	37	74	7681-52-9	Sodium Hypochlorite	12.5%	74.4	0.31	1.68E-03	3.4%		0.01	3.24%	2.41	19.8	1.51E-04	12.1%	2	20,000	40,000	2,000	18	1.00	2,500
		37	75	1310-73-2	Sodium hydroxide	5.0%	40.0	0.00	1.25E-03	2.6%		0.00	0.00%	0.00	19.8	1.51E-04	0.0%	2	20,000	40,000	2,000	18	1.00	2,500
		37	76	7732-18-5	Water	82.5%	18.0	0.34	0.05	93.99%		0.32	96.76%	17.4	19.8	1.51E-04	87.86%	2	20,000	40,000	2,000	18	1.00	2,500
CUB Building Storage																								
38	Sodium Hypochlorite, 12%	38	77	7681-52-9	Sodium Hypochlorite	12.5%	74.4	0.31	1.68E-03	3.4%		0.01	3.24%	2.41	19.8	1.51E-04	12.14%	2	7,000	14,000	57	1	1.00	2,500
		38	78	1310-73-2	Sodium Hydroxide	5.0%	40.0	0.00	1.25E-03	2.6%		0.00	0.00%	0.00	19.8	1.51E-04	0.0%	2	7,000	14,000	57	1	1.00	2,500
		38	79	7732-18-5	Water	82.50%	18.0	0.34	0.05	94.0%		0.32	96.76%	17.4	19.8	1.51E-04	87.9%	2	7,000	14,000	57	1	1.00	2,500
39	Sulfuric Acid, 70%	39	80	7664-93-9	Sulfuric Acid	70.0%	98.1	3.25E-07	7.14E-03	30.0%		9.75E-08	0.00%	4.03E-05	18.0	9.88E-05	0.0%	2	4,000	8,000	286	13	1.00	2,500
		39	81	7732-18-5	Water	30.0%	18.0	0.34	0.02	70.0%		0.24	100.00%	18.0	18.0	9.88E-05	100.00%	2	4,000	8,000	286	13	1.00	2,500
40	Biocide (NALCO 77352NA)	40	82	10377-60-3	Magnesium Nitrate	5.0%	148.3	9.47E-03	3.37E-04	0.7%		6.37E-05	0.02%	0.03	18.0	1.39E-04	0.16%	2	2,000	4,000	96	9	1.00	2,500
		40	83	2682-20-4	2-Methyl-4-Isothiazolin-3-one	1.0%	115.2	1.20E-03	8.68E-05	0.2%	VOC	2.08E-06	0.00%	7.15E-04	18.0	1.39E-04	0.00%	2	2,000	4,000	96	9	1.00	2,500
		40	84	26172-55-4	5-Chloro-2-Methyl-4-Isothiazolin-3-one	5.0%	149.6	3.48E-04	3.34E-04	0.7%	VOC	2.32E-06	0.00%	1.04E-03	18.0	1.39E-04	0.01%	2	2,000	4,000	96	9	1.00	2,500
		40	85	7732-18-5	Water	89.0%	18.0	0.34	0.05	98.5%		0.33	99.98%	18.0	18.0	1.39E-04	99.8%	2	2,000	4,000	96	9	1.00	2,500
41	Corrosion Inhibitor	41	86	[redacted]														2	2,000	4,000	188	17	1.00	2,500
		41	87	29329-71-3	Phosphonic acid, (1-hydroxyethylidene)bis-, sodium salt	5.0%	228.0	0.00	2.19E-04	0.5%	VOC	0.00	0.00%	0.00	18.0	1.39E-04	0.00%	2	2,000	4,000	188	17	1.00	2,500
		41	88	7732-18-5	Water	85.0%	18.0	0.34	0.05	98.8%		0.34	100.00%	18.0	18.0	1.39E-04	100.0%	2	2,000	4,000	188	17	1.00	2,500
42	Antiscalant and Biocide (NALCO Trasar Trac101)	42	89	7632-00-0	Sodium Nitrite	30.0%	69.0	0.00	4.35E-03	10.84%		0.00	0.00%	0.00	18.0	1.25E-04	0.00%	2	2,000	4,000	11	1	1.00	2,500
		42	90	7631-95-0	Sodium Molybdate	5.0%	205.9	0.00	2.43E-04	0.61%		0.00	0.00%	0.00	18.0	1.25E-04	0.00%	2	2,000	4,000	11	1	1.00	2,500
		42	91	[redacted]																				
		42	92	7732-18-5	Water	64.0%	18.0	0.34	0.04	88.6%		0.30	100.00%	18.0	18.0	1.25E-04	100.0%	2	2,000	4,000	11	1	1.00	2,500
Diesel Storage																								
43	ULSD Storage Tank	43	93	68334-30-5	Ultra-Low Sulfur Diesel	100.0%	130.0	6.00E-03	7.69E-03	100.0%	VOC	6.00E-03	100.00%	130.00	130.00	1.80E-05	100.00%	8	25,000	200,000	1,998	4	1.00	2,500

1. Note that partial pressures of HF, HCl, HNO_3, and H_2SO_4 solutions based on tank composition were taken directly from reference as opposed to calculating from vapor pressure data of pure solute.

Table 23-3. Breathing Losses Outdoor Tank Emissions

Tank ID	Product/Purpose	Total Tank Count - Fab 1 & Fab 2	Single Tank Capacity (gal)	Single Tank Capacity (ft3)	Tank Diameter (ft)	Tank Height (ft)	Total Annual Throughput (gal/yr)	Total Breathing Emissions IPA (lb/yr)	PGMEA (lb/yr)	ULSD (lb/yr)
19	Waste Concentrated IPA (W-IPA)	24	12,000	1,604	12	14.2	4,781,500	826	0.0	0
20	Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	24	12,000	1,604	12	14.2	3,452,900	0.0	23.5	0
21	Waste Photo Solvent 2 (W-PS2) - Photoresist	12	7,000	936	10	11.9	277,400	0.0	6.8	0
43	ULSD Storage Tank	8	25,000	3,342	25	6.8	729,343	0.0	0.0	2.35
							TOTAL	**825.7**	**30.3**	**2.35**

Conversions

1 year = 8,760

Tank Volume = $n*(D/2)^2*H$ hr

Table 23-2. Working Loss Tank Emissions

Tank S/N	Chemical Product	Raw Material Index	Raw Material Chemical Index	CAS #	Total Tank Annual Throughput	Max Emission Rate (per tank)	Pre-Control Total Tank Emissions	Tank Building	Exhaust Stack	Control Efficiency	Total Tank Emissions			Annual VOC Emissions	Annual HAP Emissions
					V_Q (annual)	L_W (hourly)	L_W (annual)				(lb/hr)	(lb/yr)	(tpy)	(tpy)	(tpy)
					(gal/yr)	(lb/hr)	(lb/yr)								
20	Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	20	39	108-65-6	3,452,900	0.12	1,025.54	Outdoors	Fab Solvent Exhaust	97%	3.51E-03	30.8	0.02	**0.02**	**0.00**
		20	40	[redacted]											
21	Waste Photo Solvent 2 (W-PS2) - Photoresist	21	41	108-65-6	277,400	9.41E-03	82.4	Outdoors	Fab Solvent Exhaust	97%	2.82E-04	2.47	1.24E-03	**1.24E-03**	**0.00**
		21	42	[redacted]											
WWT Building Storage															
22	Sodium Hydroxide 50%	22	43	1310-73-2	416,100	0.00	0.00	WWT	WWT Ammonia Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		22	44	7732-18-5	416,100	0.24	40.5			0%	N/A	N/A	N/A	**0.00**	**0.00**
23	Hydrochloric Acid, 36%	23	45	7647-01-0	824,900	0.61	200.0	WWT	WWT Acid Exhaust	98%	0.01	4.00	2.00E-03	**0.00**	**2.00E-03**
		23	46	7732-18-5	824,900	0.28	91.1			0%	N/A	N/A	N/A	**0.00**	**0.00**
24	Sodium Hypochlorite, 12%	24	47	7681-52-9	500,050	0.05	9.16	WWT	WWT Ammonia Exhaust	0%	0.05	9.16	4.58E-03	**0.00**	**0.00**
		24	48	1310-73-2	500,050	0.00	0.00			0%	0.00	0.00	0.00	**0.00**	**0.00**
		24	49	7732-18-5	500,050	0.33	66.3			0%	N/A	N/A	N/A	**0.00**	**0.00**
25	Sodium Bisulfite	25	50	7631-90-5	36,500	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		25	51	7732-18-5	36,500	0.28	4.09			0%	N/A	N/A	N/A	**0.00**	**0.00**
26	Calcium Chloride 35%	26	52	10043-52-4	6,947,045	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		26	53	7732-18-5	6,947,045	0.23	648.6			0%	N/A	N/A	N/A	**0.00**	**0.00**
27	Aluminium Sulfate, 8%	27	54	10043-01-3	461,360	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		27	55	7732-18-5	461,360	0.35	64.8			0%	N/A	N/A	N/A	**0.00**	**0.00**
28	Aluminium Chlorohydrate, 23%	28	56	12359-72-7	423,035	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		28	57	7732-18-5	423,035	0.34	58.2			0%	N/A	N/A	N/A	**0.00**	**0.00**
29	Catalase	29	58	9001-05-2	175,200	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		29	59	7732-18-5	175,200	0.00	0.00			0%	N/A	N/A	N/A	**0.00**	**0.00**
30	Sulfuric acid	30	60	7664-93-9	5,653,850	6.33E-07	1.43E-03	WWT	WWT Acid Exhaust	75%	1.58E-07	3.58E-04	1.79E-07	**0.00**	**0.00**
		30	61	7732-18-5	5,653,850	0.05	112.5			0%	N/A	N/A	N/A	**0.00**	**0.00**
31	FeCl3	31	62	7705-08-0	657,000	0.00	0.00	WWT	WWT Acid Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		31	63	7732-18-5	657,000	0.33	86.3			0%	N/A	N/A	N/A	**0.00**	**0.00**
BIO Building Storage															
32	Sodium Hydroxide 50%	32	64	1310-73-2	1,010,685	0.00	0.00	BIO	General Exhaust	0%	0.00	0.00	0.00	**0.00**	**0.00**
		32	65	7732-18-5	1,010,685	0.24	98.3			0%	N/A	N/A	N/A	**0.00**	**0.00**
33	Sulfuric Acid, 70%	33	66	7664-93-9	15,330	5.52E-07	3.38E-06	BIO	General Exhaust	0%	5.52E-07	3.38E-06	1.69E-09	**0.00**	**0.00**
		33	67	7732-18-5	15,330	0.25	1.51			0%	N/A	N/A	N/A	**0.00**	**0.00**
34	Sodium Bisulfite, 25%	34	68	7631-90-5	10,220	0.00	0.00	BIO	Atmosphere Venting	0%	0.00	0.00	0.00	**0.00**	**0.00**
		34	69	7732-18-5	10,220	0.33	1.36			0%	N/A	N/A	N/A	**0.00**	**0.00**
35	Phosphoric Acid, 85%	35	70	7664-38-2	73,000	1.67E-03	0.05	BIO	Atmosphere Venting	0%	1.67E-03	0.05	2.44E-05	**0.00**	**0.00**
		35	71	7732-18-5	73,000	0.17	5.05			0%	N/A	N/A	N/A	**0.00**	**0.00**
36	Citric Acid, 50%	36	72	77-92-9	26,645	3.05E-10	3.25E-09	BIO	Atmosphere Venting	0%	3.05E-10	3.25E-09	1.63E-12	**1.63E-12**	**0.00**
		36	73	7732-18-5	26,645	0.32	3.44			0%	N/A	N/A	N/A	**0.00**	**0.00**
37	Sodium Hypochlorite, 12%	37	74	7681-52-9	730,000	0.05	13.4	BIO	Atmosphere Venting	0%	0.05	13.4	6.69E-03	**0.00**	**0.00**
		37	75	1310-73-2	730,000	0.00	0.00			0%	0.00	0.00	0.00	**0.00**	**0.00**
		37	76	7732-18-5	730,000	0.33	96.8			0%	N/A	N/A	N/A	**0.00**	**0.00**
CUB Building Storage															
38	Sodium Hypochlorite, 12%	38	77	7681-52-9	20,805	0.05	0.38	CUB	Atmosphere Venting	0%	0.05	0.38	1.91E-04	**0.00**	**0.00**
		38	78	1310-73-2	20,805	0.00	0.00			0%	0.00	0.00	0.00	**0.00**	**0.00**
		38	79	7732-18-5	20,805	0.33	2.76			0%	N/A	N/A	N/A	**0.00**	**0.00**
39	Sulfuric Acid, 70%	39	80	7664-93-9	104,390	5.52E-07	2.30E-05	CUB	CUB Acid Exhaust	98%	1.10E-08	4.61E-07	2.30E-10	**0.00**	**0.00**
		39	81	7732-18-5	104,390	0.25	10.3			0%	N/A	N/A	N/A	**0.00**	**0.00**
40	Biocide (NALCO 77352NA)	40	82	10377-60-3	35,040	5.45E-04	7.64E-03	CUB	Atmosphere Venting	0%	5.45E-04	7.64E-03	3.82E-06	**0.00**	**0.00**
		40	83	2682-20-4	35,040	1.38E-05	1.93E-04			0%	1.38E-05	1.93E-04	9.67E-08	**9.67E-08**	**0.00**
		40	84	26172-55-4	35,040	2.00E-05	2.81E-04			0%	2.00E-05	2.81E-04	1.40E-07	**1.40E-07**	**0.00**
		40	85	[redacted]						0%	N/A	N/A	N/A	**0.00**	**0.00**
41	Corrosion Inhibitor	41	86	[redacted]											
		41	87	29329-71-3	68,620	0.00	0.00	CUB	Atmosphere Venting	0%	0.00	0.00	0.00	**0.00**	**0.00**
		41	88	7732-18-5	68,620	0.35	9.56			0%	N/A	N/A	N/A	**0.00**	**0.00**
42	Antiscalant and Biocide (NALCO Trasar Trac101)	42	89	7632-00-0	4,015	0.00	0.00	CUB	Atmosphere Venting	0%	0.00	0.00	0.00	**0.00**	**0.00**
		42	90	7631-95-0	4,015	0.00	0.00			0%	0.00	0.00	0.00	**0.00**	**0.00**
		42	91	Proprietary1											
		42	92	7732-18-5	4,015	0.31	0.50			0%	N/A	N/A	N/A	**0.00**	**0.00**
Diesel Storage															
43	ULSD Storage Tank	43	93	68334-30-5	729,270	0.05	13.1	Outdoors	Atmosphere Venting	0%	0.05	13.1	6.57E-03	**6.57E-03**	**0.00**
													Total	**0.37**	**2.06E-03**

1. Note that partial pressures of HF, HCl, HNO_3, and H_2SO_4 solutions based on tank composition were taken directly from reference as

Table 23-3. Breathing Losses Outdoor Tank Emissions

Tank ID	Product/Purpose	Total Tank Count - Fab 1 & Fab 2	Single Tank Capacity	Single Tank Capacity
			(gal)	(ft3)
19	Waste Concentrated IPA (W-IPA)	24	12,000	1,604
20	Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	24	12,000	1,604
21	Waste Photo Solvent 2 (W-PS2) - Photoresist	12	7,000	936
43	ULSD Storage Tank	8	25,000	3,342

Conversions

1 year = 8,760

Tank Volume = $\pi*(D/2)^2*H$ hr

Micron - Clay, NY Fabs 1 & 2
1-WWBIO and 2-WWBIO
Storage Silo Particulate Emissions

Table 24-1. Lime Storage Silo Inventory

Silo Contents	Silo Count	Silo Capacity (tons)	Throughput per Silo (ton/day)	Control Efficiency[1]
Lime (Calcium Oxide)	4	111.4	34.2	99.5%

1. Control efficiency assumes 100% particulate capture and 98% filter efficiency.

Table 24-2. Lime Storage Silo Particulate Emissions

Pollutant	Emission Factor[1,2] (lb/ton material processed)	Potential to Emit (Per Silo) (lb/hr)	Potential to Emit (Per Silo) (tpy)	Potential to Emit (All Silos) (lb/hr)	Potential to Emit (All Silos) (tpy)
PM (Total)	0.61	4.35E-03	0.02	0.02	0.08
PM_{10}	0.61	4.35E-03	0.02	0.02	0.08
$PM_{2.5}$	0.61	4.35E-03	0.02	0.02	0.08

1. Emission factor from AP-42 Section 11.17 - Lime Manufacturing,Table 11.17-4 for product loading to an enclosed truck used as a representative uncontrolled emission factor from lime silos at NY1 & NY2.

2. Conservatively assumes $PM_{2.5}$ = PM_{10} = PM (Total).

Conversions

1 year =	8,760 hr
1 year =	365 days
1 ton =	2,000 lbs
1 day =	24 hr

Micron - Clay, NY Fabs 1 & 2
Greenhouse Gas Global Warming Potentials

Table 25-1: Greenhouse Gas Global Warming Potentials

CAS	GHG Name	HFC/PFC Number	Molecular Formula	GWP (20-yr)	GWP (100-yr)
124-38-9	Carbon dioxide	--	CO2	1	1
74-82-8	Methane	--	CH4	84	28
10024-97-2	Nitrous oxide	--	N2O	264	265
75-10-5	Difluoromethane	HFC-32	CH2F2	2,430	677
593-53-3	Fluoromethane	HFC-41	CH3F	427	116
75-73-0	Tetrafluoromethane	PFC-14	CF4	4,880	6,630
76-16-4	Hexafluoroethane	PFC-116	C2F6	8,210	11,100
75-46-7	Trifluoromethane	HFC-23	CHF3	10,800	12,400
115-25-3	Octafluorocyclobutane	PFC-318	C4F8	7,110	9,540
685-63-2	Hexafluorobutadiene	--	C4F6	1	1
7783-54-2	Nitrogen trifluoride	--	NF3	12,800	16,100
2551-62-4	Sulfur hexafluoride	--	SF6	17,500	23,500
[redacted]					

Table 25-2: 2024 Upstream Natural Gas CO2e Emission Factors

40,877	g/MMBtu
90.12	lb/MMBtu

Table 25-3: 2024 Upstream Diesel CO2e Emission Factors

23,540	g/MMBtu
51.90	lb/MMBtu

Micron - Clay, NY Fabs 1 & 2
1-FUGEM and 2-FUGEM
Roadway Emission Calculations

Table 26-1: Roadway Emission Calculations

Material Hauled	Estimated Round Trip Distance Traveled	Silt Loading[1]	Estimated Truck Weight When Empty	Material Phase	Specific Gravity[2]	Liquid Density[3]	Estimated Load Weight	Truck Weight Loaded	Avg. Empty & Loaded Weight	Material Throughput		Pickup / Delivery Trips	Total Mileage	TSP $EF^{4,5,6}$	PM_{10} $EF^{4,5,6}$	$PM_{2.5}$ $EF^{4,5,6}$	TSP Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions
	(mi)	(g/m^2)	(Tons)			(g/cm^3)	(Tons)	(Tons)	(Tons)	(Tons/yr)	(gal/yr)	(#/yr)	(Mi/yr)	lb/VMT	lb/VMT	lb/VMT	(Ton/yr)	(Ton/yr)	(Ton/yr)
Solid Chemicals to WWT																			
Lime (Calcium hydroxide) to WWT1	0.5	1.5	20	Solid			5	25	22.5	6250		1250	606	0.34	0.07	0.02	0.10	0.02	5.01E-03
Lime (Calcium hydroxide) to WWT2	1.7	1.5	20	Solid			5	25	22.5	6250		1250	2069	0.34	0.07	0.02	0.35	0.07	0.02
Process Bulk Chemicals to HPM1 North																			
Hydrogen Peroxide 31%	1.5	1.5	20	Liquid		1.13	23.63	43.63	31.81		2,275,593	455	689.6	0.48	0.10	0.02	0.17	0.03	8.11E-03
Sulfuric Acid 96%	1.5	1.5	20	Liquid		1.84	38.29	58.29	39.15		1,326,958	265.4	402.1	0.59	0.12	0.03	0.12	0.02	5.84E-03
Hydrofluoric Acid 49%	1.5	1.5	20	Liquid		1.20	24.99	44.99	32.50		727,263	145.5	220.4	0.49	0.10	0.02	0.05	0.01	2.65E-03
Hydrofluoric Acid 100:1	1.5	1.5	20	Liquid		1.02	21.28	41.28	30.64		2,190,000	438.0	663.6	0.46	0.09	0.02	0.15	0.03	7.51E-03
Aqueous Ammonia 29%	1.5	1.5	20	Liquid		0.89	18.61	38.61	29.30		385,805	77.2	116.9	0.44	0.09	0.02	0.03	5.15E-03	1.26E-03
Tetramethyl Ammonium Hydroxide (TMAH) 25%	1.5	1.5	20	Liquid		1.02	21.20	41.20	30.60		291,453	58.3	88.3	0.46	0.09	0.02	0.02	4.07E-03	9.98E-04
[redacted]	1.5	1.5	20	Liquid		1.02	21.20	41.20	30.60		1,045,725	209.1	316.9	0.46	0.09	0.02	0.07	0.01	3.58E-03
Isopropyl Alcohol	1.5	1.5	20	Liquid	0.79		16.46	36.46	28.23		1,682,468	336.5	509.8	0.42	0.08	0.02	0.11	0.02	5.31E-03
Propylene Glycol Methyl Ether Acetate	1.5	1.5	20	Liquid		0.97	20.24	40.24	30.12		375,950	75.2	113.9	0.45	0.09	0.02	0.03	5.16E-03	1.27E-03
Argon	1.5	1.5	23.5	Gas	1.38		5.28	28.78	26.14	1216		230.5	349.2	0.39	0.08	0.02	0.07	0.01	3.36E-03
Hydrogen chloride	1.5	1.5	23.5	Gas	1.27		4.85	28.35	25.93	4.5		0.9	1.4	0.39	0.08	0.02	2.72E-04	5.43E-05	1.33E-05
Ammonia	1.5	1.5	23.5	Gas	0.60		2.28	25.78	24.64	55.7		24.4	36.9	0.37	0.07	0.02	6.82E-03	1.36E-03	3.35E-04
Carbon dioxide	1.5	1.5	23.5	Gas	1.53		5.85	29.35	26.43	505		86.3	130.7	0.40	0.08	0.02	0.03	5.18E-03	1.27E-03
Nitrogen trifluoride	1.5	1.5	23.5	Gas	2.46		9.41	32.91	28.20	141		15.0	22.8	0.42	0.08	0.02	4.82E-03	9.65E-04	2.37E-04
Nitrous oxide	1.5	1.5	23.5	Gas	1.53		5.85	29.35	26.43	197		33.6	50.9	0.40	0.08	0.02	0.01	2.02E-03	4.96E-04
Tetrafluoromethane	1.5	1.5	23.5	Gas	3.04		11.63	35.13	29.31	49.0		4.2	6.4	0.44	0.09	0.02	1.41E-03	2.81E-04	6.90E-05
Hydrogen	1.5	1.5	23.5	Gas	0.07		0.27	23.77	23.63	35.5		133.6	202.5	0.35	0.07	0.02	0.04	7.17E-03	1.76E-03
Helium	1.5	1.5	23.5	Gas	0.14		0.52	24.02	23.76	35.3		67.5	102.3	0.36	0.07	0.02	0.02	3.64E-03	8.94E-04
Silane	1.5	1.5	23.5	Gas	1.11		4.25	27.75	25.62	11.5		2.7	4.1	0.38	0.08	0.02	7.92E-04	1.58E-04	3.89E-05
Chlorine	1.5	1.5	23.5	Gas	2.49		9.52	33.02	28.26	9.9		1.0	1.6	0.42	0.08	0.02	3.34E-04	6.67E-05	1.64E-05
Process Bulk Chemicals to HPM1 South																			
Hydrogen Peroxide 31%	0.9	1.5	20	Liquid		1.13	23.63	43.63	31.81		2,275,593	455.1	415.5	0.48	0.10	0.02	0.10	0.02	4.89E-03
Sulfuric Acid 96%	0.9	1.5	20	Liquid		1.84	38.29	58.29	39.15		1,326,958	265.4	242.3	0.59	0.12	0.03	0.07	0.01	3.52E-03
Hydrofluoric Acid 49%	0.9	1.5	20	Liquid		1.20	24.99	44.99	32.50		727,263	145.5	132.8	0.49	0.10	0.02	0.03	6.50E-03	1.60E-03
Hydrofluoric Acid 100:1	0.9	1.5	20	Liquid		1.02	21.28	41.28	30.64		2,190,000	438.0	399.8	0.46	0.09	0.02	0.09	0.02	4.53E-03
Aqueous Ammonia 29%	0.9	1.5	20	Liquid		0.89	18.61	38.61	29.30		385,805	77.2	70.4	0.44	0.09	0.02	0.02	3.10E-03	7.62E-04
Tetramethyl Ammonium Hydroxide (TMAH) 25%	0.9	1.5	20	Liquid		1.02	21.20	41.20	30.60		291,453	58.3	53.2	0.46	0.09	0.02	0.01	2.45E-03	6.02E-04
[redacted]	0.9	1.5	20	Liquid		1.02	21.20	41.20	30.60		1,045,725	209.1	190.9	0.46	0.09	0.02	0.04	8.79E-03	2.16E-03
Isopropyl Alcohol	0.9	1.5	20	Liquid	0.79		16.46	36.46	28.23		1,682,468	336.5	307.2	0.42	0.08	0.02	0.07	0.01	3.20E-03
Propylene Glycol Methyl Ether Acetate	0.9	1.5	20	Liquid		0.97	20.24	40.24	30.12		375,950	75.2	68.6	0.45	0.09	0.02	0.02	3.11E-03	7.64E-04
Argon	0.9	1.5	23.5	Gas	1.38		5.28	28.78	26.14	1216		230.5	210.4	0.39	0.08	0.02	0.04	8.25E-03	2.03E-03
Hydrogen chloride	0.9	1.5	23.5	Gas	1.27		4.85	28.35	25.93	4		0.9	0.8	0.39	0.08	0.02	1.64E-04	3.27E-05	8.03E-06
Ammonia	0.9	1.5	23.5	Gas	0.60		2.28	25.78	24.64	56		24.4	22.3	0.37	0.07	0.02	4.11E-03	8.22E-04	2.02E-04
Carbon dioxide	0.9	1.5	23.5	Gas	1.53		5.85	29.35	26.43	505		86.3	78.8	0.40	0.08	0.02	0.02	3.12E-03	7.67E-04
Nitrogen trifluoride	0.9	1.5	23.5	Gas	2.46		9.41	32.91	28.20	141		15.0	13.7	0.42	0.08	0.02	2.91E-03	5.81E-04	1.43E-04
Nitrous oxide	0.9	1.5	23.5	Gas	1.53		5.85	29.35	26.43	197		33.6	30.7	0.40	0.08	0.02	6.08E-03	1.22E-03	2.99E-04
Tetrafluoromethane	0.9	1.5	23.5	Gas	3.04		11.63	35.13	29.31	49.0		4.2	3.8	0.44	0.09	0.02	8.47E-04	1.69E-04	4.16E-05
Hydrogen	0.9	1.5	23.5	Gas	0.07		0.27	23.77	23.63	35.5		133.6	122.0	0.35	0.07	0.02	0.02	4.32E-03	1.06E-03
Helium	0.9	1.5	23.5	Gas	0.14		0.52	24.02	23.76	35.3		67.5	61.6	0.36	0.07	0.02	0.01	2.19E-03	5.38E-04
Silane	0.9	1.5	23.5	Gas	1.11		4.25	27.75	25.62	11.5		2.7	2.5	0.38	0.08	0.02	4.77E-04	9.54E-05	2.34E-05
Chlorine	0.9	1.5	23.5	Gas	2.49		9.52	33.02	28.26	9.9		1.0	0.9	0.42	0.08	0.02	2.01E-04	4.02E-05	9.87E-06
Process Bulk Chemicals to HPM2 North																			
Hydrogen Peroxide 31%	1.6	1.5	20	Liquid		1.13	23.63	43.63	31.81		2,275,593	455.1	732.7	0.48	0.10	0.02	0.18	0.04	8.62E-03
Sulfuric Acid 96%	1.6	1.5	20	Liquid		1.84	38.29	58.29	39.15		1,326,958	265.4	427.2	0.59	0.12	0.03	0.13	0.03	6.21E-03
Hydrofluoric Acid 49%	1.6	1.5	20	Liquid		1.20	24.99	44.99	32.50		727,263	145.5	234.2	0.49	0.10	0.02	0.06	0.01	2.81E-03
Hydrofluoric Acid 100:1	1.6	1.5	20	Liquid		1.02	21.28	41.28	30.64		2,190,000	438.0	705.1	0.46	0.09	0.02	0.16	0.03	7.98E-03
Aqueous Ammonia 29%	1.6	1.5	20	Liquid		0.89	18.61	38.61	29.30		385,805	77.2	124.2	0.44	0.09	0.02	0.03	5.47E-03	1.34E-03
Tetramethyl Ammonium Hydroxide (TMAH) 25%	1.6	1.5	20	Liquid		1.02	21.20	41.20	30.60		291,453	58.3	93.8	0.46	0.09	0.02	0.02	4.32E-03	1.06E-03
[redacted]	1.6	1.5	20	Liquid		1.02	21.20	41.20	30.60		1,045,725	209.1	336.7	0.46	0.09	0.02	0.08	0.02	3.81E-03
Isopropyl Alcohol	1.6	1.5	20	Liquid	0.79		16.46	36.46	28.23		1,682,468	336.5	541.7	0.42	0.08	0.02	0.11	0.02	5.64E-03
Propylene Glycol Methyl Ether Acetate	1.6	1.5	20	Liquid		0.97	20.24	40.24	30.12		375,950	75.2	121.0	0.45	0.09	0.02	0.03	5.49E-03	1.35E-03
Argon	1.6	1.5	23.5	Gas	1.38		5.28	28.78	26.14	1216		230.5	366.6	0.39	0.08	0.02	0.07	0.01	3.53E-03
Hydrogen chloride	1.6	1.5	23.5	Gas	1.27		4.85	28.35	25.93	4		0.9	1.5	0.39	0.08	0.02	2.85E-04	5.70E-05	1.40E-05
Ammonia	1.6	1.5	23.5	Gas	0.60		2.28	25.78	24.64	56		24.4	38.8	0.37	0.07	0.02	7.16E-03	1.43E-03	3.52E-04
Carbon dioxide	1.6	1.5	23.5	Gas	1.53		5.85	29.35	26.43	505		86.3	137.2	0.40	0.08	0.02	0.03	5.44E-03	1.34E-03
Nitrogen trifluoride	1.6	1.5	23.5	Gas	2.46		9.41	32.91	28.20	141		15.0	23.9	0.42	0.08	0.02	5.06E-03	1.01E-03	2.49E-04
Nitrous oxide	1.6	1.5	23.5	Gas	1.53		5.85	29.35	26.43	197		33.6	53.5	0.40	0.08	0.02	0.01	2.12E-03	5.20E-04
Tetrafluoromethane	1.6	1.5	23.5	Gas	3.04		11.63	35.13	29.31	49		4.2	6.7	0.44	0.09	0.02	1.48E-03	2.95E-04	7.25E-05
Hydrogen	1.6	1.5	23.5	Gas	0.07		0.27	23.77	23.63	36		133.6	212.6	0.35	0.07	0.02	0.04	7.52E-03	1.85E-03
Helium	1.6	1.5	23.5	Gas	0.14		0.52	24.02	23.76	35		67.5	107.4	0.36	0.07	0.02	0.02	3.82E-03	9.38E-04
Silane	1.6	1.5	23.5	Gas	1.11		4.25	27.75	25.62	12		2.7	4.3	0.38	0.08	0.02	8.31E-04	1.66E-04	4.08E-05
Chlorine	1.6	1.5	23.5	Gas	2.49		9.52	33.02	28.26	10		1.0	1.6	0.42	0.08	0.02	3.50E-04	7.01E-05	1.72E-05

Table 26-1: Roadway Emission Calculations

Material Hauled	Estimated Round Trip Distance Traveled	Silt Loading[1]	Estimated Truck Weight When Empty	Material Phase	Specific Gravity[2]	Liquid Density[3]	Estimated Load Weight	Truck Weight Loaded	Avg. Empty & Loaded Weight	Material Throughput		Pickup / Delivery Trips	Total Mileage	TSP EF[4,5,6]	PM_{10} EF[4,5,6]	$PM_{2.5}$ EF[4,5,6]	TSP Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions
	(mi)	(g/m^2)	(Tons)			(g/cm^3)	(Tons)	(Tons)	(Tons)	(Tons/yr)	(gal/yr)	(#/yr)	(Mi/yr)	lb/VMT	lb/VMT	lb/VMT	(Ton/yr)	(Ton/yr)	(Ton/yr)
Process Bulk Chemicals to HPM2 South																			
Hydrogen Peroxide 31%	1.0	1.5	20	Liquid		1.13	23.63	43.63	31.81		2,275,593	455.1	458.6	0.48	0.10	0.02	0.11	0.02	5.39E-03
Sulfuric Acid 96%	1.0	1.5	20	Liquid		1.84	38.29	58.29	39.15		1,326,958	265.4	267.4	0.59	0.12	0.03	0.08	0.02	3.89E-03
Hydrofluoric Acid 49%	1.0	1.5	20	Liquid		1.20	24.99	44.99	32.50		727,263	145.5	146.6	0.49	0.10	0.02	0.04	7.18E-03	1.76E-03
Hydrofluoric Acid 100:1	1.0	1.5	20	Liquid		1.02	21.28	41.28	30.64		2,190,000	438.0	441.3	0.46	0.09	0.02	0.10	0.02	5.00E-03
Aqueous Ammonia 29%	1.0	1.5	20	Liquid		0.89	18.61	38.61	29.30		385,805	77.2	77.7	0.44	0.09	0.02	0.02	3.43E-03	8.41E-04
Tetramethyl Ammonium Hydroxide (TMAH) 25%	1.0	1.5	20	Liquid		1.02	21.20	41.20	30.60		291,453	58.3	58.7	0.46	0.09	0.02	0.01	2.70E-03	6.64E-04
[redacted]	1.0	1.5	20	Liquid		1.02	21.20	41.20	30.60		1,045,725	209.1	210.7	0.46	0.09	0.02	0.05	9.71E-03	2.38E-03
Isopropyl Alcohol	1.0	1.5	20	Liquid	0.79		16.46	36.46	28.23		1,682,468	336.5	339.0	0.42	0.08	0.02	0.07	0.01	3.53E-03
Propylene Glycol Methyl Ether Acetate	1.0	1.5	20	Liquid		0.97	20.24	40.24	30.12		375,950	75.2	75.8	0.45	0.09	0.02	0.02	3.43E-03	8.43E-04
Argon	1.0	1.5	23.5	Gas	1.38		5.28	28.78	26.14	1216		230.5	232.2	0.39	0.08	0.02	0.05	9.11E-03	2.24E-03
Hydrogen chloride	1.0	1.5	23.5	Gas	1.27		4.85	28.35	25.93	4		0.9	0.9	0.39	0.08	0.02	1.81E-04	3.61E-05	8.86E-06
Ammonia	1.0	1.5	23.5	Gas	0.60		2.28	25.78	24.64	56		24.4	24.6	0.37	0.07	0.02	4.54E-03	9.07E-04	2.23E-04
Carbon dioxide	1.0	1.5	23.5	Gas	1.53		5.85	29.35	26.43	505		86.3	86.9	0.40	0.08	0.02	0.02	3.45E-03	8.46E-04
Nitrogen trifluoride	1.0	1.5	23.5	Gas	2.46		9.41	32.91	28.20	141		15.0	15.1	0.42	0.08	0.02	3.21E-03	6.41E-04	1.57E-04
Nitrous oxide	1.0	1.5	23.5	Gas	1.53		5.85	29.35	26.43	197		33.6	33.9	0.40	0.08	0.02	6.71E-03	1.34E-03	3.30E-04
Tetrafluoromethane	1.0	1.5	23.5	Gas	3.04		11.63	35.13	29.31	49.0		4.2	4.2	0.44	0.09	0.02	9.35E-04	1.87E-04	4.59E-05
Hydrogen	1.0	1.5	23.5	Gas	0.07		0.27	23.77	23.63	35.5		133.6	134.7	0.35	0.07	0.02	0.02	4.77E-03	1.17E-03
Helium	1.0	1.5	23.5	Gas	0.14		0.52	24.02	23.76	35.3		67.5	68.0	0.36	0.07	0.02	0.01	2.42E-03	5.94E-04
Silane	1.0	1.5	23.5	Gas	1.11		4.25	27.75	25.62	11.5		2.7	2.7	0.38	0.08	0.02	5.26E-04	1.05E-04	2.58E-05
Chlorine	1.0	1.5	23.5	Gas	2.49		9.52	33.02	28.26	9.9		1.0	1.0	0.42	0.08	0.02	2.22E-04	4.44E-05	1.09E-05
Industrial Bulk Chemicals to WWT1																			
Industrial Grade Sulfuric Acid 96%	0.5	1.5	20	Liquid		1.87	39.07	59.07	39.54		2,826,940	565.4	274.1	0.60	0.12	0.03	0.08	0.02	4.02E-03
Ferric Chloride	0.5	1.5	20	Liquid		1.49	31.12	51.12	35.56		328,500	65.7	31.9	0.54	0.11	0.03	8.55E-03	1.71E-03	4.20E-04
Industrial Grade Sodium Hydroxide 50%	0.5	1.5	20	Liquid		1.53	31.82	51.82	35.91		208,050	41.6	20.2	0.54	0.11	0.03	5.47E-03	1.09E-03	2.69E-04
Hydrochloric Acid, 36%	0.5	1.5	20	Liquid		1.16	24.18	44.18	32.09		412,450	82.5	40.0	0.48	0.10	0.02	9.67E-03	1.93E-03	4.75E-04
Sodium Hypochlorite, 12%	0.5	1.5	20	Liquid		1.21	25.24	45.24	32.62		250,025	50.0	24.2	0.49	0.10	0.02	5.96E-03	1.19E-03	2.93E-04
Calcium Chloride 35%	0.5	1.5	20	Liquid		1.34	27.90	47.90	33.95		3,473,470	694.7	347.3	0.51	0.10	0.03	0.09	0.02	4.37E-03
Aluminium Sulfate, 8%	0.5	1.5	20	Liquid		1.34	27.90	47.90	33.95		230,680	46.1	22.4	0.51	0.10	0.03	5.73E-03	1.15E-03	2.81E-04
Catalase	0.5	1.5	20	Liquid	1.25		26.08	46.08	33.04		87,600	17.5	8.8	0.50	0.10	0.02	2.18E-03	4.36E-04	1.07E-04
Aluminium Chlorohydrate, 23%	0.5	1.5	20	Liquid		1.35	28.16	48.16	34.08		211,475	42.3	20.5	0.51	0.10	0.03	5.27E-03	1.05E-03	2.59E-04
Waste Materials from HPM1(N)/WWT1																			
Waste Sulfuric Acid (W-H2SO4), up to 98%	1.5	1.5	20	Liquid	1.84		38.31	58.31	39.15		2,025,750	405.2	613.9	0.59	0.12	0.03	0.18	0.04	8.92E-03
Waste Phosphoric Acid (W-H3PO4), up to 85%	0.5	1.5	20	Liquid		1.83	38.26	58.26	39.13		259,150	51.8	25.1	0.59	0.12	0.03	7.44E-03	1.49E-03	3.65E-04
Waste Concentrated HF (W-CHF), up to 49%	0.5	1.5	20	Liquid	1.20		24.99	44.99	32.50		1,719,150	343.8	166.7	0.49	0.10	0.02	0.04	8.16E-03	2.00E-03
Waste Nitric Acid (W-HNO3), up to 30%	0.5	1.5	20	Liquid		1.50	31.29	51.29	35.65		273,750	54.8	26.5	0.54	0.11	0.03	7.14E-03	1.43E-03	3.51E-04
Waste Dilute Sulfuric Peroxide (W-DSP), 9% H2SO4	0.5	1.5	20	Liquid	1.06		22.10	42.10	31.05		164,250	32.9	15.9	0.47	0.09	0.02	3.72E-03	7.45E-04	1.83E-04
Waste Concentrated IPA (W-IPA)	0.8	1.5	20	Liquid	0.79		16.46	36.46	28.23		2,390,750	478.2	366.9	0.42	0.08	0.02	0.08	0.02	3.82E-03
Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	0.8	1.5	20	Liquid		0.97	20.24	40.24	30.12		1,726,450	345.3	265.0	0.45	0.09	0.02	0.06	0.01	2.95E-03
Waste Photo Solvent 2 (W-PS2) - Photoresist	0.8	1.5	20	Liquid		0.97	20.24	40.24	30.12		138,700	27.7	21.3	0.45	0.09	0.02	4.82E-03	9.65E-04	2.37E-04
Industrial Bulk Chemicals to WWT2																			
Industrial Grade Sulfuric Acid 96%	1.7	1.5	20	Liquid		1.87	39.07	59.07	39.54		2,826,940	565.4	935.9	0.60	0.12	0.03	0.28	0.06	0.01
Ferric Chloride	1.7	1.5	20	Liquid		1.49	31.12	51.12	35.56		328,500	65.7	108.8	0.54	0.11	0.03	0.03	5.84E-03	1.43E-03
Industrial Grade Sodium Hydroxide 50%	1.7	1.5	20	Liquid		1.53	31.82	51.82	35.91		208,050	41.6	68.9	0.54	0.11	0.03	0.02	3.73E-03	9.17E-04
Hydrochloric Acid, 36%	1.7	1.5	20	Liquid		1.16	24.18	44.18	32.09		412,450	82.5	136.5	0.48	0.10	0.02	0.03	6.60E-03	1.62E-03
Sodium Hypochlorite, 12%	1.7	1.5	20	Liquid		1.21	25.24	45.24	32.62		250,025	50.0	82.8	0.49	0.10	0.02	0.02	4.07E-03	9.99E-04
Calcium Chloride 35%	1.7	1.5	20	Liquid		1.34	27.90	47.90	33.95		3,473,470	694.7	1149.9	0.51	0.10	0.03	0.29	0.06	0.01
Aluminium Sulfate, 8%	1.7	1.5	20	Liquid		1.34	27.90	47.90	33.95		230,680	46.1	76.4	0.51	0.10	0.03	0.02	3.91E-03	9.60E-04
Catalase	1.7	1.5	20	Liquid	1.25		26.08	46.08	33.04		87,600	17.5	29.0	0.50	0.10	0.02	7.22E-03	1.44E-03	3.55E-04
Aluminium Chlorohydrate, 23%	1.7	1.5	20	Liquid		1.35	28.16	48.16	34.08		211,475	42.3	70.0	0.51	0.10	0.03	0.02	3.60E-03	8.83E-04
Waste Materials from HPM2(N)/WWT2																			
Waste Sulfuric Acid (W-H2SO4), up to 98%	1.6	1.5	20	Liquid	1.84		38.31	58.31	39.15		2,025,750	405.2	652.2	0.59	0.12	0.03	0.19	0.04	9.48E-03
Waste Phosphoric Acid (W-H3PO4), up to 85%	1.7	1.5	20	Liquid		1.83	38.26	58.26	39.13		259,150	51.8	85.8	0.59	0.12	0.03	0.03	5.08E-03	1.25E-03
Waste Concentrated HF (W-CHF), up to 49%	1.7	1.5	20	Liquid	1.20		24.99	44.99	32.50		1,719,150	343.8	569.1	0.49	0.10	0.02	0.14	0.03	6.84E-03
Waste Nitric Acid (W-HNO3), up to 30%	1.7	1.5	20	Liquid		1.50	31.29	51.29	35.65		273,750	54.8	90.6	0.54	0.11	0.03	0.02	4.88E-03	1.20E-03
Waste Dilute Sulfuric Peroxide (W-DSP), 9% H2SO4	1.7	1.5	20	Liquid	1.06		22.10	42.10	31.05		164,250	32.9	54.4	0.47	0.09	0.02	0.01	2.54E-03	6.24E-04
Waste Concentrated IPA (W-IPA)	1.2	1.5	20	Liquid	0.79		16.46	36.46	28.23		2,390,750	478.2	573.8	0.42	0.08	0.02	0.12	0.02	5.97E-03
Waste Photo Solvent 1 (W-PS1) - Photoresist / PGMEA	1.2	1.5	20	Liquid		0.97	20.24	40.24	30.12		1,726,450	345.3	414.3	0.45	0.09	0.02	0.09	0.02	4.61E-03
Waste Photo Solvent 2 (W-PS2) - Photoresist	1.2	1.5	20	Liquid		0.97	20.24	40.24	30.12		138,700	27.7	33.3	0.45	0.09	0.02	7.54E-03	1.51E-03	3.70E-04
Industrial Bulk Chemicals to BIO 1																			
Sodium Hydroxide, 50%	2.5	1.5	20	Liquid		1.53	31.82	51.82	35.91		2,390,750	478.2	1215.3	0.54	0.11	0.03	0.33	0.07	0.02
Sodium Hypochlorite, 12%	2.5	1.5	20	Liquid		1.21	25.24	45.24	32.62		1,726,450	345.3	877.6	0.49	0.10	0.02	0.22	0.04	0.01
Industrial Bulk Chemicals to BIO 2																			
Sodium Hydroxide, 50%	2.5	1.5	20	Liquid		1.53	31.82	51.82	35.91		2,390,750	478.2	1215.3	0.54	0.11	0.03	0.33	0.07	0.02
Sodium Hypochlorite, 12%	2.5	1.5	20	Liquid		1.21	25.24	45.24	32.62		1,726,450	345.3	877.6	0.49	0.10	0.02	0.22	0.04	0.01
Diesel Storage																			
ULSD Storage Tank[8]	2.0	1.5	20	Liquid		0.85	17.73	37.73	28.87		729,270	145.9	291.7	0.43	0.09	0.02	0.06	0.01	3.11E-03
																Total (lb/yr)	**6.59**	**1.32**	**0.32**

Table 26-1: Roadway Emission Calculations

Material Hauled	Estimated Round Trip Distance Traveled	Silt Loading[1]	Estimated Truck Weight When Empty	Material Phase	Specific Gravity[2]	Liquid Density[3]	Estimated Load Weight	Truck Weight Loaded	Avg. Empty & Loaded Weight	Material Throughput		Pickup / Delivery Trips	Total Mileage	TSP $EF^{4,5,6}$	PM_{10} $EF^{4,5,6}$	$PM_{2.5}$ $EF^{4,5,6}$	TSP Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions
	(mi)	(g/m^2)	(Tons)			(g/cm^3)	(Tons)	(Tons)	(Tons)	(Tons/yr)	(gal/yr)	(#/yr)	(Mi/yr)	lb/VMT	lb/VMT	lb/VMT	(Ton/yr)	(Ton/yr)	(Ton/yr)

1. Silt loading values are from AP-42 Table 13.2.1-2. It is conservatively assumed that roads will have average daily traffic (ADT) of less than 500 vehicles, and that half the year is winter. The winter and non-winter factors were averaged, resulting in an average silt loading factor of 1.5 g/m^3.
2. Specific gravity and liquid density values for most materials are from Perry's Chemical Engineers' Handbook, Seventh Edition, Table 2-1 through Table 2-117. Specific gravities for liquid materials are relative to the denstity of water at STP, and for gaseous materials are relative to the density of air at STP. Specific gravities for nitrogen trifluoride, tetrafluoromethane, and silane are from Pubchem (https://pubchem.ncbi.nlm.nih.gov/)
3. Liquid density not available in Perry's are from Pubchem (https://pubchem.ncbi.nlm.nih.gov/) or SigmaAldrich (https://www.sigmaaldrich.com). Poly aluminum chloride relative density is from a representative SDS (https://nowchemwatercare.com.au/wp-content/uploads/2019/06/Poly-Aluminium-Chloride-23-SDS-July-2016.pdf).
4. Emissions based on AP-42 Section 13.2.1 (01/11), Equation (2).

$$E = [k * (sL)^{0.91} * (W)^{1.02}] * (1 - P/4N)$$

where

E = emission factor, lb/VMT
k = particle size multiplier
sL = road surface silt loading, g/m^2
W = average vehicle weight, tons
P = number of days with >= 0.01 in precipitation
N = number of days in the averaging period (365)

5. Particle Size Multiplier (k) values are from AP-42 Table 13.2.1-1.
6. Number of days with precipitation estimated from AP-42 Section 13.2.1 (01/11), Figure 13.2.1-2.
7. Transportation is modeled for liquid chemistries with total throughputs exceeding 150,000 gal/yr and selected gaseous chemistries, which are expected to represent the majority of truck traffic from material delivery/pickup.
8. The round trip distance travelled by diesel trucks for has been conservatively assumed to be 2 miles since the location of the tanks is uncertain.

Constants

Water Density =	8.345	lb/gal
Air Density =	0.0765	lb/ft^3 at STP
Liquid Delivery Tanker Volume =	5000	gal
Gas Delivery Tanker Volume =	100,000	ft^3
1 gallon =	3785	cm^3
1 mile =	5280	ft
k (PM-30) =	0.011	lb/VMT
k (PM-10) =	0.0022	lb/VMT
k (PM-2.5) =	0.00054	lb/VMT
P =	170	days

Micron - Clay, NY Fabs 1 & 2
1-FUGEM and 2-FUGEM
Sulfur Hexafluoride (SF_6) Emissions from Circuit Breakers and other Gas Insulated Equipment

Table 28-1: Sulfur Hexafluoride (SF6) Leak Emissions

Pollutant	Total Usage in Circuit Breakers, etc. (lb/yr)	Estimated Max Annual SF_6 Leak Rate (%/yr)	Potential Leak Emissions	
			(lb/yr)	(tpy)
SF_6	80,196	0.5%	401	0.20
CO_2e - 20-yr[2]	-	-	7,017,132	3,509
CO_2e - 100-yr[3]	-	-	9,423,006	4,712

1. Leak rates based on manufacturer guarantee.
2. 20-yr global warming potentials per 6 NYCRR Part 496.
3. 100-yr global warming potential per IPCC AR5.

Micron - Clay, NY Fabs 1 & 2
1-ADMPR, 2-ADMPR, 1-WWBIO, 2-WWBIO
Lab Operations Emissions

Table 29-1: Probe Lab Operations Emissions

Contaminant	HAP	VOC	Concentration	Usage (L/yr)	Density (g/L)	Potential to Emit (lb/yr)	Potential to Emit (tpy)
HYDROFLUORIC ACID	X		49.00%	109.13	1000	240.60	0.12
ETHYL ACETATE		X	100.00%	1.33	900.3	2.65	0.00
HYDROCHLORIC ACID	X		0.75%	0.00	1000	0.00	0.00
Methanol	X	X	30.00%	0.25	791.3	0.44	0.00
Ethylene glycol	X	X	38.00%	0.32	111.3	0.08	0.00
Choline chloride		X	40.00%	0.33	1100	0.81	0.00
Methanol	X	X	60.00%	0.50	791.3	0.87	0.00
Diethanolamine	X	X	15.00%	0.13	1095	0.30	0.00
Other VOC		X	50.00%	0.42	1000	0.92	0.00
HYDROCHLORIC ACID	x		10.00%	0.03	1000	0.06	0.00
Mineral Oil		X	100.00%	0.21	822	0.38	0.00
FORMIC ACID RGNT		X	100.00%	0.17	1000	0.37	0.00
BENZOTRIAZOLE		X	100.00%	0.05	1360	0.15	0.00
HYDROCHLORIC ACID	X		20.00%	0.10	1000	0.22	0.00
METHYLPENTANE		X	100.00%	0.27	655	0.39	0.00
Other VOC		X	100.00%	6.00	1000	13.23	0.01
Other VOC		X	100.00%	6.00	1000	13.23	0.01
Methanol	X	X	97.74%	0.00	791.3	0.00	0.00
IPA		X	1.01%	0.00	785	0.00	0.00
HYDROCHLORIC ACID	X		36.00%	10.90	1000	24.03	0.01
METHANOL	X	X	100.00%	90.67	791.3	158.17	0.08
ACETIC ACID		X	100.00%	13.33	1000	29.39	0.01
IPA		X	15.00%	10.60	785	18.34	0.01
IPA		X	100.00%	65.61	785	113.54	0.06
HYDROCHLORIC ACID	X		3.65%	0.10	1000	0.21	0.00
METHANESULFONIC ACID		X	99.50%	1.00	1000	2.19	0.00
HYDROCHLORIC ACID	X		0.37%	0.00	1000	0.01	0.00
PGMEA		X	100.00%	6.67	969	14.24	0.01
HYDROFLUORIC ACID	X		60.00%	2.27	1000	5.01	0.00
HYDROCHLORIC ACID	X		2.50%	0.01	1000	0.01	0.00
						Total VOC	**0.18**
						Total HAP	**0.22**

Table 29-2: WWT Lab Operations Emissions

Chemical	HAP	VOC	Total Annual Usage / Potential to Emit (lb/yr)
(+)-TARTARIC ACID		X	0.50
1-(2-BUTOXY-1-METHYLETHOXY)PROPAN-2-OL		X	0.05
1-ETHYLPYRROLIDIN-2-ONE		X	1.25E-03
2-(2-AMINOETHOXY)ETHANOL		X	7.51E-03
2,4,7,9-TETRAMETHYLDEC-5-YNE-4,7-DIOL		X	1.88E-03
2,6-PYRIDINEDICARBOXYLIC ACID		X	1.46
2-AMINOETHANOL, MONOESTER WITH BORIC ACID		X	1.25E-03
ANTIMONY	X		0.08
ASCORBIC ACID		X	0.88
BENZOIC ACID, 2-[[4-(DIMETHYLAMINO)PHENYL]AZO]-, SODIUM SALT	X	X	1.10E-03
BERYLLIUM DI(ACETATE)	X	X	3.03E-03
COBALT DINITRATE	X		2.79E-03
ETHANEDIOIC ACID, DISODIUM SALT		X	0.08
ETIDRONIC ACID		X	6.26E-04
FORMALDEHYDE	X	X	0.03
FORMIC ACID		X	4.41
HYDROGEN CHLORIDE	X		29.92277014
HYDROGEN FLUORIDE	X		116.2710789
LACTIC ACID		X	2.75E-03
LEAD NITRATE	X		0.17
[redacted]			
MERCURIC SULFATE	X		0.30
METHANESULPHONIC ACID		X	3.59
METHANOL	X	X	33.16158596
METHYL-1H-BENZOTRIAZOLE		X	6.26E-04
PARAFFIN OILS		X	0.94
PHENOLPHTHALEIN	X	X	6.84E-03
POTASSIUM HYDROGEN PHTHALATE		X	0.26
PROPAN-2-OL		X	69.97645765
PROPIONIC ACID		X	0.25
PROPYLENE GLYCOL		X	0.25
SELENIOUS ACID	X		0.08
SODIUM ACETATE		X	8.34E-03
SODIUM HYDROGEN 4,4'-(3H-2,1-BENZOXATHIOL-3-YLIDENE)BIS(2-METHYLPHENOLATE) S,S-DIOXIDE	X	X	7.82E-04
SODIUM LAURYL SULFATE		X	40.1960615
SULFURIC ACID, MONO-C10-16-ALKYL ESTERS, SODIUM SALTS		X	36.17645535
TETRABUTYLAMMONIUM HYDROXIDE		X	9.91
TETRAHYDROFURFURYL ALCOHOL		X	3.13E-03
TRIMETHYLAMINE		X	5.51E-04
TRISODIUM 5-HYDROXY-1-(4-SULPHOPHENYL)-4-(4-SULPHOPHENYLAZO)PYRAZOLE-3-CARBOXYLATE	X	X	0.03
UREA		X	2.20E-03
		Total VOC	204.49
		Total HAP	180.06

Micron - Clay, NY Fabs 1 & 2
1-HPMCU and 2-HPMCU
Spin On Dielectric (SOD) Waste Treatment Emissions

Table 30-1: SOD Waste and Processing Chemical Usage

Mixture	SOD Waste Generated (lb/yr)
SOD Waste	24,714
Rinse Solvent	273,307
Reactant	16,009
Total SOD Waste	314,030

Table 30-2: Individual Chemical Emissions

Mixture	Primary Chemical					Emission Chemical			Molecular Weight (lb/lbmol)	Process Emission Factor (lb emitted / lb used)	Emission Chemical Classifications									Pre-Control Emissions (lb/yr)	RCTO DRE	Annual Emissions from Lab (lb/yr)
	CAS #	Chemical Name	Molecular Formula	Weight % of Mixture[1]	Usage (lb/yr)	CAS #	Emission Chemical	Molecular Formula			VOC	PM	NO_x	CO	SO_2	HAP	GHG	HTAC	Fluorides			
SOD Waste	90387-00-1	Polysilazane	Varies	4%	903.48	90387-00-1	Polysilazane	Varies	1000	0	X									0.00	0%	-
SOD Waste	90387-00-1	Polysilazane	Varies	4%	903.48	7803-62-5	Silane	SiH4	32.12	0										0.00	100%	-
SOD Waste	90387-00-1	Polysilazane	Varies	4%	903.48	7631-86-9	Silicon dioxide	SiO2	60.08	2.15		X								1,939	0%	1,938.61
SOD Waste	90387-00-1	Polysilazane	Varies	4%	903.48	7664-41-7	Ammonia	NH3	17.03	1.22										1,099	90%	109.90
SOD Waste	90387-00-1	Polysilazane	Varies	4%	903.48	10102-44-0	Nitrogen dioxide	NO2	46.01	3.29			X							2,969	0%	2,969.23
SOD Waste	142-96-1	Dibutyl Ether	$C_8H_{18}O$	98%	24262.55	142-96-1	Dibutyl Ether	C8H18O	130.23	0.2	X									4,853	90%	485.25
SOD Waste	142-96-1	Dibutyl Ether	$C_8H_{18}O$	98%	24262.55	124-38-9	Carbon dioxide	CO2	44.01	0.54							X			13,119	0%	13,118.88
Rinse Solvent	91-20-3	Naphthalene	$C_{10}H_8$	8%	21864.6	91-20-3	Naphthalene	C10H8	128.17	0.05	X					X				1,093	90%	109.32
Rinse Solvent	91-20-3	Naphthalene	$C_{10}H_8$	8%	21864.6	124-38-9	Carbon dioxide	CO2	44.01	0.17							X			3,754	0%	3,753.84
Rinse Solvent	95-63-6	1,2,4-Trimethylbenzene	C_9H_{12}	5%	13665.4	95-63-6	1,2,4-Trimethylbenzene	C9H12	120.19	0.2	X									2,733	90%	273.31
Rinse Solvent	95-63-6	1,2,4-Trimethylbenzene	C_9H_{12}	2%	5466.1	124-38-9	Carbon dioxide	CO2	44.01	0.66							X			3,603	0%	3,602.77
Rinse Solvent	108-67-8	1,3,5-Trimethylbenzene	C_9H_{12}	5%	13665.4	108-67-8	1,3,5-Trimethylbenzene	C9H12	120.19	0.2	X									2,733	90%	273.31
Rinse Solvent	108-67-8	1,3,5-Trimethylbenzene	C_9H_{12}	2%	5466.1	124-38-9	Carbon dioxide	CO2	44.01	0.66							X			3,603	0%	3,602.77
Rinse Solvent	64742-94-5	Solvent naphtha (petroleum), heavy arom.	Varies	100%	273307.1	64742-94-5	Solvent naphtha (petroleum), heavy arom.	Varies	192.00	0.2	X					X				54,661	90%	5,466.14
Rinse Solvent	64742-94-5	Solvent naphtha (petroleum), heavy arom.	Varies	100%	273307.1	124-38-9	Carbon dioxide	CO2	44.01	0.41							X			112,765	0%	112,764.81
Reactant	64-17-5	Ethanol	C_2H_6O	71%	11398.11	64-17-5	Ethanol	C2H6O	46.07	1	X									11,398	90%	1,139.81
Reactant	64-17-5	Ethanol	C_2H_6O	71%	11398.11	124-38-9	Carbon dioxide	CO2	44.01	1.91							X			21,777	0%	21,776.90
Reactant	1310-58-3	Potassium Hydroxide	KOH	10%	1600.86	1310-58-3	Potassium Hydroxide	KOH	56.11	0										0.00	0	-

1. The total of this column for all components in each mixture may exceed 100% due to variable composition.

Table 30-3: Emissions per Exhaust Type

CAS	Emission Chemical Name	Exhaust Type[1,2]	Annual Pre-Control Emissions	Average Hourly Pre-Control Emissions	Variance Factor to Account for Hourly Operational Differences[3]	Emission Rate Potential per HPM Building[4]	RCTO DRE	Annual Potential Emissions	Number of Operational Stacks	Maximum Hourly Emissions Per Stack	Average Hourly Emissions Per Stack
			(lb/yr)	(lb/hr)		(lb/hr)		(lb/yr)		(lb/hr/stack)	(lb/hr/stack)
7631-86-9	Silicon dioxide	RCTO Burner Exhaust	1,939	2.21E-01	2400%	1.38	0%	1,939	12	4.61E-01	1.84E-02
7664-41-7	Ammonia	Solvent Exhaust	1,044	1.19E-01	2400%	7.45E-01	-	104.4	12	2.48E-02	9.93E-04
7664-41-7	Ammonia	RCTO Burner Exhaust	55.0	6.27E-03	2400%	3.92E-02	90%	5.50	12	1.31E-03	5.23E-05
10102-44-0	Nitrogen dioxide	RCTO Burner Exhaust	2,969	3.39E-01	2400%	2.12	0%	2,969	12	7.06E-01	2.82E-02
142-96-1	Dibutyl Ether	Solvent Exhaust	4,610	5.26E-01	2400%	3.29	-	461.0	12	1.10E-01	4.39E-03
142-96-1	Dibutyl Ether	RCTO Burner Exhaust	242.6	2.77E-02	2400%	1.73E-01	90%	24.3	12	5.77E-03	2.31E-04
124-38-9	Carbon dioxide	RCTO Burner Exhaust	158,620	18.1	2400%	113.2	0%	158,620	12	37.7	1.51E+00
91-20-3	Naphthalene	Solvent Exhaust	1,039	1.19E-01	2400%	7.41E-01	-	103.9	12	2.47E-02	9.88E-04
91-20-3	Naphthalene	RCTO Burner Exhaust	54.7	6.24E-03	2400%	3.90E-02	90%	5.47	12	1.30E-03	5.20E-05
95-63-6	1,2,4-Trimethylbenzene	Solvent Exhaust	2,596	2.96E-01	2400%	1.85	-	259.6	12	6.17E-02	2.47E-03
95-63-6	1,2,4-Trimethylbenzene	RCTO Burner Exhaust	136.7	1.56E-02	2400%	9.75E-02	90%	13.7	12	3.25E-03	1.30E-04
108-67-8	1,3,5-Trimethylbenzene	Solvent Exhaust	2,596	2.96E-01	2400%	1.85	-	259.6	12	6.17E-02	2.47E-03
108-67-8	1,3,5-Trimethylbenzene	RCTO Burner Exhaust	136.7	1.56E-02	2400%	9.75E-02	90%	13.7	12	3.25E-03	1.30E-04
64742-94-5	Solvent naphtha (petroleum), heavy arom.	Solvent Exhaust	51,928	5.93	2400%	37.0	-	5,193	12	1.23E+00	4.94E-02
64742-94-5	Solvent naphtha (petroleum), heavy arom.	RCTO Burner Exhaust	2,733	3.12E-01	2400%	1.95	90%	273.3	12	6.50E-02	2.60E-03
64-17-5	Ethanol	Solvent Exhaust	10,828	1.24	2400%	7.73	-	1,083	12	2.58E-01	1.03E-02
64-17-5	Ethanol	RCTO Burner Exhaust	569.9	6.51E-02	2400%	4.07E-01	90%	57.0	12	1.36E-02	5.42E-04

1. 95% of total VOC emissions are emitted through the Solvent Exhaust
2. 5% of total VOC emissions are emitted through the RCTO Burner Exhaust. 100% of thermal oxidation byproducts are emitted through the RCTO burner exhaust.
3. The SOD waste treatment process will occur intermittently. Maximum hourly emission rates are based on the treatment process occuring for one hour each day.
4. There are two proposed separate HPM buildings per fab, a "north" and "south" HPM.

Conversions

1 gal =	3785 cm^3
1 gram =	2.205E-03 lbs

Micron - Clay, NY Fabs 1 & 2
1-FABOP and 2-FABOP
Regenerative Catalytic System (RCS) Combustion Emissions

Table 31-1. RCS Specifications and Inventory

Equipment Description[1]	Equipment Count	Burner Rating (MMBtu/hr)
Regenerative Catalytic System - Process FA1 and FA2	20	0.6

1. Exhaust from the outlet of each RCS, including emissions from natural gas combustion, will pass through fab acid exhausts.

Table 31-2. RCS Criteria Pollutant and GHG Potential to Emit

Pollutant	Emission Factor[1,2,3] (lb/MMscf)	Potential to Emit (per Unit)[4,5]		Potential to Emit (All Units)	
		(lb/hr)	(tpy)	(lb/hr)	(tpy)
PM (Total)	7.6	4.47E-03	0.02	0.09	0.39
PM_{10}	7.6	4.47E-03	0.02	0.09	0.39
$PM_{2.5}$	7.6	4.47E-03	0.02	0.09	0.39
SO_2	0.6	3.53E-04	1.55E-03	0.01	0.03
CO	420	0.25	1.08	4.94	21.6
NO_x	100	0.06	0.26	1.18	5.15
VOC	5.5	3.24E-03	0.01	0.06	0.28
Lead	0.0005	2.94E-07	1.29E-06	5.88E-06	2.58E-05
CO_2	120,000	70.6	309.2	1,412	6,184
CH_4	2.3	1.35E-03	0.01	0.03	0.12
N_2O	2.2	1.29E-03	0.01	0.03	0.11
CO_2e - 20-yr[6]	-	71.0	311.2	1,421	6,223
CO_2e - 100-yr[7]	-	71.0	310.8	1,419	6,217
Upstream CO_2e[8]	91,921	54.1	236.8	1,081	4,737

1. Emission Factors from AP-42 Section 1.4 Table 1.4-1 and 1.4-2 for Small Boilers.
2. Per AP-42 Section 1.4 Table 1.4-2, PM (total) = PM_{10} = $PM_{2.5}$.
3. AP-42 emission factor for CO from NG combustion multiplied by safety factor of 5 to account for emissions as a result of partial oxidation of process chemicals.
4. 20-yr Global warming potentials per 6 NYCRR Part 496.
5. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials*).
6. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 40,877 g/MMBtu

Table 31-3. Tool-Level Thermal Oxidation System HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1]	Potential to Emit (per Unit)		Potential to Emit (Total per Stack)	
		(lb/MMscf)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
Benzene	Yes	2.10E-03	1.24E-06	5.41E-06	2.47E-05	1.08E-04
Formaldehyde	Yes	7.50E-02	4.41E-05	1.93E-04	8.82E-04	3.86E-03
Toluene	Yes	3.40E-03	2.00E-06	8.76E-06	4.00E-05	1.75E-04
2-Methylnaphthalene	Yes	2.40E-05	1.41E-08	6.18E-08	2.82E-07	1.24E-06
3-Methylchloranthrene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
7,12-Dimethylbenz(a)anthracene	Yes	1.60E-05	9.41E-09	4.12E-08	1.88E-07	8.24E-07
Acenaphthylene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Benzo(a)pyrene	Yes	1.20E-06	7.06E-10	3.09E-09	1.41E-08	6.18E-08
Benzo(b)fluoranthene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Benzo(k)fluoranthene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Dibenzo(a,h)anthracene	Yes	1.20E-06	7.06E-10	3.09E-09	1.41E-08	6.18E-08
Dichlorobenzene	Yes	1.20E-03	7.06E-07	3.09E-06	1.41E-05	6.18E-05
Hexane	Yes	1.80E+00	1.06E-03	4.64E-03	0.02	0.09
Naphthalene	Yes	6.10E-04	3.59E-07	1.57E-06	7.18E-06	3.14E-05
Acenaphthene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Anthracene	Yes	2.40E-06	1.41E-09	6.18E-09	2.82E-08	1.24E-07
Benzo(a)anthracene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Benzo(g,h,i)perylene	Yes	1.20E-06	7.06E-10	3.09E-09	1.41E-08	6.18E-08
Chrysene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Fluoranthene	Yes	3.00E-06	1.76E-09	7.73E-09	3.53E-08	1.55E-07
Fluorene	Yes	2.80E-06	1.65E-09	7.21E-09	3.29E-08	1.44E-07
Indeno(1,2,3-cd)pyrene	Yes	1.80E-06	1.06E-09	4.64E-09	2.12E-08	9.28E-08
Phenanthrene	Yes	1.70E-05	1.00E-08	4.38E-08	2.00E-07	8.76E-07
Pyrene	Yes	5.00E-06	2.94E-09	1.29E-08	5.88E-08	2.58E-07
Arsenic	Yes	2.00E-04	1.18E-07	5.15E-07	2.35E-06	1.03E-05
Beryllium	Yes	1.20E-05	7.06E-09	3.09E-08	1.41E-07	6.18E-07
Cadmium	Yes	1.10E-03	6.47E-07	2.83E-06	1.29E-05	5.67E-05
Chromium	Yes	1.40E-03	8.24E-07	3.61E-06	1.65E-05	7.21E-05
Cobalt	Yes	8.40E-05	4.94E-08	2.16E-07	9.88E-07	4.33E-06
Lead	Yes	5.00E-04	2.94E-07	1.29E-06	5.88E-06	2.58E-05
Manganese	Yes	3.80E-04	2.24E-07	9.79E-07	4.47E-06	1.96E-05
Mercury	Yes	2.60E-04	1.53E-07	6.70E-07	3.06E-06	1.34E-05
Nickel	Yes	2.10E-03	1.24E-06	5.41E-06	2.47E-05	1.08E-04
Selenium	Yes	2.40E-05	1.41E-08	6.18E-08	2.82E-07	1.24E-06
		Total HAP PTE	**1.11E-03**	**4.87E-03**	**2.22E-02**	**9.73E-02**

1. Emission factors are from AP-42, Section 1.4, Tables 1.4-3 and 1.4-4.

Conversions

1 lb =	453.59 g
1 scf NG =	1,020 BTU - Average heat content of NG from AP-42 1.4.1.
1 year =	8,760 hours

Micron - Clay, NY Fabs 1 & 2
1-CMPOP and 2-CMBOP
Diesel Fire Pump Combustion Emissions

Table 32-1. Diesel Fire Pump Engine Information

Equipment Description	Annual Operating Hours Limit (hrs/yr/engine)	Engine Full Load	Engine Power
		HP	kW
Diesel Backup Fire Pump Engine	500	250	186

1. This diesel fire pump engine is a backup to an electric fire pump. It will only run in the event of a fire during a loss of power. It will be tested weekly.

Table 32-2. Diesel Fire Pump Engine Criteria Pollutant and GHG Potential to Emit

Pollutant	Tier 3 Exhaust Emission Standards[1,2]	AP-42 Emission Factors[3]	GHG Emission Factors[4]	Potential to Emit	
	(g/kW-hr)	(lb/HP-hr)	(kg/MMBtu)	(lb/hr)	(tpy)
PM (Total)	0.200	-	-	0.08	0.02
PM_{10}	0.200	-	-	0.08	0.02
$PM_{2.5}$					
NO_x	4.0	-	-	1.64	0.41
VOC	4.0	-	-	1.64	0.41
CO_2	-	-	73.96	103.8	25.9
CH_4	-	-	0.0030	4.21E-03	1.05E-03
N_2O	-	-	0.00060	8.42E-04	2.10E-04
CO_2e - 20-yr[5]	-	-	-	104.4	26.1
CO_2e - 100-yr[6]	-	-	-	104.1	26.0
Upstream CO_2e[7]	-	-	23.54	33.0	8.26

1. Tier 3 emission factors for all pollutants besides SO_2 are from Table 1 of 40 CFR Part 1039 Subpart B - Emission Standards and Related Requirements.
2. $PM_{2.5}$ and PM_{10} emission factors conservatively assumed to be equal to that of PM (total).
3. SO_2 emission factor is based on AP-42 Section 3.3, Table 3.3-1.
4. CO_2, N_2O and CH_4 emission factors based on 40 CFR Part 98 Table C-1 and C-2 Default diesel emissions factors.
5. 20-yr Global warming potentials per 6 NYCRR Part 496.
6. 100-yr Global warming potentials per 40 CFR Part 98, Table A-1 (*Global Warming Potentials*).
7. Upstream CO_2e emission factor per Appendix of 2024 NYS Statewide GHG Emissions Report: 23,540 g/MMBtu

Table 32-3. Diesel Fire Pump Engine HAP Potential to Emit

Pollutant	HAP?	Emission Factor[1] (lb/MMBtu)	Potential to Emit (lb/hr)	Potential to Emit (tpy)
Benzene	Yes	9.33E-04	5.94E-04	1.48E-04
Toluene	Yes	4.09E-04	2.60E-04	6.51E-05
Xylenes	Yes	2.85E-04	1.81E-04	4.54E-05
1,3 Butadiene	Yes	3.91E-05	2.49E-05	6.22E-06
Formaldehyde	Yes	1.18E-03	7.51E-04	1.88E-04
Acetaldehyde	Yes	7.67E-04	4.88E-04	1.22E-04
Acrolein	Yes	9.25E-05	5.89E-05	1.47E-05
Total PAH	Yes	1.68E-04	1.07E-04	2.67E-05
		Total HAP PTE	**2.47E-03**	**6.16E-04**

1. Emissions are calculated based on emission factors for diesel engines per AP-42 Section 3.3, Table 3.3-2.

Conversions

1 lb =	453.59	g
1 year (Emergency Operation) =	500	hr
Energy Conversion Factor:	392.75	bhp-hr/MMBtu (mechanical) in AP-42 Appendix A
15 ppm S =	0.0015	wt% S
Hoursepower (mechanical) =	0.74558	Kilowatts
Diesel Usage Conversion Factor:	0.138	MMBtu/gal

Micron - Clay, NY Fabs 1 & 2
Exhaust Types

Table 33-1. Exhaust Stack Information

Exhaust Type	Number of Operational stacks	Exhaust Rate (ACFM)
HPM Acid	12	36,500
CUB Acid	4	12,000
Fab Acid	72	80,000
WWT Acid	6	15,000
Probe Acid	2	10,000
Fab CVD	24	26,500
HPM Solvent	12	24,150
Fab Solvent	64	52,500
WWT Solvent	4	2,000
Probe Solvent	2	4,000
HPM Ammonia	12	18,000
Fab Ammonia	24	40,000
WWT Ammonia	4	2,000
BIO General	2	66,234
Fab General	70	55,000

Micron - Clay, NY Fabs 1 & 2
Results of SafeBridge-Micron and NYSDEC Toxicity Derivations

Table 34-1. Results of SafeBridge-Micron and NYSDEC Toxicity Derivations

Chemical Name	CAS#	Interim AGC ($\mu g/m^3$)	Interim SGC ($\mu g/m^3$)	Initial ER	SafeBridge-Micron Derivation Method	NYSDEC Approval date
1,2,4-Triazole	288-88-0	0.48	Not Derived	B	Analogy to amitrole (CAS # 61-82-5)	7/15/2024
[redacted]						7/15/2024
[redacted]						7/15/2024
[redacted]						7/15/2024
[redacted]						7/15/2024
Difluoromethane	75-10-5	50600	Not Derived	C	WEEL, based on 90d inhalation tox study	11/1/2024
Disilane	1590-87-0	16	Not Derived	B	Analogy to silicon tetrahydride (CAS # 7803-62-5)	7/15/2024
Ethyl (S)-2-Hydroxypropionate	687-47-8	71	Not Derived	B	Analogy to butyl lactate (CAS # 138-22-7)	7/15/2024
Fluoromethane	593-53-3	50600	Not Derived	C	Analogy to difluoromethane (75-10-5)	11/1/2024
Germanium Tetrafluoride	62566-74-9	0.131	10.364	B	Based on NYS DAR-1 "Equivalent" 1-hr & Annual Fluoride Standards	7/15/2024
Indium Iodide	13966-94-4	0.24	100	A	Based on Components of CAS# 7440-74-6 (AGC & TOX) & CAS# 7553-56-2 (SGC)	7/15/2024
Methyl 2-Hydroxy-2-Methylpropionate	2110-78-3	71	Not Derived	B	Analogy to butyl lactate (CAS # 138-22-7)	7/15/2024
Phosphorus Pentoxide	1314-56-3	4.8	300	B	MAK TWA value phosphorus pentoxide for AGC; Analogy to phosphoric acid (CAS #7654-38-2) by hydrolysis product for SGC	7/15/2024
Propylene carbonate	108-32-7	200	Not Derived	C	MAK TWA value of propylene carbonate for AGC	7/15/2024
[redacted]						7/15/2024
[redacted]						7/15/2024
[redacted]						7/15/2024
Tungsten Trioxide	1314-35-8	7.1	Not Derived	B	Analogy to tungsten (CAS # 7440-33-7) by component	7/15/2024
1-ethoxypropan-2-ol	1569-02-4	5070	85200	C	Derived from ACGIH TLVs (AGC from TLV-TWA & SGC from TLV-STEL)	8/13/2024
[redacted]						8/13/2024
2-Oxobornane-10-Sulphonic Acid	3144-16-9	1	120	B	Analogy to sulfuric acid (CAS # 7664-93-9)	8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
[redacted]						8/13/2024
Trifluoromethane	75-46-7	50600	Not Derived	C	Analogy to difluoromethane (CAS # 75-10-5)	11/1/2024
[redacted]						11/26/2024
[redacted]						12/16/2024

Table 34-1. Results of SafeBridge-Micron and NYSDEC Toxicity Derivations

Chemical Name	CAS#	Interim AGC (µg/m³)	Interim SGC (µg/m³)	Initial ER	SafeBridge-Micron Derivation Method	NYSDEC Approval date
Germanium Oxide	1310-53-8	12.9	Not Derived	B	Based on ambient air value from Tox data, derived AGC	1/27/2025
[redacted]						1/27/2025
[redacted]						1/27/2025
[redacted]						1/27/2025
[redacted]						1/27/2025
1,2-epoxyhexane	1436-34-6			B	Analogy to 1,2-epoxybutane (CAS # 106-88-7)	1/30/2025
[redacted]						2/19/2025
Tetrahydrofurfuryl alcohol	97-99-4			B	Based on an evaluation of toxicity data for substance	2/19/2025
Hexafluoroethane	76-16-4	50400	Not Derived	C	Based on ambient air value from Tox data, derived AGC	Pending
Octafluorocyclobutane	115-25-3	50400	Not Derived	C	Analogy to hexafluoroethane (CAS # 76-16-4)	Pending
[redacted]						Pending
[redacted]						Pending
[redacted]						Pending

APPENDIX G. EMISSION FACTORS

As introduced in Section 2.1.4 of the Micron Clay Air Permit Application, the "Process Emission Factors" listed in Table 6-1 of Appendix F are a critical aspect of the potential to emit (PTE) calculations for the Proposed Air Permit Project. These emission factors are presented in pounds of "Emission Chemical" shown in Table 6-1 emitted per pound of "Primary Chemical" shown in Table 6-1 that is projected to be used (lb emitted / lb used). This Appendix documents the sources from which these emission factors were obtained and explains the methodologies used to derive them when published sources were unavailable.

1.1 Reaction Byproduct Emission Factors

Emission chemicals are formed as a result of chemical reactions within the semiconductor manufacturing processes. Emission chemicals may also be generated in process equipment exhaust conditioners (PEECs) which manage exhaust from process tools for protection of equipment and personnel. In addition, in point-of-use (POU) control devices and regenerative catalytic systems (RCS) installed for removal of fluorinated greenhouse gases (F-GHGs), and centralized rotor-concentrator thermal oxidizers (RCTOs) installed for removal of volatile organic compounds (VOC) can generate emission chemicals. When these reactions occur, use of the primary chemical results in emissions of one or more emission chemicals that are not the primary chemical itself. These emission factors are described below.

1.1.1 Greenhouse Gas Primary Chemicals

As described in Sections 1.4.1.1 and 1.4.1.3 of the Micron Clay Air Permit Application, thin films and plasma etch processes utilize several F-GHG compounds for chamber cleaning and wafer etching. Chemical reactions in these process categories result in several F-GHG and non-GHG emission chemicals for each primary chemical used. In addition, nitrous oxide (N_2O) is used in thin films processes.

Emission factors for use of these GHGs in semiconductor manufacturing were published by the Intergovernmental Panel on Climate Change (IPCC) 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (the "2019 Refinement").[1] This guidance provides multiple tiers of granularity with different emission factors for each tier. To calculate PTE from the Proposed Air Permit Project, the GHG EFs found in the 2019 Refinement Table 6.11, Tier 2C were selected, as they provide different emission factors for each primary chemical depending on how it is used. Table 4-1 of Appendix F lists each of the emission factors used from the 2019 Refinement utilized in the emission calculations in Table 6-1 as "Process Emission Factors".

In addition to the emission factors listed in Table 6.11, other emission factors were utilized that are embedded into the text of the 2019 Refinement. On pages 6.29 through 6.31, the 2019 Refinement describes emissions of tetrafluoromethane (CF_4) that can be generated when exhaust containing fluorine (F_2) gas is combusted with hydrocarbon fuel. This mode of emissions can occur through direct use of F_2 or through use of nitrogen trifluoride (NF_3) in remote plasma clean (RPC) operations. The 2019 Refinement

[1] IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6: Electronics Industry Emissions.

sets default emission factors for CF_4 for each of these cases in Equation 6.15. These two emission factors are also listed on Table 4-1 of Appendix F.

1.1.1.1 Hydrogen Fluoride Emission Factors

The GHGs used in semiconductor manufacturing processes are expected to result in emissions of hydrogen fluoride (HF) in addition to F-GHGs. Emission factors for HF are not included in the 2019 Refinement, which focuses on only GHGs emissions. Emission factors for HF from use of F-GHGs were developed utilizing the equation detailed in Section 1.1.2.2 below and are presented alongside IPCC published emission factors in Table 4-1 of Appendix F. To ensure a conservative estimate of emissions, it is assumed that 100% of the fluorine atoms in each primary chemical are emitted as HF. By assuming that 100% of fluorine atoms in each F-GHG primary chemical are converted into HF in addition to other fluorinated compounds, more than 100% of the fluorine atoms from each F-GHG primary chemical are assumed to be emitted.

1.1.1.2 Oxidation of GHGs

The 2019 Refinement does not address oxidation of GHGs, including F-GHGs and N_2O, that occurs during process reactions or in POU control devices. Emission factors for generation of carbon dioxide (CO_2), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) from use of GHGs were developed utilizing the equations detailed in Section 1.1.2.2 and are presented alongside IPCC published emission factors in Table 4-1 of Appendix F. To ensure a conservative estimate of emissions, it is assumed in most cases that 100% of the carbon, nitrogen, or sulfur atoms in each primary chemical that are present in the exhaust are emitted as CO_2, NO_x, or SO_x, respectively. By also assuming that 100% of carbon, nitrogen, and sulfur, respectively, in each GHG primary chemical is converted into the oxidation byproducts in addition to other carbon, nitrogen, or sulfur containing emission chemicals, more than 100% of the carbon, nitrogen, or sulfur atoms from each GHG primary chemical is assumed to be emitted. These oxidation emission factors were derived using the same methodology used for all other primary chemicals described in Section 1.1.2.3 below and outlined in Table 3-1 of Appendix F.

NO_X generated from the oxidation of N_2O is calculated assuming that 60% of N_2O leaving the tool is oxidized, consistent with the default destruction and removal efficiency (DRE) published in the 2019 Refinement. This calculation approach reflects the fact that N_2O is less likely to oxidize than other nitrogen-bearing compounds. In addition, 10% of N_2O is conservatively assumed to react directly to NO_X in the plasma environment of the tool.

1.1.2 Derived Emission Factors

For all primary chemicals other than those discussed above, emission factors were derived based on stoichiometric equations and conservative engineering estimates of emission chemical formation. The identity of emission chemicals for which emission factors were developed was based on the chemical structure of each primary chemical and semiconductor process knowledge. Different individual chemicals may have different derived emission factors, described in the following sections.

1.1.2.1 Carbon Monoxide Emission Factors

As described in Section 2.1.3.1 of the Micron Clay Air Permit Application, carbon monoxide (CO) is potentially emitted from semiconductor manufacturing processes due to both thermal oxidation of primary

chemicals and incomplete combustion of fuels used in thermal oxidation systems. Emissions of CO were conservatively estimated using an emission factor equal to five times the emission factor for CO in AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Table 1.4-1 based on a semiconductor exhaust management and control book that addresses this matter.[2] Therefore, emission factors for CO were not developed for each individual primary chemical used, and emissions of CO are not discussed further in this appendix.

1.1.2.2 Emission Factor Derivation Equation

Emission factors to determine decomposition and oxidation reactions in cases where publicly available emission factors could not be identified were developed according to the equations below:

$$\frac{lb\ EC}{Year} = \frac{\frac{lb\ PC}{Year} * \%\ Available * (lb - mole\ EC) * \left[MW_{EC}\ \left(\frac{lb}{lb - mole}\right)\right]}{\left[MW_{PC}\ \left(\frac{lb}{lb - mole}\right)\right] *\ (lb - mole\ PC)}$$

The equation above is then simplified into the equation below to calculate the emission factor and demonstrate how it will be used to calculate emissions.

$$\frac{lb\ EC}{Year} = EF * \frac{lb\ PC}{Year}$$

Where:

EF = Emission Factor (lb EC/lb PC)
% Available = The portion of primary chemical assumed to be available to form the emission chemical. In most cases, this is 1.0.
PC = Primary Chemical
EC = Emission Chemical
MW_{PC} = Primary Chemical Molecular Weight (lb/lbmol)
MW_{EC} = Emission Chemical Molecular Weight (lb/lbmol)

1.1.2.3 Oxidation Emission Factors

Emission factors for all potential oxidation reactions of primary chemicals were developed utilizing the formula in Section 1.1.2.2. To ensure a conservative estimate of the emissions, it was assumed that 100% of the carbon, nitrogen, sulfur, silicon, boron, phosphorus, and metal (e.g., aluminum, etc.) atoms in each primary chemical will be oxidized. By assuming 100% of the appropriate atoms will be fully oxidized in addition to emissions of other emission chemicals, including primary chemicals themselves a conservative estimate of the PTE is achieved. Table 3-1 of Appendix F outlines the derivation of all oxidation emission factors.

The oxidation emission factor for ammonia specifically has been refined to provide a more realistic assumption of NO_X formation. A portion of ammonia used is not available to be oxidized, as it is consumed

[2] J. Michael Sherer, *Semiconductor Industry Wafer Fab Exhaust Management*, pg. 166, published 2005 by CRC Press, Taylor & Francis Group, Boca Raton, FL.

to deposit nitrogen on wafers. Based on test results from other Micron facilities with comparable processes that utilize ammonia gas, less than 40% of ammonia by mass actually converts to NO_X. In some processes, less than 10% of ammonia is converted. Therefore, it is conservatively assumed that 40% of gaseous ammonia used will oxidize to NO_X.

1.1.2.4 Other Chemical Reaction Emission Factors

Aside from oxidation reactions, certain primary chemicals are expected to participate in chemical reactions during semiconductor manufacturing processes. The identity of emission chemicals for which emission factors were calculated in this section was determined based on primary chemical molecular structure and semiconductor process experience.

In its technical review (TR) comment letter dated July 19, 2024, the NYSDEC requested in TR Comment #12 that Micron "quantify, and incorporate" various additional contaminants the NYSDEC "determined are reasonable potential byproducts" of the semiconductor manufacturing processes. Micron has updated this appendix to include the emission factor derivation for those contaminants, including dimethylamine and formaldehyde. Emission factors for ethane have not been added, as agreed upon with the NYSDEC, since emissions of ethane are trivial per Title 6 of the New York Codes, Rules, and Regulations (6 NYCRR) Subpart 201-3.3(c)(94).

1.1.2.4.1 [redacted]

Thin Films / Diffusion Deposition Processes

([redacted] is used in atomic layer deposition (ALD) processes, a subset of thin films processes, with an oxygen source to form a layer of [redacted] on a wafer. It is assumed that 100% of [redacted] reacts to form [redacted], nitrogen dioxide (NO_2), [redacted] dimethylamine (C_2H_7N), methanol (CH_3OH), and carbon dioxide (CO_2). [redacted], while the methyl groups are assumed to be emitted as both dimethylamine and methanol.

$$\frac{\text{lbs [redacted]}}{\text{year}} = \frac{(\text{lbs [redacted] used/year})\ (1.0)\ [\text{redacted}]}{([\text{redacted}]/\text{lb-mole})\ (\text{lb-mole [redacted]})\ (\text{lb-mole})}$$

$$\frac{\text{lbs [redacted]}}{\text{year}} = ([\text{redacted}])(\text{lbs [redacted] used/year})$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = \frac{([\text{redacted}]/\text{year})\ (1.0)\ ([\text{redacted}]\text{ lb-moles } CH_3OH\ I)(32.04\text{ lbs } CH_3OH)}{([\text{redacted}]\text{ lbs [redacted]}/\text{lb-mole})\ (\text{lb-mole [redacted]})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = [\text{redacted}]\text{ used/year})$$

$$\frac{\text{lbs } C_2H_7N}{\text{year}} = \frac{([\text{redacted}]\text{ year})\ (1.0)\ ([\text{redacted}]\text{ lb-moles } C_2H_7N)(45.08\text{ lbs } C_2H_7N)}{([\text{redacted}]\text{ lb-mole})\ (\text{lb-[redacted]})\ (\text{lb-mole})}$$

$\frac{\text{lbs } C_2H_7N}{\text{year}}$ = [redacted] used/year)

The emission factor derivation for CO_2, NO_2, and [redacted] is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is expected to be present in the tool when [redacted] is used.

1.1.2.4.2 Boron Trifluoride (BF_3) - Ion Implant Processes

Boron trifluoride (BF_3) is used in ion implant processes. The estimated process efficiency is 75% for boron implant based on semiconductor process experience. It is assumed that the remaining 25% of boron atoms that are not implanted into a wafer form boric oxide (B_2O_3). It is conservatively assumed that 100% of fluorine atoms form hydrogen fluoride (HF).

$$\frac{\text{lbs } B_2O_3}{\text{year}} = \frac{(\text{lbs } BF_3 \text{ used/year})\ (0.25)\ (\text{lb-mole } B_2O_3)\ (69.62 \text{ lbs } B_2O_3)}{(67.81 \text{ lbs } BF_3/\text{lb-mole})\ (2 \text{ lb-moles } BF_3)\ (\text{lb-mole})}$$

$$\frac{\text{lbs } B_2O_3}{\text{year}} = (0.128)\ (\text{lbs } BF_3 \text{ used/year})$$

$$\frac{\text{lbs HF}}{\text{year}} = \frac{(\text{lbs } BF_3 \text{ used/year})\ (1.0)\ (3 \text{ lb-moles HF})\ (20.01 \text{ lbs HF})}{(67.81 \text{ lbs } BF_3/\text{lb-mole})\ (\text{lb-mole } BF_3)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HF}}{\text{year}} = (0.885)\ (\text{lbs } BF_3 \text{ used/year})$$

The presence or absence of oxygen in the tool, when BF_3 is used, is not expected to affect the byproducts derived above.

1.1.2.4.3 [redacted] – Thin Films / Diffusion Deposition Processes

[redacted] is used in atomic layer deposition (ALD) processes with an oxygen source. It is assumed that 100% of [redacted] reacts to form methanol (CH_3OH), nitrogen dioxide (NO_2), carbon dioxide (CO_2), and silicon dioxide (SiO_2).

$$\frac{\text{lbs } CH_3OH}{\text{year}} = \frac{(\text{lbs [redacted] used/year})\ (1.0)\ ([redacted]\ CH_3OH)\ (32.04 \text{ lbs } CH_3OH)}{([redacted] \text{ lbs [redacted] lb-mole})(\text{lb-mole [redacted]})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = ([redacted](\text{lbs [redacted] used/year})$$

The emission factor derivation for CO_2, NO_2, and SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is expected to be present in the tool when [redacted] is used.

1.1.2.4.4 [redacted] – Thin Films / Diffusion Deposition Processes

[redacted] is used in atomic layer deposition (ALD) processes. It is assumed that 100% of [redacted] reacts to form dimethylamine (C_2H_7N), ammonia (NH_3), methane (CH_4), nitrogen dioxide (NO_2), carbon dioxide (CO_2), and silicon dioxide (SiO_2).

$$\frac{\text{lbs } C_2H_7N}{\text{year}} = \left(\frac{[\text{redacted}]\ \text{year}}{[\text{redacted}]\ \text{lb-mole}}\right)\left(\frac{1.0\ [\text{redacted}]\text{-moles } C_2H_7N}{\text{lb-mole } [\text{redacted}]}\right)\left(\frac{45.08\ \text{lbs } C_2H_7N}{\text{lb-mole}}\right)$$

$$\frac{\text{lbs } C_2H_7N}{\text{year}} = ([\text{redacted}])(\text{lbs } [\text{redacted}]\ \text{used/year})$$

$$\frac{\text{lbs } NH_3}{\text{year}} = \left(\frac{\text{lbs } [\text{redacted}]\ \text{used/year}}{[\text{redacted}]\ \text{lb-mole}}\right)\left(\frac{1.0\ [\text{redacted}]\ \text{lb-moles } NH_3}{\text{lb-mole } [\text{redacted}]}\right)\left(\frac{17.03\ \text{lbs } NH_3}{\text{lb-mole}}\right)$$

$$\frac{\text{lbs } NH_3}{\text{year}} = ([\text{redacted}])(\text{lbs } [\text{redacted}]\ \text{used/year})$$

$$\frac{\text{lbs } CH_4}{\text{year}} = \left(\frac{\text{lbs } [\text{redacted}]\ \text{used/year}}{[\text{redacted}]\ \text{/lb-mole}}\right)\left(\frac{1.0\ [\text{redacted}]\ \text{lb-moles } CH_4}{\text{lb-mole } [\text{redacted}]}\right)\left(\frac{16.04\ \text{lbs } CH_4}{\text{lb-mole}}\right)$$

$$\frac{\text{lbs } CH_4}{\text{year}} = ([\text{redacted}])(\text{lbs } [\text{redacted}]\ \text{used/year})$$

The emission factor derivation for CO_2, NO_2, and SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is not expected to be present in the tool when [redacted] is used.

1.1.2.4.5 Boron Trichloride (BCl_3) – Plasma Etch Processes

Boron trichloride (BCl_3) is used in plasma etch processes when etching metal substrates, such as aluminum and titanium. Tools using BCl_3 will use POUs capable of removing BCl_3 from the exhaust prior to oxidation. It is projected that POUs will remove 95% of BCl_3 prior to oxidation. It is assumed that the remaining 5% of BCl_3 reacts to form boric oxide (B_2O_3) and hydrogen chloride (HCl). It is assumed that 20% of the hydrogen chloride generated from BCl_3 etches aluminum (90%) and titanium (10%) to form aluminum trichloride ($AlCl_3$) and titanium tetrachloride ($TiCl_4$). It is assumed that 100% of $AlCl_3$ and $TiCl_4$ will then be oxidized to form aluminum trioxide (Al_2O_3), titanium dioxide (TiO_2), and HCl.

$$\frac{\text{lbs HCl}}{\text{year}} = \left(\frac{\text{lbs } BCl_3\ \text{used/year}}{117.17\ \text{lbs } BCl_3/\text{lb-mole}}\right)\left(\frac{3\ \text{lb-moles HCl}}{\text{lb-mole } BCl_3}\right)\left(\frac{36.46\ \text{lbs HCl}}{\text{lb-mole}}\right)(1\text{-}0.95)$$

$$\frac{\text{lbs HCl}}{\text{year}} = (0.047)\ (\text{lbs } BCl_3 \text{ used/year})$$

$$\frac{\text{lbs } Al_2O_3}{\text{year}} = \frac{(\text{lbs } BCl_3 \text{ used/year})\ (0.2)\ (0.9)\ (\text{lb-mole } AlCl_3)\ (\text{lb-mole } Al_2O_3)\ (101.96 \text{ lbs } Al_2O_3)\ (1\text{-}0.95)}{(117.17 \text{ lbs } BCl_3/\text{lb-mole})\ (\text{lb-mole } BCl_3)\ (2 \text{ lb-moles } AlCl_3)\ (\text{lb-mole})}$$

$$\frac{\text{lbs } Al_2O_3}{\text{year}} = (0.004)\ (\text{lbs } BCl_3 \text{ used/year})$$

$$\frac{\text{lbs } TiO_2}{\text{year}} = \frac{(\text{lbs } BCl_3 \text{ used/year})\ (0.2)\ (0.1)\ (0.75 \text{ lb-mole } TiCl_4)\ (\text{lb-mole } TiO_2)\ (79.90 \text{ lbs } TiO_2)\ (1\text{-}0.95)}{(117.17 \text{ lbs } BCl_3/\text{lb-mole})\ (\text{lb-mole } BCl_3)\ (\text{lb-mole } TiCl_4)\ (\text{lb-mole})}$$

$$\frac{\text{lbs } TiO_2}{\text{year}} = (0.001)\ (\text{lbs } BCl_3 \text{ used/year})$$

The emission factor derivation for B_2O_3, which also reflects 95% removal of BCl_3, is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when BCl_3 is used, is not expected to affect the byproducts derived above.

1.1.2.4.6 Chlorine Trifluoride (ClF_3) – Thin Films/Diffusion Deposition Processes

Chlorine trifluoride (ClF_3) is utilized as a clean gas for thin films/diffusion deposition tools. It is assumed that 100% of ClF_3 reacts to form hydrogen chloride (HCl) and hydrogen fluoride (HF). The materials cleaned in the process system (e.g., titanium, etc.) are accounted for in deposition chemical calculations.

$$\frac{\text{lbs HCl}}{\text{year}} = \frac{(\text{lbs } ClF_3 \text{ used/year})\ (1.0)\ (\text{lb-mole HCl})\ (36.46 \text{ lbs HCl})}{(92.45 \text{ lbs } ClF_3/\text{lb-mole})\ (\text{lb-mole } ClF_3)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HCl}}{\text{year}} = (0.394)\ (\text{lbs } ClF_3 \text{ used/year})$$

$$\frac{\text{lbs HF}}{\text{year}} = \frac{(\text{lbs } ClF_3 \text{ used/year})\ (1.0)\ (3 \text{ lb-moles HF})\ (20.01 \text{ lbs HF})}{(92.45 \text{ lbs } ClF_3/\text{lb-mole})\ (\text{lb-mole } ClF_3)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HF}}{\text{year}} = (0.649)\ (\text{lbs } ClF_3 \text{ used/year})$$

The presence or absence of oxygen in the tool, when ClF_3 is used, is not expected to affect the byproducts derived above.

1.1.2.4.7 Dichlorosilane (SiH_2Cl_2) – Thin Films / Diffusion Deposition Processes

Dichlorosilane (SiH_2Cl_2) is also called DCS and is used primarily in chemical vapor deposition (CVD) processes, a subset of thin films processes. It is assumed that 100% of DCS will react to form silicon dioxide (SiO_2) and hydrogen chloride (HCl).

$$\frac{\text{lbs HCl}}{\text{year}} = \frac{(\text{lbs DCS used/year})\ (1.0)\ (2\text{ lb-moles HCl})\ (36.46\text{ lbs HCl})}{(101.01\text{ lbs DCS/lb-mole})\ (\text{lb-mole DCS})\ (\text{lb-mole})}$$

$$\frac{\text{lbs HCl}}{\text{year}} = (0.722)\ (\text{lbs DCS used/year})$$

The emission factor derivation for SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when ClF_3 is used, is not expected to affect the byproducts derived above.

1.1.2.4.8 Fluorine (F_2) – Thin Films/Diffusion Deposition Processes

Fluorine (F_2) is utilized as a clean gas for thin films/diffusion deposition tools. It is assumed that 100% of F_2 reacts to form hydrogen fluoride (HF). The materials cleaned in the process system (e.g., titanium, etc.) are accounted for in deposition chemical calculations.

$$\frac{\text{lbs HF}}{\text{year}} = \frac{(\text{lbs } F_3\text{ used/year})\ (1.0)\ (2\text{ lb-moles HF})\ (20.01\text{ lbs HF})}{(38.0\text{ lbs } F_2\text{/lb-mole})\ (\text{lb-mole } F_2)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HF}}{\text{year}} = (1.05)\ (\text{lbs } F_2\text{ used/year})$$

Fluorine is also assumed to react with methane used in PEEC natural gas burners to form CF_4, as described in Section 1.1.1 above.

The presence or absence of oxygen in the tool, when F_2 is used, is not expected to affect the byproducts derived above.

1.1.2.4.9 Germanium Tetrafluoride (GeF4) – Thin Films / Diffusion Deposition Processes

Germanium tetrafluoride (GeF_4) is used primarily in deposition processes. It is assumed that 100% of germanium tetrafluoride (GeF_4) will react to form hydrogen fluoride (HF) and germanium dioxide (GeO_2).

$$\frac{\text{lbs HF}}{\text{year}} = \frac{(\text{lbs } GeF_4\text{ used/year})\ (1.0)\ (4\text{ lb-moles HF})\ (20.01\text{ lbs HF})}{(148.6\text{ lbs } GeF_4\text{/lb-mole})\ (\text{lb-mole } GeF_4)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HF}}{\text{year}} = (0.539)\ (\text{lbs } GeF_4\text{ used/year})$$

The emission factor derivation for GeO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when SiH_2Cl_2 is used, is not expected to affect the byproducts derived above.

1.1.2.4.10 Hexachlorodisilane (Si_2Cl_6) – Thin Films / Diffusion Deposition Processes

Hexachlorodisilane (Si_2Cl_6) is used in CVD processes. It is assumed that 100% of Si_2Cl_6 reacts to form silicon dioxide (SiO_2) and hydrogen chloride (HCl).

$$\frac{\text{lbs HCl}}{\text{year}} = \frac{(\text{lbs } Si_2Cl_6 \text{ used/year})\ (1.0)\ (6 \text{ lb-mole HCl})\ (36.46 \text{ lbs HCl})}{(268.89 \text{ lbs } Si_2Cl_6 \text{/lb-mole})\ (\text{lb-mole } Si_2Cl_6)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HCl}}{\text{year}} = (0.814)\ (\text{lbs } Si_2Cl_6 \text{ used/year})$$

The emission factor derivation for SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when Si_2Cl_6 is used, is not expected to affect the byproducts derived above.

1.1.2.4.11 Hydrogen Bromide (HBr) – Plasma Etch Processes

Hydrogen bromide (HBr) is used in plasma etch processes. The byproducts of plasma etch processes are being accounted for by other etch gases such as boron trichloride (BCl_3), except for bromine (Br_2) from HBr which is included below. It is assumed that 100% of HBr used is emitted from plasma etch processes and that Br_2 is created from of the HBr formed. This double accounting is a conservative engineering estimate for both HBr and Br_2 as the amount of HBr converted to Br_2 varies with plasma etch processes.

$$\frac{\text{lbs HBr}}{\text{year}} = (1.0)\ (\text{lbs HBr used/year})$$

$$\frac{\text{lbs } Br_2}{\text{year}} = \frac{(\text{lbs HBr used/year})\ (1.0)\ (\text{lb-mole } Br_2)\ (159.82 \text{ lbs } Br_2)}{(80.92 \text{ lbs HBr/lb-mole HBr})\ (2 \text{ lb-moles HBr})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } Br_2}{\text{year}} = (0.988)\ (\text{lbs HBr used/year})$$

The presence or absence of oxygen in the tool, when HBr is used, is not expected to affect the byproducts derived above.

1.1.2.4.12 [redacted] – Thin Films / Diffusion Deposition Processes

[redacted] is used in atomic layer deposition (ALD) process. It is assumed that 100% [redacted] to form ammonia (NH_3), propane (C_3H_8), nitrogen dioxide (NO_2), carbon dioxide (CO_2), and silicon dioxide (SiO_2).

$$\frac{\text{lbs } NH_3}{\text{year}} = \frac{(\text{lbs [redacted] used/year}) [redacted] (\text{lb-mole } NH_3) (17.03 \text{ lbs } NH_3)}{([redacted] \text{ lb-mole})(\text{lb-mole [redacted]}) (\text{lb-mole})}$$

$$\frac{\text{lbs } NH_3}{\text{year}} = ([redacted])(\text{lbs [redacted] used/year})$$

$$\frac{\text{lbs } C_3H_8}{\text{year}} = \frac{(\text{lbs [redacted] used/year}) (1.0) [redacted] \text{-moles } C_3H_8) (44.10 \text{ lbs } C_3H_8)}{([redacted] \text{ lb-mole})(\text{lb-mole [redacted]} (\text{lb-mole})}$$

$$\frac{\text{lbs } C_3H_8}{\text{year}} = ([redacted])(\text{lbs [redacted] used/year})$$

The emission factor derivation for CO_2, NO_2, and SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is not expected to be present in the tool when [redacted] is used.

1.1.2.4.13 Phosphorous Trifluoride (PF_3) – Plasma Etch Processes

Phosphorous Trifluoride (PF_3) is used in plasma etch processes. It is assumed that 100% of PF_3 reacts to form phosphorus pentoxide (P_2O_5) and hydrogen fluoride (HF).

$$\frac{\text{lbs HF}}{\text{year}} = \frac{(\text{lbs } PF_3 \text{ used/year}) (1.0) (3 \text{ lb-mole HF}) (20.01 \text{ lbs HF})}{(87.97 \text{ lbs } PF_3 \text{ /lb-mole}) (\text{lb-mole } PF_3) (\text{lb-mole})}$$

$$\frac{\text{lbs HF}}{\text{year}} = (0.68) (\text{lbs } PF_3 \text{ used/year})$$

The emission factor derivation for P_2O_5 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when PF_3 is used, is not expected to affect the byproducts derived above.

1.1.2.4.14 Polysilazane – Spin-on-Dielectric (SOD)

The SOD process is a specific fab process using polysilazane. Any unused material is sent to an HPM building for required neutralization to ensure safe shipment offsite, in which the polysilazane is reacted to offgas silane. It is assumed that the 100% of offgassed silane is combusted to form silicon dioxide (SiO_2). Ammonia (NH_3) is also offgassed. Ammonia (NH_3) is assumed to be emitted directly *and* combusted to form

nitrogen dioxide (NO_2). Since polysilazane has a variable molecular weight, its molecular weight was assumed to be 1000, and emission factors were derived conservatively assuming that the entire mass of polysilizane consists of the atom necessary to form each byproduct.

$$\frac{\text{lbs } SiO_2}{\text{year}} = \frac{(\text{lbs polysilazane neutralized/year})\ (1000 \text{ lbs polysilazane/lb-mole})\ (60.08 \text{ lbs } SiO_2\text{/lb-mole})}{(28 \text{ lbs Si/lb-mole})\ (1000 \text{ lbs polysilazane/lb-mole})}$$

$$\frac{\text{lbs } SiO_2}{\text{year}} = (2.15)(\text{lbs polysilazane neutralized/year})$$

$$\frac{\text{lbs } NH_3}{\text{year}} = \frac{(\text{lbs polysilazane neutralized/year})\ (1000 \text{ lbs polysilazane/lb-mole})\ (17.03 \text{ lbs } NH_3\text{/lb-mole})}{(14 \text{ lbs N/lb-mole})\ (1000 \text{ lbs polysilazane/lb-mole})}$$

$$\frac{\text{lbs } NH_3}{\text{year}} = (1.22)(\text{lbs polysilazane used/year})$$

$$\frac{\text{lbs } NO_2}{\text{year}} = \frac{(1.22 \text{ lbs } NH_3 \text{ /lb polysilizane})\ (46.01 \text{ lbs } NO_2)}{(17.03 \text{ lbs } NH_3)}$$

$$\frac{\text{lbs } NO_2}{\text{year}} = (3.29)(\text{lbs polysilazane used/year})$$

1.1.2.4.15 Octamethylcyclotetrasiloxane ($C_8H_{24}O_4Si_4$) – Thin Films / Diffusion Deposition Processes

Octamethylcyclotetrasiloxane ($C_8H_{24}O_4Si_4$) is used in CVD processes. It is assumed that 100% of $C_8H_{24}O_4Si_4$ reacts to form carbon dioxide (CO_2), silicon dioxide (SiO_2) and methanol (CH_3OH).

$$\frac{\text{lbs } CH_3OH}{\text{year}} = \frac{(\text{lbs } C_8H_{24}O_4Si_4 \text{ used/year})\ (1.0)\ (8 \text{ lb-moles } CH_3OH)\ (32.04 \text{ lbs } CH_3OH)}{(296.62 \text{ lbs } C_8H_{24}O_4Si_4 \text{ /lb-mole})\ (\text{lb-mole } C_8H_{24}O_4Si_4)\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = (0.864)\ (\text{lbs } C_8H_{24}O_4Si_4 \text{ used/year})$$

The emission factor derivation for CO_2 and SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is expected to be present in the tool when $C_8H_{24}O_4Si_4$ is used.

1.1.2.4.16 [redacted] – Thin Films / Diffusion Deposition Processes

[redacted] is used primarily in atomic layer deposition (ALD) processes. It is assumed that 100% of [redacted] reacts to form

diethylamine ($C_4H_{11}N$), ammonia (NH_3), nitrogen dioxide (NO_2), carbon dioxide (CO_2), and silicon dioxide (SiO_2).

$$\frac{\text{lbs } C_4H_{11}N}{\text{year}} = [\text{redacted}]\text{ used/year) (1.0) ([redacted] lb-moles } C_4H_{11}N) (73.14 \text{ lbs } C_4H_{11}N)$$
$$[\text{redacted}]\text{/lb-mole)(lb-mole [redacted]) (lb-mole)}$$

$$\frac{\text{lbs } C_4H_{11}N}{\text{year}} = ([\text{redacted}]\text{ used/year)}$$

$$\frac{\text{lbs } NH_3}{\text{year}} = \text{(lbs [redacted] used/year) (1.0) ([redacted] lb-moles } NH_3) (17.03 \text{ lbs } NH_3)$$
$$\text{([redacted] lbs [redacted]/lb-mole)(lb-mole [redacted]) (lb-mole)}$$

$$\frac{\text{lbs } NH_3}{\text{year}} = ([\text{redacted}])(\text{lbs [redacted] used/year)}$$

The emission factor derivation for CO_2, NO_2, and SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is not expected to be present in the tool when [redacted] is used.

1.1.2.4.17 Silicon Tetrachloride ($SiCl_4$) –Plasma Etch Processes

Silicon tetrachloride ($SiCl_4$) is used in both CVD and plasma etch processes. Tools using $SiCl_4$ will exhaust to the RCS, which will remove $SiCl_4$ from the exhaust prior to oxidation. It is projected that the RCS will remove 95% of $SiCl_4$ prior to oxidation. It is assumed that the remaining 5% of $SiCl_4$ will react to form silicon dioxide (SiO_2) and hydrogen chloride (HCl).

$$\frac{\text{lbs HCl}}{\text{year}} = \frac{\text{(lbs } SiCl_4 \text{ used/year) (1.0) (4 lb-moles HCl) (36.46 lbs HCl)}}{\text{(169.90 lbs } SiCl_4\text{/lb-mole) (lb-mole } SiCl_4\text{) (lb-mole)}} \text{ (1-0.95)}$$

$$\frac{\text{lbs HCl}}{\text{year}} = (0.043)\ (\text{lbs } SiCl_4 \text{ used/year})$$

The emission factor derivation for SiO_2, which also reflects 95% removal of $SiCl_4$, is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when $SiCl_4$ is used, is not expected to affect the byproducts derived above.

1.1.2.4.18 Tetraethylorthosilicate (TEOS) –Thin Films / Diffusion Deposition Processes

Tetraethylorthosilicate (TEOS) is used in CVD processes. It is assumed that 100% of TEOS will react to form ethanol (C_2H_5OH), carbon dioxide (CO_2), and silicon dioxide (SiO_2).

$$\frac{\text{lbs } C_2H_5OH}{\text{year}} = \frac{\text{(lbs TEOS used/year) (1) (4 lb-moles } C_2H_5OH) (46.07 \text{ lbs } C_2H_5OH)}{\text{(208.33 lbs TEOS/lb-mole) (lb-mole TEOS) (lb-mole)}}$$

$$\frac{\text{lbs } C_2H_5OH}{\text{year}} = (0.885)\ (\text{lbs TEOS used/year})$$

The emission factor derivation for CO_2 and SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is expected to be present in the tool when TEOS is used.

1.1.2.4.19 Titanium Tetrachloride ($TiCl_4$) – Thin Films / Diffusion Deposition Processes

Titanium tetrachloride ($TiCl_4$) is used in CVD processes. It is assumed that 100% of $TiCl_4$ reacts form titanium dioxide (TiO_2) and hydrogen chloride (HCl) (note: this includes titanium emitted as TiO_2 as a result of chamber cleaning).

$$\frac{\text{lbs HCl}}{\text{year}} = \frac{(\text{lbs } TiCl_4 \text{ used/year})\ (1.0)\ (4 \text{ lb-moles HCl})\ (36.46 \text{ lbs HCl})}{(189.71 \text{ lbs } TiCl_4/\text{lb-mole})\ (\text{lb-mole } TiCl_4)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HCl}}{\text{year}} = (0.769)\ (\text{lbs } TiCl_4 \text{ used/year})$$

The emission factor derivation for TiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when $TiCl_4$ is used, is not expected to affect the byproducts derived above.

1.1.2.4.20 Trimethylaluminum (TMAl) - Thin Films / Diffusion Deposition Processes

Trimethylaluminum (TMAl) is used with ozone in atomic layer deposition (ALD) processes. It is assumed that 100% of TMAl reacts to form formaldehyde (CH_2O), aluminum trioxide (Al_2O_3), methanol (CH_3OH), and carbon dioxide (CO_2) .

$$\frac{\text{lbs } CH_2O}{\text{year}} = \frac{(\text{lbs TMAl used/year})\ (1.0)\ (3 \text{ lb-moles } CH_2O)\ (30.03 \text{ lbs } CH_2O)}{(72.09 \text{ lbs TMAl/lb-mole})\ (\text{lb-mole TMAl})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_2O}{\text{year}} = (1.25)\ (\text{lbs TMAl used/year})$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = \frac{(\text{lbs TMAl used/year})\ (1.0)\ (3 \text{ lb-moles } CH_3OH)\ (32.04 \text{ lbs } CH_3OH)}{(72.09 \text{ lbs TMAl/lb-mole})\ (\text{lb-mole TMAl})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = (1.33)\ (\text{lbs TMAl used/year})$$

The emission factor derivation for Al_2O_3 and CO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is expected to be present in the tool when TMAl is used.

1.1.2.4.21 Trimethylsilane ($C_3H_{10}Si$) - Thin Films / Diffusion Deposition Processes

Trimethylsilane ($C_3H_{10}Si$) is used in CVD processes. It is assumed that 100% of $C_3H_{10}Si$ reacts to form silicon dioxide (SiO_2) and methane (CH_4).

$$\frac{\text{lbs } CH_4}{\text{year}} = \frac{(\text{lbs } C_3H_{10}Si \text{ used/year})\ (1.0)\ (3 \text{ lb-moles } CH_4)\ (16.04 \text{ lbs } CH_4)}{(74.20 \text{ lbs } C_3H_{10}Si \text{ /lb-mole})\ (\text{lb-mole } C_3H_{10}Si)\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_4}{\text{year}} = (0.649)\ (\text{lbs } C_3H_{10}Si \text{ used/year})$$

The emission factor derivation for SiO_2 is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is not expected to be present in the tool when $C_3H_{10}Si$ is used.

1.1.2.4.22 [redacted] - Thin Films / Diffusion Deposition Processes

[redacted] is used in deposition processes with ozone or oxygen. It is assumed that 100% of [redacted] reacts to form [redacted]), nitrogen dioxide (NO_2), [redacted] dimethylamine (C_2H_7N), methanol (CH_3OH), and carbon dioxide (CO_2). The carbon in [redacted] is assumed to break down to either methanol and dimethylamine, or [redacted] as well as CO_2 as listed below.

$$\frac{\text{lbs } CH_3OH}{\text{year}} = \frac{(\text{lbs [redacted] used/year})\ (1.0)\ ([redacted]\ CH_3OH)\ (32.04 \text{ lbs } CH_3OH)}{([redacted] \text{ lbs C[redacted]-mole})\ (\text{lb-mole C[redacted]})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } CH_3OH}{\text{year}} = ([redacted]\ (\text{lbs [redacted] used/year})$$

$$\frac{\text{lbs } C_2H_7N}{\text{year}} = \frac{(\text{lbs [redacted] used/year})\ (1.0)\ ([redacted] \text{ lb-moles } C_2H_7N)\ (45.08 \text{ lbs } C_2H_7N)}{([redacted]\text{lb-mole})\ (\text{lb-mole [redacted]})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } C_2H_7N}{\text{year}} = (0.469)\ (\text{lbs } C_{11}H_{23}N_3Zr \text{ used/year})$$

$$\frac{\text{lbs } C_5H_6}{\text{year}} = \frac{(\text{lbs [redacted] used/year})\ [redacted]\ (\text{lb-mole } C_5H_6)\ (66.10 \text{ lbs } C_5H_6)}{([redacted]\text{lb-mole})\ (\text{lb-mole [redacted]})\ (\text{lb-mole})}$$

$$\frac{\text{lbs } C_5H_6}{\text{year}} = (\text{[redacted]}) \text{ (lbs [redacted] used/year)}$$

The emission factor derivation for CO_2, NO_2, and [redacted] is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

Oxygen is expected to be present in the tool when [redacted] is used.

1.1.2.4.23 Tungsten Hexafluoride (WF6) – Thin Films / Diffusion Deposition Processes

Tungsten hexafluoride (WF_6) is used in deposition processes. Tools using WF_6 will use PEECs capable of removing WF_6 from exhaust prior to oxidation. It is projected that PEECs will remove 95% of WF_6 prior to oxidation. It is assumed the remaining 5% of WF_6 reacts to form tungsten trioxide (WO_3) and hydrogen fluoride (HF) (note: this includes tungsten from chamber clean).

$$\frac{\text{lbs HF}}{\text{year}} = \frac{(\text{lbs } WF_6 \text{ used/year})\ (1.0)\ (6 \text{ lb-moles HF})\ (20.01 \text{ lbs HF})\ (1\text{-}0.95)}{(297.84 \text{ lbs } WF_6\text{/lb-mole})\ (\text{lb-mole } WF_6)\ (\text{lb-mole})}$$

$$\frac{\text{lbs HF}}{\text{year}} = (0.020)\ (\text{lbs } WF_6 \text{ used/year})$$

The emission factor derivation for WO_3, which also reflects 95% removal of WF_6, is described in Section 1.1.2.3 above and shown in Table 3-1 of Appendix F.

The presence or absence of oxygen in the tool, when WF_6 is used, is not expected to affect the byproducts derived above.

1.2 Primary Chemicals Emitted Directly

The emission factors described in this section are for primary chemicals that are emitted directly without participating in chemical reactions. These chemicals have been grouped into categories to the extent possible.

1.2.1 Emission Factor of 1.0

Some of the chemicals used in the CMP, wet etch, plasma etch, thin films, SOD waste neutralization and ion implant process operations are expected to react incompletely or evaporate during processing. This leads to direct emission of the primary chemical. The following primary chemicals are conservatively assumed to be 100% emitted and have process emission factors of 1 lb emitted per lb used.

Table 1-1: Primary Chemicals with Emission Factor of 1.0

CAS #	Chemical Name	Molecular Formula	Production Process Type
74-86-2	Acetylene	C_2H_2	Thin Films / Diffusion Deposition
124-38-9	Carbon dioxide	CO_2	Wet Etch / Wet Clean
630-08-0	Carbon monoxide	CO	Plasma Etch
463-58-1	Carbonyl sulfide	COS	Plasma Etch
7782-50-5	Chlorine	Cl_2	Plasma Etch
19287-45-7	Diborane	B_2H_6	Thin Films / Diffusion Deposition
64-17-5	Ethanol	C_2H_6O	SOD Waste Neutralization
999-97-3	Hexamethyldisilazane	$C_6H_{19}NSi_2$	Photolithography
10035-10-6	Hydrogen bromide	HBr	Plasma Etch
7647-01-0	Hydrogen chloride	HCl	Thin Films / Diffusion Deposition/
7647-01-0	Hydrogen chloride	HCl	Diffusion Non-Deposition
7664-39-3	Hydrogen fluoride	HF	Thin Films / Diffusion Deposition
7664-39-3	Hydrogen fluoride	HF	Diffusion Non-Deposition
67-63-0	Isopropanol	C_3H_8O	Wiping
74-82-8	Methane	CH_4	Plasma Etch
67-56-1	Methanol	CH_4O	Photolithography
79-41-4	Methacrylic Acid	$C_4H_6O_2$	Thin Films / Diffusion Deposition
91-20-3	Naphthalene	$C_{10}H_8$	Thin Films / Diffusion Deposition
7803-51-2	Phosphine	PH_3	Thin Films / Diffusion Deposition
115-07-1	Propylene	C_3H_6	Thin Films / Diffusion Deposition
7446-09-5	Sulfur dioxide	SO_2	Plasma Etch
[redacted]	[redacted]	[redacted]	Thin Films / Diffusion Deposition
97-99-4	Tetrahydrofurfuryl alcohol	$C_5H_{10}O_2$	Thin Films / Diffusion Deposition

1.2.2 Emission Factor of 0.20

The following primary chemicals are volatile solvents. 20% evaporation is a conservative engineering estimate for these chemicals used in the specific process types indicated below. These chemicals are assigned process emission factor of 0.20 lbs emitted per lb used:

Table 1-2: Primary Chemicals with Emission Factor of 0.20

CAS #	Chemical Name	Molecular Formula	Production Process Type
[redacted]	[redacted]	[redacted]	Photolithography
95-63-6	1,2,4-Trimethylbenzene	C_9H_{12}	Thin Films / Diffusion Deposition

CAS #	Chemical Name	Molecular Formula	Production Process Type
95-63-6	1,2,4-Trimethylbenzene	C_9H_{12}	SOD Waste Neutralization
108-67-8	1,3,5-Trimethylbenzene	C_9H_{12}	SOD Waste Neutralization
123-91-1	1,4-Dioxane	$C_4H_8O_2$	Photolithography
107-98-2	1-Methoxy-2-propanol	$C_4H_{10}O_2$	Photolithography
929-06-6	2-(2-aminoethoxy)ethanol	$C_4H_{11}NO_2$	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
108-65-6	2-Methoxy-1-methylethyl acetate	$C_6H_{12}O_3$	Photolithography
108-65-6	2-Methoxy-1-methylethyl acetate	$C_6H_{12}O_3$	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
75-65-0	2-Methylpropan-2-ol	$C_4H_{10}O$	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
123-42-2	4-Hydroxy-4-methylperntan-2-one	$C_6H_{12}O_2$	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
108-11-2	4-Methylpentan-2-ol	$C_6H_{14}O$	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
108-94-1	Cyclohexanone	$C_6H_{10}O$	Photolithography
120-92-3	Cyclopentanone	C_5H_8O	Photolithography
142-96-1	Dibutyl ether	$C_8H_{18}O$	Photolithography SOD Waste Neutralization
[redacted]	[redacted]	[redacted]	Photolithography
687-47-8	ethyl (S)-2-hydroxypropionate	$C_5H_{10}O_3$	Photolithography
97-64-3	Ethyl lactate	$C_5H_{10}O_3$	Photolithography
96-48-0	Gamma-butyrolactone	$C_4H_6O_2$	Photolithography
110-43-0	Heptan-2-one	$C_7H_{14}O$	Photolithography
67-63-0	Isopropanol	C_3H_8O	Wet Etch / Wet Clean
2110-78-3	Methyl 2-hydroxy-2-methylpropionate	$C_5H_{10}O_3$	Photolithography
1319-77-3	Mixed cresols	C_7H_8O	Photolithography
123-86-4	n-Butyl acetate	$C_6H_{12}O_2$	Photolithography
52125-53-8	Propanol, 1(or 2)-ethoxy-	$C_5H_{12}O_2$	Photolithography
110-86-1	Pyridine	C_5H_5N	Photolithography

CAS #	Chemical Name	Molecular Formula	Production Process Type
64742-94-5	Solvent naphtha (petroleum), heavy arom.	Varies	Photolithography SOD Waste Neutralization

1.2.3 Emission Factor of 0.05

The following primary chemicals are not expected to be emitted at a high rate. These chemicals are either aqueous solutions of organic compounds expected to have low vapor pressures, pure organic compounds with low vapor pressures, inorganic acids with low vapor pressures, or gases used in ion implant processes expected to have high utilization leaving little raw material to be emitted. To maintain a conservative engineering estimate of emissions, these chemicals are assigned process emission factors of 0.05 lbs emitted per lbs used:

Table 1-3: Primary Chemicals with Emission Factor of 0.05

CAS #	Chemical Name	Molecular Formula	Production Process Type
Aqueous Solutions of Organics w/ Low Vapor Pressure			
288-88-0	1,2,4-Triazole	$C_2H_3N_3$	CMP
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	CMP
64-19-7	Acetic acid	CH_4CO_2	Wet Etch / Wet Clean
77-92-9	Citric acid	$C_6H_8O_7$	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	CMP
107-21-1	Ethanediol	$C_2H_6O_2$	Photolithography
150-77-6	N,N,N′,N′-Tetraethylethylenediamine	$C_{10}H_{24}N_2$	CMP
91-20-3	Naphthalene	$C_{10}H_8$	SOD Waste Neutralization
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
121-44-8	Triethylamine	$C_6H_{15}N$	Wet Etch / Wet Clean
Pure Organics w/ Low Vapor Pressure			
872-50-4	1-Methyl-2-pyrrolidone	C_5H_9NO	Photolithography
[redacted]	[redacted]	[redacted]	Photolithography
Inorganic Acids w/ Low Vapor Pressure			
7647-01-0	Hydrogen chloride	HCl	Wet Etch / Wet Clean

CAS #	Chemical Name	Molecular Formula	Production Process Type
7664-39-3	Hydrogen fluoride	HF	Wet Etch / Wet Clean
Ion Implant Process Gases			
7784-42-1	Arsine	AsH_3	Ion Implant
7803-51-2	Phosphine	PH_3	Ion Implant

1.2.4 Emission Factor of 0.001

The following primary chemicals may result in air emissions, but have either very low vapor pressures, or are expected to exist as a solid at room temperature. Therefore, emissions from these chemicals are expected to be in trace quantities, and an emission factor of 0.001 lbs emitted per lbs used to conservatively estimate some quantity of emissions.

Table 1-4: Primary Chemicals with Emission Factor of 0.001

CAS #	Chemical Name	Molecular Formula	Production Process Type
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	Photolithography
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
7722-84-1	Hydrogen peroxide	H_2O_2	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
13966-94-4	Indium iodide	InI	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	CMP
[redacted]	[redacted]	[redacted]	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	Photolithography
7664-38-2	Phosphoric acid	H_3PO_4	Wet Etch / Wet Clean
1310-58-3	Potassium hydroxide	KOH	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	CMP
7664-93-9	Sulfuric acid	H_2SO_4	Wet Etch / Wet Clean
[redacted]	[redacted]	[redacted]	Photolithography
75-59-2	Tetramethylammonium hydroxide	$C_4H_{13}NO$	Photolithography

1.2.5 Other Emission Factors

Four chemicals projected to be used as part of the Proposed Air Permit Project and emitted directly without participating in chemical reactions and do not fit into the four categories addressed in Sections 1.2.1, 1.2.2, 1.2.3, and 1.2.4. No more than 90% of gaseous ammonia is expected to be emitted without being oxidized to form NO_2. Aqueous ammonia, aqueous ammonium bifluoride, aqueous ammonium fluoride, and nitric acid solutions will be used, which have vapor pressures distinct from other chemicals addressed in the sections above to warrant distinct emission factors. Ammonium bifluoride and ammonium fluoride will evaporate and generate emissions as both NH_3 and HF. The emission factors for these chemicals are summarized below.

Table 1-5: Primary Chemicals with Other Direct Emission Factors

Primary CAS #	Primary Chemical	Emission Chemical	Production Process Type	Emission Factor
7664-41-7	Ammonia (NH_3), Gaseous	Ammonia (NH_3)	Thin Films / Diffusion Deposition	0.90
7664-41-7	Ammonia (NH_3), Aqueous	Ammonia (NH_3)	CMP	0.50
7664-41-7	Ammonia (NH_3), Aqueous	Ammonia (NH_3)	Wet Etch / Wet Clean	0.50
1341-49-7	Ammonium bifluoride (NH_5F_2)	Ammonia (NH_3)	Wet Etch / Wet Clean	0.01
1341-49-7	Ammonium bifluoride (NH_5F_2)	Hydrogen fluoride (HF)	Wet Etch / Wet Clean	0.02
12125-01-8	Ammonium fluoride (NH_4F)	Ammonia (NH_3)	Wet Etch / Wet Clean	0.01
12125-01-8	Ammonium fluoride (NH_4F)	Hydrogen fluoride (HF)	Wet Etch / Wet Clean	0.01
7697-37-2	Nitric Acid (HNO_3)	Nitric Acid (HNO_3)	Wet Etch / Wet Clean	0.01

APPENDIX H. NITROGEN OXIDES BACT/LAER ANALYSIS

This appendix presents the best available control technology (BACT) and lowest achievable emissions rate (LAER) determinations for control of nitrogen oxide (NO_X) emissions from the proposed emission sources at the Proposed Air Permit Project. Micron has reviewed the RACT/BACT/LAER Clearinghouse (RBLC), documentation from the Bay Area Air Quality Management District (BAAQMD), and relevant semiconductor fab permits to identify appropriate control technologies and/or limits for emission source categories. The analysis to determine BACT/LAER described in Section 5.4 of the Micron Clay Air Permit Application, and the sources of information for both BACT and LAER are very similar. The most significant difference between the two is that BACT allows for a determination of economic feasibility for an identified control technology whereas LAER does not. Because of this, it is generally accepted that LAER is more stringent than BACT and satisfies BACT requirements. Therefore, the analysis to select BACT and LAER is similar, except for economic feasibility considerations, and the process is combined in this appendix.

As the add-on control technologies and other control mechanisms are similar for many of the sources that Micron operates, types of control technologies identified are summarized in Section 1.1 of this appendix. Not all technologies are applicable to all emission sources, and as such, source-specific considerations for each source category are discussed in the subsequent sections.

Emission sources evaluated in this BACT/LAER analysis include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine; and
- Semiconductor process tools and other process and support operations that emit NO_X.

1.1 Available Technology Summary

The technologies identified to mitigate NO_X emissions are described in the following subsections.

1.1.1 Tier 4 Compliant Emergency Generator Engines

Engines meeting Tier 4 emissions standards are designed with a focus on reducing emissions, including NO_X, to meet stringent environmental and regulatory standards. These engines utilize various engineering and technological advancements to minimize NO_X emissions while maintaining performance and efficiency.

1.1.2 Good Combustion and Maintenance Practices for Fuel-Fired Equipment

Good combustion and maintenance practices are essential for operating fuel-fired equipment efficiently and effectively while minimizing NO_X emissions. For this source category, good combustion practices are generally considered to be implementing the manufacturer's recommendations, which may include a combination of the following:

- Optimizing the air-fuel ratio;

- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Minimizing engine idle time at startup;
- Conducting operator training; and
- Conducting periodic maintenance.

The specific practices available for each source category are discussed in the subsequent sections.

1.1.3 Low-NO_X Burners and Ultra-Low-NO_X Burners

Low-NO_X burners (LNBs) and ultra-low-NO_X burners (ULNBs) are advanced combustion technologies that significantly reduce NO_X emissions during combustion. LNBs achieve this by employing staged combustion and controlling flame shape and intensity. This process results in a cooler flame temperature which reduces NO_X formation.[1]

1.1.4 Flue Gas Recirculation

Flue gas recirculation (FGR) controls NO_X emissions by reintroducing a portion of the exhaust gases back into the combustion process. FGR systems reduce NO_X emissions by diluting the inlet air to reduce combustion temperature and lowering oxygen concentration in the flame zone, limiting the formation of thermal NO_X.[2]

1.1.5 Selective Catalytic Reduction

Selective Catalytic Reduction (SCR) reduces NO_X emissions by injecting ammonia into the exhaust stream upstream of a catalyst bed. The ammonia reacts with the NO_X over the catalyst to convert nitrogen oxide (NO) or nitrogen dioxide (NO_2) into diatomic nitrogen (N_2) and water vapor.[3] The catalyst serves to reduce the temperature required for the reduction reaction to occur.

1.1.6 Selective Non-Catalytic Reduction

Selective non-catalytic reduction (SNCR) is an emissions control technique used to reduce NO_X emissions in combustion processes. Unlike SCR, SNCR does not use a catalyst. Instead, SNCR introduces a reducing agent, typically an ammonia or urea solution, directly into the combustion flue gas. When the reducing agent mixes with the hot exhaust gases, a chemical reaction occurs, resulting in the conversion of NO_X into N_2.

[1] AP-42 Vol. I, Chapter 1.4 - Natural Gas Combustion.

[2] AP-42 Vol. I, Chapter 1.4 - Natural Gas Combustion.

[3] Ibid. Selective Catalytic Reduction Air Pollution Control Fact Sheet, EPA-452-F-03-032.

1.1.7 Turbocharger

Turbochargers are generally used by internal combustion engines and function by using exhaust gas to spin a turbine that is attached to a second turbine that compresses the air to increase the air flow rate into the engine, improving the combustion of fuel.[4]

1.1.8 Intercooler/Aftercooler

Intercooler and aftercooler systems generally apply to internal combustion engines. An intercooler cools compressed air from the turbocharger before it enters the engine's combustion chamber, allowing for increased density of air and more oxygen in the combustion chamber. The aftercooler cools hot gases after the combustion process before they enter the turbocharger to prevent overheating. Collectively, the primary purpose of these devices is to promote more complete combustion.[5]

1.1.9 Operating Limitations

Limiting the hours of operation for engines, water bath vaporizers, and boilers reduces NO_X emissions by decreasing the overall time the equipment runs and consumes fuel.

1.1.10 Wet Scrubbing of NO_2

Micron is aware of wet scrubbing technology that is potentially capable of removing NO_2 from the vapor phase. To accomplish this, NO generated from oxidation in the process tools and/or process equipment exhaust conditioners (PEECs) must first be oxidized into NO_2 through reaction with an oxidizing agent.

1.1.11 Control Technologies Not Evaluated

Some control technologies have been omitted from the BACT and LAER evaluation due to various considerations. These control technologies, and the reasons for their omission, are summarized in Table 1-1.

Table 1-1. Summary of Control Technologies Not Evaluated

Emission Source Category	Technology	Reasoning
All Source Categories	Use of Alternate Fuels	The use of different fuel or raw material that would redefine the Proposed Air Permit Project are out of the scope of BACT and LAER evaluations. Where different fuel specifications within the fuel type (i.e., use of ULSD) are feasible for the project, they have been identified above in Section 1.1 and are evaluated in the sections following this table.

[4] AP-42 Vol. I, Chapter 3.3: Gasoline And Diesel Industrial Engines.

[5] Ibid.

Emission Source Category	Technology	Reasoning
Natural Gas-Fired Boilers and Water Bath Vaporizers	SCR	In some cases, SCR has been identified in the sources listed in the introduction to this Appendix as a control for natural gas-fired boilers; however, there were no examples identified for natural gas-fired boilers with heat input ratings less than 50 MMBtu/hr. Since all the natural gas-fired boilers at the Proposed Air Permit Project will be less than 50 MMBtu/hr, SCR has not been demonstrated in practice for the small size of the equipment at the Proposed Air Permit Project. There has been no documented use of SCR as a control for natural gas-fired water bath vaporizers.
	SNCR	The use of SNCR as a method of controlling NO_X emissions from small natural gas-fired boilers or water bath vaporizers has not been demonstrated at a commercial scale and was not identified in the sources listed in the introduction to this Appendix.
Diesel-Fired Emergency Generator Engines and Diesel-Fired Emergency Fire Pump Engine	Use of ULSD	The fuel sulfur content does not reduce NO_X emissions for diesel-fired engines.[6]
	Oxy-fuel Combustion	The use of oxy-fuel combustion as a method of controlling NO_X emissions from small diesel-fired generators has not been demonstrated and was not identified in the sources listed in the introduction to this Appendix.
Semiconductor Process Tools and PEECs	LNBs / ULNBs	LNBs and ULNBs are not generally manufactured and incorporated into PEECs in semiconductor manufacturing. These PEECs typically have a heat input rating of less than 0.2 MMBtu/hr.
	SCR	There has been no documented use of SCR as a method used to reduce NO_X emissions from semiconductor process tools and PEECs.
	SNCR	There has been no documented use of SNCR as a method used to reduce NO_X emissions from semiconductor process tools and PEECs.
	FGR	There has been no documented use of FGR as a method used to reduce NO_X emissions emitted from semiconductor process tools and PEECs.
	Oxy-fuel Combustion	There has been no documented use of oxy-fuel combustion as a method used to reduce NO_X emissions emitted from PEECs in semiconductor manufacturing.

[6] AP-42 Vol. I, Chapter 3.3: Gasoline And Diesel Industrial Engines.

1.2 Natural Gas-Fired Boilers

Natural gas-fired boilers are heating systems used to generate hot water or steam for maintaining precise temperature control for various stages of production, ensuring the efficient operation of machinery. Micron is proposing to use efficient units that are specifically designed to meet the Proposed Air Permit Project's thermal requirements while minimizing energy consumption and emissions.

The BACT and LAER analysis for NO_X emissions from natural gas-fired boilers is presented in this section.

1.2.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing NO_X emissions from the proposed natural gas-fired boilers:

- Good combustion and maintenance practices;
- The use of LNBs and ULNBs;
- Integrated FGR;
- Oxy-fuel combustion; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered BACT and LAER for natural gas-fired boilers. Proposed BACT and LAER emission limits are discussed further in Step 4.

1.2.2 Step 2. Eliminate Technically Infeasible Options

Micron has evaluated the use of oxy-fuel combustion at the Proposed Air Permit Project. Oxy-fuel combustion burners and equipment are not available from manufacturers for the requisite equipment capacities and ratings needed for the boilers at the Proposed Air Permit Project. Additionally, the high purity oxygen required for oxy-fuel combustion requires more complex oxygen generation and separation processes upstream, and therefore results in higher energy consumption. Based on this review, oxy-fuel combustion is more suitable for coal-fired, industrial-grade boilers, rather than natural gas fire-tube boilers in the Proposed Air Permit Project. Therefore, oxy-fuel combustion is not technically feasible for the Proposed Air Permit Project.

1.2.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to select BACT and LAER.

1.2.4 Step 4. Select BACT and LAER

Micron intends to purchase natural gas-fired boilers designed to meet a NO_X emission limit of 9 parts per million by volume on a dry basis (ppmvd) at 3% oxygen (O_2) as BACT and LAER. This is the lowest emission limitation identified as BACT and LAER based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will also implement the

manufacturer's recommendations for good combustion and maintenance practices including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes utilizing engines with LNBs, ULNBs, and/or integrated FGR as needed to meet the proposed limit, and an operating limit of 6,000 hours per year for each boiler.

A BACT or LAER limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The boilers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for NO_X for natural gas-fired steam generating units.

1.3 Natural Gas-Fired Water Bath Vaporizers

This Permit Application 2 separates "natural gas-fired combustion equipment" into boilers and water bath vaporizers. Natural gas-fired water bath vaporizers are used in the semiconductor industry to provide a reliable and efficient source of high-purity nitrogen gas. These water bath vaporizers use natural gas to heat water that is used to vaporize liquified nitrogen used in semiconductor manufacturing.

The BACT and LAER analysis for NO_X emissions from natural gas-fired water bath vaporizers is presented in this section.

1.3.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing NO_X emissions from the proposed natural gas-fired water bath vaporizers:

- Good combustion and maintenance practices;
- The use of LNBs and ULNBs;
- Integrated FGR;
- Oxy-fuel combustion; and
- Operating hours limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered BACT and LAER for natural gas-fired water bath vaporizers. Proposed BACT and LAER emission limits are discussed further in Step 4.

1.3.2 Step 2. Eliminate Technically Infeasible Options

Micron has evaluated the use of oxy-fuel combustion at the Proposed Air Permit Project. Oxy-fuel combustion burners and equipment are not available from manufacturers for the requisite equipment

capacities and ratings needed for the water bath vaporizers at the Proposed Air Permit Project. Additionally, the high purity oxygen required for oxy-fuel combustion requires more complex oxygen generation and separation processes upstream, and therefore results in higher energy consumption. Therefore oxy-fuel combustion is not technically feasible for the Proposed Air Permit Project.

1.3.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to select BACT and LAER.

1.3.4 Step 4. Select BACT and LAER

Micron intends to purchase natural gas-fired water bath vaporizers designed to meet a NO_X emission limit of 50 pounds per million standard cubic feet(lb/MMscf) as BACT and LAER. This is the lowest emission limitation identified as BACT and LAER based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes utilizing water bath vaporizers with LNBs, ULNBs, and/or integrated FGR as needed to meet the proposed limit, and an operating limit of 8,000 hours per year for all water bath vaporizers combined, with no more than four units operating at a time.

Note that the emission limit identified is different than Permit Application 1 due to the separation of "natural gas-fired combustion equipment" into boilers and water bath vaporizers.

A BACT or LAER limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The water bath vaporizers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for NO_X for natural gas-fired steam generating units.

1.4 Diesel-Fired Emergency Generator Engines

The Proposed Air Permit Project will utilize diesel-fired emergency generator engines to ensure that critical life safety and process safety systems receive uninterrupted power during power outages. These units will not be designed to run manufacturing operations during major electrical outages and instead will allow equipment and processes to shut down gradually as necessary, protecting sensitive manufacturing

operations, preventing unsafe conditions from forming in the fabs, reducing emissions of process gases directly to the atmosphere, and protecting employee safety.

1.4.1 Step 1. Identify All Control Technologies

Diesel-fired emergency generator engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT and LAER. These standards are based on the engine's maximum power capacity and the year in which the engine was manufactured. Currently, the EPA has implemented the Tier 4 Final emission standards for non-road diesel engines, which set stringent limits for newly manufactured units.[7] EPA has also set limitations for stationary internal combustion engines under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." For engines with certain power capacity and manufacture year, NSPS Subpart IIII references the engine standards established for nonroad engines under 40 CFR 1039.

In addition, the following control methods have been identified for reducing NO_X emissions from the proposed diesel-fired emergency generator engines:

- Good combustion and maintenance practices; and
- Operating hour limitations.

1.4.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for diesel-fired emergency generator engines are technically feasible.

1.4.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 4, Micron is proposing to use all identified control technologies to achieve BACT and LAER. As a result, ranking the remaining control technologies is unnecessary, and the next step is to select BACT and LAER.

1.4.4 Step 4. Select BACT and LAER

The following control technologies are proposed to achieve BACT and LAER for diesel-fired emergency generator engines:

- Purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and

[7] 40 CFR 1039.101

- Conducting periodic maintenance

► Operating hour limitations.

A BACT or LAER limit must not be higher than an applicable NSPS emission limit. The diesel-fired generators will be affected facilities under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." NSPS Subpart IIII provides NO_X emission standards for various engine power and displacement categories. However, these emission standards are less stringent than the Tier 4 Final emission standards.

Therefore, Micron is proposing the Tier 4 Final emission standards outlined in Table 1-2 as the BACT and LAER NO_X limit for diesel-fired emergency generator engines and will procure engines for the Proposed Air Permit Project that meet these standards. Control technologies to achieve Tier 4 Final emission standards may vary depending on the engine manufacturer and may include the use of SCR, turbochargers, intercoolers and/or aftercoolers, where that technology is available and appropriate. In addition, Micron proposes an operating hours limit of 100 hours per year for each engine.

Table 1-2. 40 CFR §1039.101
Tier 4 Final Exhaust Emission Standards After the 2014 Model Year, g/kW-hr

Maximum Engine Power	Application	NOx Emission Standard	NOx + NMHC Emission Standard
kW <19	All	--	7.5
19 ≤ kW <56	All	--	4.7
56 ≤ kW <130	All	0.40	--
130 ≤ kW ≤560	All	0.40	--
kW >560	Generator Sets	0.67	--
	All Except Generator Sets	3.5	--

1.5 Diesel-Fired Emergency Fire Pump Engines

The Proposed Air Permit Project will include one diesel-fired emergency fire pump engine to provide a reliable power source in the event of a fire occurring during a power outage when the electric fire pump would not be available.

1.5.1 Step 1. Identify All Control Technologies

Diesel-fired emergency fire pump engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT and LAER. These standards are based on the fire pump engine's maximum power capacity and the year in which the engine was manufactured. EPA has set limitations for stationary internal combustion engines, including fire pump engines, under NSPS Subpart IIII, "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." The EPA has also implemented Tier emission standards (Tier 1 – Tier 4 Final) for non-road diesel engines, which set stringent limits for newly manufactured units. Based on the RBLC search conducted, as well as input from Micron's equipment vendors, Tier 4 compliant fire pump engines are not available. As such, the most stringent emission standards are Tier 3, which align with NSPS IIII requirements for the proposed fire pump engine for NO_X.

In addition, the following control methods have been identified for reducing NO_X emissions from the proposed diesel-fired emergency fire pump engine:

- Good combustion and maintenance practices;
- Operating hours limitations; and
- Use of ULSD.

1.5.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for the diesel-fired emergency fire pump engine are technically feasible.

1.5.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 4, Micron is proposing to use all identified control technologies to achieve BACT and LAER. As a result, ranking the remaining control technologies is unnecessary.

1.5.4 Step 4. Select LAER and BACT

The following control technologies are proposed to achieve BACT and LAER for the diesel-fired emergency fire pump engine:

- The purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine's idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and
  - Conducting periodic maintenance
- The use of ULSD; and
- Operating hour limitations.

A BACT or LAER limit must not be higher than an applicable NSPS emission limit. The diesel-fired emergency fire pump engine will be an affected facility under NSPS Subpart IIII. NSPS Subpart IIII provides NO_X emission standards for various engine power and displacement categories. For the capacity of the proposed diesel-fired emergency fire pump engine, NSPS IIII emission standards align with Tier 3 emission standards.

Therefore, Micron is proposing compliance with the NSPS IIII and Tier 3 emission standard (which is inclusive of NO_X and NMHC) of 3.0 grams per brake horsepower-hour (g/bhp-hr) for the diesel-fired emergency fire pump engine. Control technologies to achieve this emission standards may vary depending on the engine manufacturer and may include the use of SCR, turbochargers, intercoolers and/or aftercoolers, where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency fire pump engine and proposes an operating hours limit of 500 hours per year.

1.6 Semiconductor Process Tools and PEECs

Micron is proposing to install semiconductor process equipment, or "tools", as discussed within the Micron Clay Air Permit Application. Nitrogen oxides are generated through the operation of the semiconductor process tools as a reaction byproduct of nitrogen-containing raw materials. In addition, management of nitrogen-containing materials in PEECs generates NO_X, as does natural gas combustion within those units. NO_X generated through the semiconductor process tools and PEECs will be exhausted through the wet scrubbers. Refer to the process flow diagrams in Appendix E for additional details.

1.6.1 Step 1. Identify All Control Technologies

A review of the EPA's RBLC database did not identify any entries of semiconductor facilities that utilize add-on control devices to abate NO_X emissions that are generated from semiconductor process tools.

Micron also reviewed relevant semiconductor air permits to evaluate if any control technologies are currently being utilized to abate NO_X emissions from semiconductor process tools. During the review of these permits, it was determined that no add-on control devices are currently installed to abate such NO_X emissions.

Good combustion and maintenance practices for PEECs is the only method that has been identified for reducing NO_X emissions from the semiconductor process tools.

Micron has identified wet scrubbing of NO_2 as an additional NO_X control technology that was not present in the RBLC database analysis. This technology is evaluated as part of this analysis.

1.6.2 Step 2. Eliminate Technically Infeasible Options

All control technologies identified in Step 1 for semiconductor process tools are technically feasible and can be used in combination. Therefore, the next step is to rank remaining control technologies by control effectiveness.

1.6.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are technically feasible and can be used in combination, ranking the remaining control technologies is unnecessary. Therefore, the next step is to select BACT and LAER.

1.6.4 Step 4. Select BACT and LAER

Based on the analysis presented above, Micron is proposing to achieve BACT and LAER for NO_X emitted from semiconductor process tools by using good combustion and maintenance practices for PEECs, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

Additionally, Micron proposes wet scrubbing of NO_2 as part of the CVD exhaust centralized wet scrubbers. NOx generated as a result of reactions between process gases in tools, or due to oxidation in PEECs, will be routed to the CVD exhaust. The ionizing wet scrubbers (IWS) proposed for the CVD exhaust will incorporate oxidation of NO into NO_2 and wet scrubbing of NO_2 in addition to control of other contaminants as outlined in this application and Permit Application 1.

Given the diverse processes and complexity of semiconductor manufacturing, Micron is proposing to comply with good combustion and maintenance practices as a work practice standard to achieve BACT and LAER for NO_X emitted from semiconductor process equipment in lieu of a formal limit. Since wet scrubbing of NO_2 has not been historically identified as BACT/LAER for semiconductor manufacturing, there is no precedent for potential limits within the industry.

Attachment 1
RACT/BACT/LAER Clearinghouse Search Results

Attachment 2
Bay Area Air Quality Management District Summary

Attachment 3
Semiconductor Permit Review Summary

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/9/2015	PACKAGE BOILER	13.31	LOW NOX BURNER FLUE GAS RECIRCULATION GCP	30	PPMVD
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/9/2015	2 CALP Line Boilers	13.31	LOW NOX BURNER FLUE GAS RECIRCULATION (FGR) GOOD COMBUSTION PRACTICES (GCP)	30	PPMVD
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	2/14/2019	SN-233 Galvanizing Line Boilers	13.31	Low Nox Burners	0.1	LB/MMBTU
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	9/1/2021	SN-202, 203, 204 Pickle Line Boilers	13.31	Low NOx burners	0.035	LB/MMBTU
*IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	1/11/2024	Auxiliary Boiler (AB-3)	13.31	Low NOx burners and Good Combustion Practices	35	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	4/19/2021	Pickle Line #2 Boiler #1 & #2 (EP 21-04 & EP 21-05)	13.31	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan. Equipped with low-NOx burners.	50	LB/MMSCF
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	4/8/2014	AUXILLARY BOILER	13.31	EXCLUSIVE USE OF PIPELINE QUALITY NATURAL GAS AND GOOD COMBUSTION PRACTICES	0.01	LB/MMBTU
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	AUXILIARY BOILER	13.31	EXCLUSIVE USE OF PIPELINE QUALITY NATURAL GAS, ULTRA LOW-NOX BURNERS, AND GOOD COMBUSTION PRACTICES	0.01	LB/MMBTU

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0420	DTE GAS COMPANY--MILFORD COMPRESSOR STATION	MI	185-15	6/3/2016	FGAUXBOILERS	13.31	Ultra low NOx burners and good combustion practices.	14	PPMVOL
MI-0426	DTE GAS COMPANY - MILFORD COMPRESSOR STATION	MI	185-15A	3/24/2017	FGAUXBOILERS (6 auxiliary boilers EUAUXBOIL2A, EUAUXBOIL3A, EUAUXBOIL2B, EUAUXBOIL3B, EUAUXBOIL2C, EUAUXBOIL3C)	13.31	Ultra-low NOx burners and good combustion practices.	20	PPM AT 3% O2
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	8/25/2015	Auxiliary Boiler (B001)	13.31	Flue gas recirculation (FGR) and low NOx burner	0.68	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	9/7/2017	Auxiliary Boiler (B001)	13.31	Flue gas recirculation (FGR), low NOx burner	0.76	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	9/27/2017	Auxiliary Boiler (B001)	13.31	low NOX burners and flue gas recirculation	0.76	LB/H
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/7/2017	Auxiliary Boiler (B001)	13.31	Flue gas recirculation and low NOX burner	0.29	LB/H
OH-0377	HARRISON POWER	OH	P0122266	4/19/2018	Auxiliary Boiler (B001)	13.31	Good combustion practices and low NOx burner	1.56	LB/H
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	2/6/2019	Startup boiler (B001)	13.31	Low-NOX burners, good combustion practices and the use of natural gas	0.634	LB/H

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.31	Ultra-low NOX burners, good combustion practices, and the use of natural gas	9.74	T/YR
OR-0050	TROUTDALE ENERGY CENTER, LLC	OR	26-0235	3/5/2014	Auxiliary boiler	13.31	Utilize Low-NOx burners and FGR.	0.035	LB/MMBTU
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Auxiliary Boiler	13.31	SCR and ultra low NOx burners, Fired only on natural gas supplied by a public utility.	0.006	LB/MMBTU
*PA-0316	RENOVO ENERGY CENTER, LLC	PA	18-00033A	1/26/2018	Auxiliary Boiler	13.31	Ultra-low NOx burners and flue gas re-circulation operated in accordance with the manufacturer's specifications and good operating practices	0.011	LB
TX-0772	PORT OF BEAUMONT PETROLEUM TRANSLOAD TERMINAL (PBPTT)	TX	118901, GHGPSDTX108 AND PSDTX1	11/6/2015	Commercial/Institutional-Size Boilers/Furnaces	13.31	Not Specified	0.1	LB/MMBTU
WI-0283	AFE, INC. LCM PLANT	WI	17-JJW-207	4/24/2018	B01-B12, Boilers	13.31	Ultra-low NOx Burners, Flue Gas Recirculation and Good Combustion Practices	0.0105	LB/MMBTU
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	4/24/2018	B13-B24 & B25-B36 Natural Gas-Fired Boilers	13.31	Ultra-Low NOx Burners, Flue Gas Recirculation, and Good Combustion Practices.	0.0105	LB/MMBTU

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
WI-0306	WPL- RIVERSIDE ENERGY CENTER	WI	19-POY-212	2/28/2020	Temporary Boiler (B98A)	13.31	Low NOx burners, flue gas recirculation, shall be operated for no more than 500 hours, and shall combust only pipeline quality natural gas.	0.04	LB/MMBTU
WY-0075	CHEYENNE PRAIRIE GENERATING STATION	WY	MD-16173	7/16/2014	Auxiliary Boiler	13.31	Ultra low NOx burners and flue gas recirculation	0.0175	LB/MMBTU
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	5/4/2018	Pickle Line Equipment (pickle line no. 3 boilers)	19.6	Use of Low NOX Burners and Good Combustion Practices	50	LB/MMSCF

Process IDs: --
Other Search Criteria: Process Name Contains "Vaporizer"
Process Description: Natural Gas-fired Water Bath Vaporizers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered for Fuel Type as "Natural Gas" or Equivalent

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
*AR-0180	HYBAR LLC	AR	2470-AOP-R0	4/28/2023	Air Separation Plant Water Vaporizer	81.29	Low NOX burners, combustion of clean fuel, and good combustion practices	0.1	LB/MMBTU
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	7/23/2020	EP 13-01 - Water Bath Vaporizer	19.9	Low-Nox Burners (Designed to maintain 0.05 lb/MMBtu); and a Good Combustion and Operating Practices (GCOP) Plan.	50	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	4/19/2021	Air Separation Unit Water Bath Vaporizer (2 indirect burners) (EP 23-01)	19.6	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan. Equipped with low-NOx burners.	50	LB/MMSCF
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.31	Ultra-low NOX burners, good combustion practices, and the use of natural gas	2.59	T/YR
*WV-0034	WEST VIRGINIA STEEL MILL	WV	R14-0039	5/5/2022	Water Bath Vaporizer	81.29	LNB Good Combustion Practices	1.08	LB/HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0082	POINT THOMSON PRODUCTION FACILITY	AK	AQ1201CPT03	1/23/2015	Emergency Camp Generators	17.11	Not Specified	4.8	GRAMS/HP-H
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	6/30/2017	Black Start and Emergency Internal Combustion Engines	17.11	Good Combustion Practices	8	G/KW-HR
AL-0301	NUCOR STEEL TUSCALOOSA, INC.	AL	413-0033-X014 - X020	7/22/2014	Diesel fired Emergency Generator	17.11	Not Specified	0.015	LB/HP-H
AR-0177	NUCOR STEEL ARKANSAS	AR	1139-AOP-R27	11/21/2022	SN-230 Galvanizing Line No, 2 Emergency Generator	17.11	Not Specified	5.6	G/KW-HR
*AR-0180	HYBAR LLC	AR	2470-AOP-R0	4/28/2023	Emergency Generators	17.11	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	3.9	G/BHP-HR
FL-0347	ANADARKO PETROLEUM CORPORATION - EGOM	FL	OCS-EPA-R4015	9/16/2014	Emergency Diesel Engine	17.11	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	--	--
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	7/27/2018	1,500 kW Emergency Diesel Generator	17.11	Operate and maintain the engine according to the manufacturer's written instructions	6.4	G/KW-HOUR
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	6/7/2021	1,500 kW Emergency Diesel Generator	17.11	Not Specified	6.4	G/KW-HOUR
IL-0114	CRONUS CHEMICALS, LLC	IL	13060007	9/5/2014	Emergency Generator	17.11	Tier IV standards for non-road engines at 40 CFR 1039.102, Table 7.	0.67	G/KW-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
*IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Emergency Generator Engine	17.11	Not Specified	6.4	G/KW-HR
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	6/4/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	4.46	G/BHP-H
IN-0180	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	6/4/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	4.46	G/B-HP-H
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	3/23/2017	EMERGENCY GENERATORS (EU014A AND EU-014B)	17.11	GOOD COMBUSTION PRACTICES	4.42	G/HP-H EACH
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	6/11/2019	Emergency generator EU-6006	17.11	Tier II diesel engine	6.4	G/KWH
IN-0324	MIDWEST FERTILIZER COMPANY LLC	IN	129-44510-00059	5/6/2022	emergency generator EU 014a	17.11	Not Specified	4.42	G/HP-HR
IN-0359	NUCOR STEEL	IN	107-45480-00038	3/30/2023	Emergency Generator (CC-GEN1)	17.11	certified engine	4.8	G/HP-HR
*IN-0365	MAPLE CREEK ENERGY LLC	IN	T153-45909-00056	6/19/2023	Emergency generator	17.11	Not Specified	4.8	G/HP-HR
*IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	1/11/2024	Emergency Generator (400 kW)	17.11	Good Combustion Practices and meeting NSPS Subpart IIII requirements.	2.29	G/HP-HR
*IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	1/11/2024	Emergency Generator (1000 kW)	17.11	Good Combustion Practices and meeting NSPS Subpart IIII requirements.	3.81	G/HP-HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
*IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	1/11/2024	Emergency Generator (2000 kW)	17.11	Good Combustion Practices and meeting NSPS Subpart IIII requirements.	3.81	G/HP-HR
*IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	1/11/2024	Ammonia Plant Emergency Generator	17.11	Good Combustion Practices and meeting NSPS Subpart IIII requirements.	4.8	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	7/23/2020	EP 10-02 - North Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	4.77	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	7/23/2020	EP 10-03 - South Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	4.77	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	7/23/2020	EP 10-07 - Air Separation Plant Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	4.77	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	7/23/2020	EP 10-01 - Caster Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	4.77	G/HP-HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	4/19/2021	New Pumphouse (XB13) Emergency Generator #1 (EP 08-05)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	4/19/2021	Tunnel Furnace Emergency Generator (EP 08-06)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	4/19/2021	Caster B Emergency Generator (EP 08-07)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	4/19/2021	Air Separation Unit Emergency Generator (EP 08-08)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	5/23/2014	Emergency Diesel Generators (EQT 629, 639, 838, 966, & 1264)	17.11	Comply with 40 CFR 60 Subpart IIII; operate the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	27.37	LB/HR
LA-0292	HOLBROOK COMPRESSOR STATION	LA	PSD-LA-769(M-1)	1/22/2016	Emergency Generators No. 1 & No. 2	17.11	Good equipment design, proper combustion techniques, use of low sulfur fuel, and compliance with 40 CFR 60 Subpart IIII	14.16	LB/HR
LA-0296	LAKE CHARLES CHEMICAL COMPLEX LDPE UNIT	LA	PSD-LA-779	5/23/2014	Emergency Diesel Generators (EQTs 622, 671, 773, 850, 994, 995, 996, 1033, 1077, 1105, & 1202)	17.11	Compliance with 40 CFR 60 Subpart IIII; operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage.	27.37	LB/HR
LA-0305	LAKE CHARLES METHANOL FACILITY	LA	PSD-LA-803(M1)	6/30/2016	Diesel Engines (Emergency)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	6/4/2015	Emergency Generator Engines	17.11	Complying with 40 CFR 60 Subpart IIII	6.4	G/KW-HR
*LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	6/30/2017	DEG1-13 - Diesel Fired Emergency Generator Engine (EQT0012)	17.11	Compliance with NSPS Subpart IIII	19.23	LB/HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	8/31/2016	SCPS Emergency Diesel Generator 1	17.11	Compliance with NESHAP 40 CFR 63 Subpart ZZZZ and NSPS 40 CFR 60 Subpart IIII, and good combustion practices (use of ultra-low sulfur diesel fuel).	27.34	LB/H
*LA-0315	G2G PLANT	LA	PSD-LA-781	5/23/2014	Emergency Diesel Generator 1	17.11	Compliance with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	52.58	LB/H
*LA-0315	G2G PLANT	LA	PSD-LA-781	5/23/2014	Emergency Diesel Generator 2	17.11	Compliance with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	52.58	LB/H
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	2/17/2017	emergency generator engines (6 units)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0317	METHANEX - GEISMAR METHANOL PLANT	LA	PSD-LA-761(M4)	12/22/2016	Emergency Generator Engines (4 units)	17.11	complying with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	--	--
*LA-0324	COMMONWEALTH LNG FACILITY	LA	PSD-LA-841	3/28/2023	Generator Engines (EQT0016)	17.11	Compliance with 40 CFR 60 Subpart IIII and operating engines per manufacturers' instructions and written procedures designed to maximize combustion efficiency and minimize fuel usage.	8.46	G/KW-HR
LA-0331	CALCASIEU PASS LNG PROJECT	LA	PDS-LA-805	9/21/2018	Large Emergency Engines (>50kW)	17.11	Good Combustion and Operating Practices	5.6	G/KW-H
LA-0350	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-744(M2)	3/28/2018	emergency generators (3 units) EQT0039, EQT0040, EQT0041	17.11	Comply with 40 CFR 60 Subpart IIII	--	--

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0364	FG LA COMPLEX	LA	PSD-LA-812	1/6/2020	Emergency Generator Diesel Engines	17.11	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	--	--
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	6/3/2022	Emergency Diesel Generator Engine	17.11	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and use of ultra-low sulfur diesel fuel.	4.8	G/HP-HR
*LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	06-22 - AO-5 Emergency Generator	17.11	Use of good combustion practices and compliance with NSPS Subpart IIII	4.24	LB/HR
*LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	53-22 - PAO Emergency Generator	17.11	Use of good combustion practices, compliance with NSPS Subpart IIII	4.24	LB/HR
*LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	EGEN - Plant Emergency Generator	17.11	Compliance with 40 CFR 60 Subpart IIII	38.24	LB/HR
*LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	E. GEN 01 - Generac SD 2000	17.11	Compliance with the requirements of 40 CFR 60 Subpart IIII	28.48	LB/HR
*LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	E. GEN 02 - Generac SD 2000	17.11	Compliance with the requirements of 40 CFR 60 Subpart IIII	28.48	LB/HR
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	1/30/2014	Emergency Engine/Generator	17.11	Not Specified	4.8	GM/BHP-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0043	PERRYMAN GENERATING STATION	MD	PSC CASE NO. 9136	7/1/2014	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES, LIMITED HOURS OF OPERATION, AND EXCLUSIVE USE OF ULSD	4.8	G/HP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	6/9/2014	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES AND DESIGNED TO ACHIEVE EMISSION LIMIT	4.8	G/HP-H
MI-0418	WARREN TECHNICAL CENTER	MI	160-11B	1/14/2015	FG-BACKUPGENS (Nine (9) DRUPS Emergency Engines)	17.11	No add-on controls, but injection timing retardation (ITR) is good design. Engines are tuned for low-NOx operation versus low CO operation.	8	G/KW-H
MI-0418	WARREN TECHNICAL CENTER	MI	160-11B	1/14/2015	Four (4) emergency engines in FG-BACKUPGENS	17.11	No add-on controls, but injection timing retardation (ITR) is good design. Engines are tuned for low-NOx operation versus low CO operation.	7.13	G/KW-H
MI-0421	GRAYLING PARTICLEBOARD	MI	59-16	8/26/2016	Emergency Diesel Generator Engine (EUEMRGRICE in FGRICE)	17.11	Certified engines, limited operating hours.	22.6	LB/H
MI-0423	INDECK NILES, LLC	MI	75-16	1/4/2017	EUEMENGINE (Diesel fuel emergency engine)	17.11	Good combustion practices and meeting NSPS IIII requirements.	6.4	G/KW-H
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	5/9/2017	EUEMRGRICE1 in FGRICE (Emergency diesel generator engine)	17.11	Certified engines, limited operating hours.	21.2	LB/H
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	5/9/2017	EUEMRGRICE2 in FGRICE (Emergency Diesel Generator Engine)	17.11	Certified engines, limited operating hours	4.4	LB/H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	6/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.11	Good combustion practices and meeting NSPS Subpart IIII requirements.	6.4	G/KW-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	6/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.11	Good combustion practices and meeting NSPS IIII requirements.	6.4	G/KW-H
MI-0434	FLAT ROCK ASSEMBLY PLANT	MI	122-17	3/22/2018	EUENGINE01 through EUENGINE08	17.11	Good combustion practices.	6.4	G/KW-H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	7/16/2018	EUEMENGINE: Emergency engine	17.11	State of the art combustion design.	6.4	G/KW-H
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD1--A 1500 HP diesel fueled emergency engine	17.11	Good combustion practices and will be NSPS compliant.	6.4	G/KW-H
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD2--A 6000 HP diesel fuel fired emergency engine	17.11	Good combustion practices and will be NSPS compliant.	6.4	G/KW-H
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	8/21/2019	FGEMENGINE	17.11	Not Specified	5.3	G/HP-H
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE1 in FGRICE)	17.11	Certified engines, limited operating hours	21.2	LB/H
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE2 in FGRICE)	17.11	Certified Engines, Limited Operating Hours	4.4	LB/H
MI-0451	MEC NORTH, LLC	MI	167-17B	6/23/2022	EUEMENGINE (North Plant): Emergency engine	17.11	Good combustion practices and meeting NSPS Subpart IIII requirements.	6.4	G/KW-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0452	MEC SOUTH, LLC	MI	168-17B	6/23/2022	EUEMENGINE (South Plant): Emergency engine	17.11	Good Combustion Practices and meeting NSPS Subpart IIII requirements	6.4	G/KW-H
MI-0454	LBWL-ERICKSON STATION	MI	74-18D	12/20/2022	EUEMGD	17.11	Good combustion practices and will be NSPS compliant.	6.4	G/KW-H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	3/10/2016	Diesel Fired Emergency Generator	17.11	use of ultra low sulfur diesel a clean burning fuel.	42.3	LB/H
OH-0363	NTE OHIO, LLC	OH	P0116610	11/5/2014	Emergency generator (P002)	17.11	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	29.01	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	8/25/2015	Emergency generator (P003)	17.11	State-of-the-art combustion design	21.6	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	9/23/2016	Emergency generator (P003)	17.11	State-of-the-art combustion design	27.18	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	4/19/2017	Emergency Generator (P009)	17.11	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	5.5	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	9/7/2017	Emergency generator (P003)	17.11	State-of-the-art combustion design	16.07	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	9/27/2017	Emergency generator (P003)	17.11	State-of-the-art combustion design	16.1	LB/H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Generators (2 identical, P004 and P005)	17.11	Certified to the meet the emissions standards in 40 CFR 89.112 and 89.113 pursuant to 40 CFR 60.4205(b) and 60.4202(a)(2). Good combustion practices per the manufacturer's operating manual.	23.21	LB/H
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/7/2017	Emergency Diesel Generator Engine (P001)	17.11	Good combustion design	24.71	LB/H
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	2/9/2018	Emergency diesel-fired generator (P007)	17.11	Comply with NSPS 40 CFR 60 Subpart IIII	28.2	LB/H
OH-0377	HARRISON POWER	OH	P0122266	4/19/2018	Emergency Diesel Generator (P003)	17.11	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	19.68	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Emergency Diesel-fired Generator Engine (P007)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer's operating manual	37.41	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	1,000 kW Emergency Generators (P008 - P010)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer's operating manual	14.96	LB/H
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	2/6/2019	Emergency Generators (P005 and P006)	17.11	Tier IV engine Tier IV NSPS standards certified by engine manufacturer.	3.45	LB/H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	5,051 bhp (3,768 kWm) Diesel-Fired Emergency Generators: P001 through P046	17.11	Certified to meet Tier 2 standards and good combustion practices	6.4	G/KW-H
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	9/2/2016	Emergency Generator Engines	17.11	Not Specified	4.8	G/BHP-HR
PA-0311	MOXIE FREEDOM GENERATION PLANT	PA	40-00129A	9/1/2015	Emergency Generator	17.11	Not Specified	4.93	G/HP-HR
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	4/10/2014	Emergency Diesel Generator	17.11	Not Specified	2.85	G/B-HP-H
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	4/1/2015	Emergency Diesel Generator	17.11	Minimized hours of operations Tier II engine	0.0218	G/HP HR
VA-0325	GREENSVILLE POWER STATION	VA	52525	6/17/2016	DIESEL-FIRED EMERGENCY GENERATOR 3000 kW (1)	17.11	Good Combustion Practices/Maintenance	6.4	G/KW
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	4/24/2018	Diesel-Fired Emergency Generators	17.11	The Use of Ultra-Low Sulfur Fuel and Good Combustion Practices	5.36	G/KWH
WI-0286	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-022	4/24/2018	P42 -Diesel Fired Emergency Generator	17.11	Good Combustion Practices, The Use of an Engine Turbocharger and Aftercooler.	5.36	G/KWH

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	9/1/2020	Emergency Diesel Generator (P07)	17.11	Operation limited to 500 hours/year and operate and maintain according to the manufacturer's recommendations.	4.8	G/HP-H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Emergency Generator	17.11	Not Specified	--	--
WV-0027	INWOOD	WV	R14-0015M	9/15/2017	Emergency Generator - ESDG14	17.11	Engine Design	4.77	G/HP-HR
*WV-0033	MAIDSVILLE	WV	R14-0038	1/5/2022	Emergency Generator	17.11	Combustion Control (retarded timing and/or lean burn)	24.6	LB/HR
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	3/17/2021	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	4.86	G/KW-HR
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	1/31/2022	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	3.9	G/BHP-HR
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED AUXILIARY (EMERGENCY) ENGINES (TWO)	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES	6.4	G/KW-H
MI-0434	FLAT ROCK ASSEMBLY PLANT	MI	122-17	3/22/2018	EULIFESAFETYENG - One diesel-fueled emergency engine/generator	17.21	Good combustion practices.	4	G/KW-H

Process IDs: 99.011, 99.006
Other Search Criteria: –
Process Description: Semiconductor Manufacturing
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/17/2025
Notes & Filtering: Filtered for Process ID and Process Name

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	Semiconductor Fabrication: P179 through P182	99.011	Not Specified	--	--
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P12, P22, P18, P19, P28, P29 Organic Stripping Systems, Array/Color Filter and Cell Processes	99.006	Regenerative Thermal Oxidizer	0.04	LB/MMBTU
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P15 & P25 VOC System Array Process	99.006	Use of Ultra-low NOx Burners & Flue Gas Recirculation	2.64	LB/MMBTU
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P13 & P23 Chemical Vapor Deposition System Array Process	99.006	Combustor, Baghouse and Wet Scrubber in series	95	% CONTROL
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P14 & P24 Dry Etching System Array Process	99.006	Combustor and Wet Scrubber in series	0.04	LB/MMBTU

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0083	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT06	01/06/2015	Diesel Fired Well Pump	17.21	Limited Operation of 168 hr/yr.	4.41	LB/MMBTU
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Fire Pump Diesel Internal Combustion Engines	17.21	Good Combustion Practices	3.7	G/KW-HR
AK-0085	GAS TREATMENT PLANT	AK	AQ1524CPT01	08/13/2020	Three (3) Firewater Pump Engines and two (2) Emergency Diesel Generators	17.21	Good combustion practices, limit operation to 500 hours per year per engine	3.6	G/HP-HR
AK-0086	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT07	03/26/2021	Diesel Fired Well Pump	17.21	Good Combustion Practices and Limited Use	4.41	LB/MMBTU
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	14.06	G/BHP-HR
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	14.06	G/BHP-HR
FL-0354	LAUDERDALE PLANT	FL	0110037-013-AC	08/25/2015	Emergency fire pump engine, 300 HP	17.21	Low-emitting fuel and certified engine	4	G / KWH
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	Emergency Fire Pump Engine (347 HP)	17.21	Operate and maintain the engine according to the manufacturer's written instructions	4	G/KW-HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	06/07/2021	Emergency Fire Pump Engine (347 HP)	17.21	Not Specified	4	G/KW-HOUR
IL-0129	CPV THREE RIVERS ENERGY CENTER	IL	16060032	07/30/2018	Firewater Pump Engine	17.21	Not Specified	---	---
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Firewater Pump Engine	17.21	Not Specified	4	G/KW-HR
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Fire Water Pump Engine	17.21	Not Specified	4	GRAMS
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Firewater Pump Engine	17.21	Not Specified	4	G/KW-HR
KS-0030	MID-KANSAS ELECTRIC COMPANY, LLC - RUBART STATION	KS	C-13309	03/31/2016	Compression ignition RICE emergency fire pump	17.21	Not Specified	3	G/HP-HR
LA-0301	LAKE CHARLES CHEMICAL COMPLEX ETHYLENE 2 UNIT	LA	PSD-LA-779	05/23/2014	Firewater Pump Nos. 1-3 (EQTs 997, 998, & 999)	17.21	Compliance with 40 CFR 60 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage	3.21	LB/HR
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Firewater Pump Engines	17.21	Complying with 40 CFR 60 Subpart IIII	3	G/BHP-HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Firewater Pump 1	17.21	Compliance with NESHAP 40 CFR 63 Subpart ZZZZ and NSPS 40 CFR 60 Subpart IIII, and good combustion practices (use of ultra-low sulfur diesel fuel).	1.87	LB/H
LA-0314	INDORAMA LAKE CHARLES FACILITY	LA	PSD-LA-813	08/03/2016	Diesel Firewater pump engines (6 units)	17.21	complying with 40 CFR 63 subpart ZZZZ	---	---
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	firewater pump engines (8 units)	17.21	Complying with 40 CFR 60 Subpart IIII	---	---
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39A	17.21	Good combustion practices and NSPS IIII	4	G/KW-H
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39B	17.21	Good combustion practices and NSPS Subpart IIII	4	G/KW-H
LA-0370	WASHINGTON PARISH ENERGY CENTER	LA	PSD-LA-829(M-1)	04/27/2020	Emergency Fire Pump Engine (EQT0021, ENG-1)	17.21	The use of low sulfur fuels and compliance with 40 CFR 60 Subpart IIII	1.15	LB/HR
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Fired Water Pump Engine	17.21	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and use of ultra-low sulfur diesel fuel.	3	G/HP-HR
LA-0397	WESTLAKE ETHYLENE PLANT	LA	PSD-LA-813(M3)	04/29/2022	Emergency Generators and Fire Water Pumps (EQT0027 - EQT0032, EQT0044, EQT0045)	17.21	Compliance with applicable requirements of 40 CFR 60 Subpart IIII	---	---

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-01 - Firewater Pump Engine No. 1	17.21	Compliance with 40 CFR 60 Subpart IIII	3.96	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-02 - Firewater Pump Engine No. 2	17.21	Compliance with 40 CFR 60 Subpart IIII	3.96	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-03 - Firewater Pump Engine No. 3	17.21	Compliance with the requirements of 40 CFR 60 Subpart IIII	1.49	LB/HR
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Fire Pump Engine	17.21	Not Specified	3	GM/BHP-H
MD-0041	CPV ST. CHARLES	MD	PSC CASE NO. 9280	04/23/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES, AND LIMITING THE HOURS OF OPERATION	3	G/HP-H
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	LIMITED OPERATING HOURS, USE OF ULTRA- LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES	3	G/HP-H
MD-0043	PERRYMAN GENERATING STATION	MD	PSC CASE NO. 9136	07/01/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	GOOD COMBUSTION PRACTICES, LIMITED HOURS OF OPERATION, AND EXCLUSIVE USE OF ULSD	3	G/HP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	5 EMERGENCY FIRE WATER PUMP ENGINES	17.21	GOOD COMBUSTION PRACTICES AND DESIGNED TO ACHIEVE EMISSION LIMIT	3	G/HP-H
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES	4	G/KW-H
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED FIRE PUMP ENGINE	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR DIESEL FUEL AND GOOD COMBUSTION PRACTICES	4	G/KW-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	3	G/BHP-H
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices.	3	G/HP-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (South Plant): Fire pump engine	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	3	G/BHP-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (North Plant): Fire pump engine	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	3	G/BHP-H
MI-0434	FLAT ROCK ASSEMBLY PLANT	MI	122-17	03/22/2018	EUFIREPUMPENGS (2 emergency fire pump engines)	17.21	Good combustion practices.	3	G/B-HP-H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUFPENGINE: Fire pump engine	17.21	State of the art combustion design.	4	G/KW-H
MI-0445	INDECK NILES, LLC	MI	75-16B	11/26/2019	EUFPENGINE (Emergency engine-diesel fire pump	17.21	Good Combustion Practices and meeting NSPS Subpart IIII requirements	3	G/BHP-H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUFPENGINE (North Plant): Fire Pump Engine	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	3	G/B-HP-H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUFPENGINE (South Plant): Fire pump engine	17.21	Good Combustion Practices and meeting NSPS Subpart IIII requirements	3	G/B-HP-H
NJ-0081	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068 -(BOP120002)	03/07/2014	Emergency diesel fire pump	17.21	Not Specified	1.75	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Emergency Diesel Fire Pump	17.21	use of ULSD a clean burning fuel, and limited hours of operation	1.7	LB/H
NJ-0085	MIDDLESEX ENERGY CENTER, LLC	NJ	19149/PCP150001	07/19/2016	EMERGENCY DIESEL FIRE PUMP	17.21	Use of Ultra Low Sulfur Diesel (ULSD) Oil a clean burning fuel and limited hours of operation	2.05	LB/H
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency Fire Pump Engine (P003)	17.21	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	1.72	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.81	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	1.79	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Fire Pump Diesel Engine (P008)	17.21	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	0.3	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	1.97	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	1.97	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Fire Pump (P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII. Good combustion practices per the manufacturer's operating manual	2.7	LB/H
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fueled fire pump (P006)	17.21	Comply with NSPS 40 CFR 60 Subpart IIII	1.6	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Fire Pump (P004)	17.21	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	2.12	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Firewater Pumps (P005 and P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII and employ good combustion practices per the manufacturer's operating manual	2.64	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	275 hp (205 kW) Diesel-Fired Emergency Fire Pump Engine	17.21	Certified to meet the standards in Table 4 of 40 CFR Part 60, Subpart IIII and good combustion practices	4	G/KW-H
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Fire pump engine	17.21	Not Specified	3	GM/HP-HR
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	09/02/2016	Emergency Fire Pump Engine	17.21	Not Specified	3	G/BHP-HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Fire Pump	17.21	Not Specified	2.85	G/B-HP-H
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED WATER PUMP 376 bph (1)	17.21	Good Combustion Practices/Maintenance	---	---
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Emergency Fire Water Pump	17.21	Good combustion practices and the use of ultra low sulfur diesel (S15 ULSD) fuel oil with a maximum sulfur content of 15 ppmw.	3	G/HP-HR
WI-0263	WISCONSIN POWER & LIGHT - NEENAH GENERATING STATION	WI	14-DMM-200	02/15/2016	Fire pump (process P05)	17.21	Good combustion practices, use diesel fuel, and operate <500 hr/yr	---	---
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Fire Pump (P06)	17.21	Operation limited to 500 hours/year and shall be operated and maintained according to the manufacturer's recommendations.	3	G/HP-H
WI-0302	WPL- RIVERSIDE ENERGY CENTER	WI	19-DMM-153	02/28/2020	Diesel-Fired Fire Pump Engine (P04)	17.21	Only use diesel fuel oil with a sulfur content of no greater than 0.0015% by weight	3.64	LB/H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Fire Pump Engine	17.21	Not Specified	---	---

					BACT Determination		Typical Technology	
Source Type	Classification	Primary Fuel	Reference [a]	Date of Reference	Feasible /Cost Effective	Achieved in Practice	Feasible/ Cost Effective	Achieved in Practice
Diesel-Fired Emergency Engine	> 50 BHP and < 1000 BHP Output	Diesel	BAAQMD	12/22/2020	Not Specified	CARB ATCM standard for NO_x at applicable horsepower rating (see attached Table 1).	Not Specified	Any engine certified or verified to achieve the applicable standard.
Diesel-Fired Emergency Engine	> 1000 BHP Output	Diesel	BAAQMD	12/22/2020	Not Specified	0.5 g/bhp-hr	Not Specified	Any engine certified or verified to achieve the applicable standard.

Notes:
a. Data sources include:
BAAQMD - Bay Area Air Quality Management District (https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook);

Source Type	Permit Emission Unit Description	Permittee	State	Permit ID	Issue Date	Pollutant	Control Technology	Permit Limit
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	NOx	Low NOx burners on RCTOs Wet Scrubbers (for acid and NH3) Good Combustion Practices (Trimix System catalyst zones operating between 500-600 degrees F)	212.7 tons per rolling, 12-month period RCTO average emissions shall not exceed 0.96 lb NOx per hour; Combined NOx emssions from scrubbers shall not exceed 39.9 lb/hr; NOx < 0.34 lb/hr for each trimix system
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	NOx	Low NOx burners on RCTOs Wet Scrubbers (for acid and NH3) Good Combustion Practices (Trimix System catalyst zones operating between 500-600 degrees F)	212.7 tons per rolling, 12-month period RCTO average emissions shall not exceed 0.96 lb NOx per hour; Combined NOx emssions from scrubbers shall not exceed 39.9 lb/hr; NOx < 0.34 lb/hr for each trimix system
Semiconductor Process Tool Emissions	Semiconductor Fab Process Tools	Intel Corp	OR	34-2681-ST-01	1/22/2016	NOx	Good Work Practices	---
Semiconductor Process Tool Emissions	Semiconductor Fab Tool Processes	TSMC Arizona Corporation	AZ	P0008497	11/4/2022	NOx	Good Combustion Practices in POU Abatement Devices	---

APPENDIX I. NITROGEN OXIDES RACT ANALYSIS

This appendix presents the reasonably available control technology (RACT) determination for control of nitrogen oxide (NO_X) emissions from the proposed emission sources at the Proposed Air Permit Project.

RACT is defined in 6 NYCRR 200.1 as "the lowest emission limit that a particular source is capable of meeting by application of control technology that is reasonably available considering technological and economic feasibility". The Proposed Air Permit Project would be a major source of NO_X emissions and would therefore be subject to the NO_X RACT requirements under the following regulations of Title 6 of the New York Codes, Rules, and Regulations (6 NYCRR):

- Part 227 – Stationary Combustion Installations, Subpart 227-2 - Reasonably Available Control Technology (RACT) for Major Facilities of Oxides of Nitrogen (NO_X); and
- Part 212 – Process Operations, Subpart 212-3 - Reasonably Available Control Technology for Major Facilities.

RACT requirements for the control of NO_X emissions generally fall into one of two categories: (i) presumptive RACT limits or (ii) case-by-case RACT determinations. Presumptive RACT limits are category wide requirements and are based on capabilities that are generally reasonably achievable for units in an emission source category. For some categories of emission sources, however, presumptive RACT limits may not be attainable at individual emission sources. Case-by-case RACT determinations consider the technological and economic circumstances of the individual emission source and may include factors such as site space constraints, burner design and existing fuel types, emission controls and ductwork geometry. In addition, there may be sources that are subject to NO_X RACT, but are not in a category having a presumptive RACT limit. These sources are subject to case-by-case determinations. Facilities including sources for which no presumptive RACT limit exists must submit proposals for RACT limits based on an analysis of the available control technologies.

Emission sources with potential to emit NO_X in the Proposed Air Permit Project include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine; and
- Semiconductor process tools and other process and support operations that emit NO_X.

1.1 6 NYCRR 227-2 Presumptive NO_X RACT

6 NYCRR 227-2 stipulates presumptive NO_X RACT for six types of combustion installations:

1. Very large boilers;
2. Large boilers;

3. Mid-Size boilers;
4. Small boilers, small combustion turbines, and small stationary internal combustion engines;
5. Combustion turbines; and
6. Stationary internal combustion engines.

1.1.1 Very Large Boilers

While 'very large boilers' are not explicitly defined in 6 NYCRR 227-2.2, it is understood to mean boilers with a maximum rated heat input capacity greater than 250 MMBtu/hr. The Proposed Air Permit Project does not include any sources under this category.

1.1.2 Large Boilers

As per 6 NYCRR 227-2.2, a 'large boiler' is a boiler with a maximum rated heat input capacity greater than 100 MMBtu/hr and equal to or less than 250 MMBtu/hr. The Proposed Air Permit Project does not include any sources under this category.

1.1.3 Mid-Size Boilers

As per 6 NYCRR 227-2.2, a 'mid-size boiler' is a boiler with a maximum rated heat input capacity greater than 25 MMBtu/hr and equal to or less than 100 MMBtu/hr. The natural gas fired boilers are rated at approximately 32.7 MMBtu/hr and therefore would qualify as mid-size boilers. The boilers must meet the presumptive RACT limit of 0.05 lb/MMBtu NO_X emission limit as stipulated in 6 NYCRR 227-2.4(c)(1).

1.1.4 Small boilers, small combustion turbines, and small stationary internal combustion engines.

As per 6 NYCRR 227-2.2, a 'small boiler' is a boiler with a maximum rated heat input capacity equal to or greater than 1 MMBtu/hr and equal to or less than 25 MMBtu/hr; a ' small combustion turbine' is a combustion turbine with a maximum rated heat input capacity less than 10 MMBtu/hr; and a 'small stationary internal combustion engine' is a stationary internal combustion engine with a maximum mechanical output rating of less than 400 brake horsepower outside of New York's severe ozone nonattainment area.

No natural gas-fired small boilers are planned as part of the Proposed Air Permit Project. No combustion turbines are planned as part of the Proposed Air Permit Project. No small stationary internal combustion engines are planned as part of the Proposed Air Permit Project.

Subject small boilers will comply with the presumptive RACT stipulated in 6 NYCRR 227-2.4(d) by conducting an annual tune-up and maintaining pertinent records.

1.1.5 Combustion turbines

The Proposed Air Permit Project does not include any combustion turbines.

1.1.6 Stationary Internal Combustion Engines

The Proposed Air Permit Project will include several stationary internal combustion engines with a maximum mechanical output rating of 400 HP or greater. These engines will be used for the operation of emergency generators. 6 NYCRR 227-2.4(f) stipulates presumptive NO_X RACT for stationary internal combustion engines. However, as per 6 NYCRR 227-2.4(f)(6), emergency power generating stationary internal combustion engines are exempt from the presumptive NO_X RACT limits contained in that subsection. Therefore, presumptive NO_X RACT limits do not apply to these engines.

1.2 6 NYCRR 212-3.1 NO_X RACT for Major Facilities

As per 6 NYCRR 212-3.1(f), each new emission point that has a potential to emit greater than 3 lb/hr and actual emissions in excess of 15 lb/day NO_X must be included in a NO_X RACT analysis. Nitrogen oxide emission sources at the Proposed Air Permit Project that are not already addressed under the presumptive RACT (Section 1.1 of this Appendix) that would be subject to case-by-case RACT evaluation would include semiconductor process tools and other process and support operations that emit NO_X and natural gas-fired water bath vaporizers.

Micron has completed a NO_X Lowest Achievable Emission Rate (LAER) evaluation as required by the federal Nonattainment New Source Review (NNSR) regulation. This evaluation is included in Appendix H of this air permit application. As described in Section 3.3.9 of the Micron Clay Air Permit Application, the Proposed Air Permit Project will be a major new source of NO_X. Because this is a new major source, all emission sources at the facility that generate NO_X are subject to LAER. Since LAER is inherently more stringent than RACT, Micron proposes to comply with NO_X RACT by complying with the NO_X LAER determination.

APPENDIX J. CARBON MONOXIDE BACT ANALYSIS

This appendix presents the best available control technology (BACT) determinations for the control of carbon monoxide (CO) emissions from the proposed emission sources at the Proposed Air Permit Project. Micron has reviewed the RACT/BACT/LAER Clearinghouse (RBLC), documentation from the Bay Area Air Quality Management Districts (BAAQMD), and relevant semiconductor fab permits to identify appropriate technologies and/or limits for emission source categories. Additional details of the full search are provided in Section 5.4 of the Micron Clay Air Permit Application. As the add-on control technologies and other control mechanisms are similar for many of the sources that Micron operates, types of control technologies identified are summarized in Section 1.1 of this appendix. Not all technologies are applicable to all emission sources, and as such, source-specific considerations for each source category are discussed in the subsequent sections.

Emission sources evaluated in this BACT analysis include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine; and
- Semiconductor process tools and other process and support operations that emit CO.

1.1 Available Technology Summary

The technologies identified to mitigate CO emissions are described in the following subsections.

1.1.1 Tier 4 Compliant Emergency Generator Engines

Engines meeting Tier 4 emissions standards are designed with a focus on reducing emissions, including CO, to meet stringent environmental and regulatory standards. These engines utilize various engineering and technological advancements to minimize CO emissions while maintaining performance and efficiency.

1.1.2 Good Combustion and Maintenance Practices for Fuel-Fired Equipment

Good combustion and maintenance practices are essential for operating fuel-fired equipment efficiently and effectively while minimizing CO emissions. For this source category, good combustion practices are generally considered to be implementing the manufacturer's recommendations, which may include a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Minimizing engine idle time at startup;
- Conducting operator training; and
- Conducting periodic maintenance.

The specific practices available for each source category are discussed in the subsequent sections.

1.1.3 Use of Ultra-Low-Sulfur Diesel for Emergency Generator Engines

The utilization of ultra-low-sulfur diesel (ULSD) in diesel fuel-fired equipment results in lower CO emissions by promoting cleaner combustion and more efficient utilization of fuel.[1]

1.1.4 Oxidation Catalyst, Catalytic Controls, or Catalytic Oxidation Systems

Catalytic oxidation (also known as catalytic controls or catalytic incineration) can be used to oxidize an oxidizable compound in an air stream, including CO. As such, the use of catalytic oxidation is an effective method for reducing CO emissions. In this CO BACT selection analysis, the catalysts evaluated are specifically designed to facilitate the chemical conversion of CO into CO_2.[2]

1.1.5 Operating Limitations

Limiting the hours of operation for engines, water bath vaporizers, and boilers reduces CO emissions by decreasing the overall time the equipment runs and consumes fuel.

1.1.6 Control Technologies Not Evaluated

Some control technologies have been omitted from the BACT evaluation due to various considerations. These control technologies, and the reasons for their omission, are summarized in Table 1-1.

Table 1-1. Summary of Control Technologies Not Evaluated

Emission Source Category	Technology	Reasoning
All Source Categories	Use of Alternate Fuels	The use of different fuel or raw material that would redefine the Proposed Air Permit Project are out of the scope of BACT evaluations. Where different fuel specifications within the fuel type (i.e., use of ULSD) are feasible for the project, they have been identified above in Section 1.1 and are evaluated in the sections following this table.
Natural Gas-Fired Boilers and Water Bath Vaporizers	Economizer	Economizers are only mentioned once in the RBLC for a boiler that is significantly larger than the boilers at the Proposed Air Permit Project. Further, the primary purpose of economizers is to improve fuel efficiency and not to control CO emissions.
	Insulation	Insulation is considered part of "Good Combustion and Maintenance Practices" and is thus not evaluated as a separate control technology.

[1] *Nationwide Emission Benefits of a Low Sulfur Diesel Fuel*, Air Improvement Resource, Inc., March 3, 1999.

[2] EPA Cost reports and Guidance for Air Pollution Regulations, Section 3 – VOC Controls, Chapter 2 - Incinerators and Oxidizers", U.S. Environmental Protection Agency, EPA-450/3-79-006.

Emission Source Category	Technology	Reasoning
Natural Gas-Fired Boilers and Water Bath Vaporizers	Oxygen Trim Control Systems	Oxygen trim control systems reduce CO emissions by continuously adjusting the air-to-fuel ratio in combustion systems based on real-time measurements of oxygen levels, ensuring optimal combustion efficiency and minimizing the production of CO. Oxygen trim control systems are considered part of "Good Combustion and Maintenance Practices" as a part of optimizing the air-fuel ratio and thus are not evaluated as a separate control technology.
Diesel-Fired Emergency Generator Engines and Diesel-Fired Emergency Fire Pump Engine	Turbocharger	EPA documentation suggests that turbocharging does not impact CO emissions for diesel-fired engines.[3]
	Intercooler/Aftercooler Systems	EPA documentation suggests that intercoolers and aftercoolers do not impact CO emissions for diesel-fired engines.[4]

1.2 Natural Gas-Fired Boilers

Natural gas-fired boilers are heating systems used to generate hot water or steam for maintaining precise temperature control for various stages of production, ensuring the efficient operation of machinery. Micron is proposing to use efficient units that are specifically designed to meet the Proposed Air Permit Project's thermal requirements while minimizing energy consumption and emissions.

The BACT analysis for CO emissions from natural gas-fired boilers is presented in this section.

1.2.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing CO emissions from the proposed natural gas-fired boilers:

- Good combustion and maintenance practices;
- Oxidation catalysts; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered BACT for natural gas-fired boilers. Proposed BACT emission limits are discussed further in Step 5.

1.2.2 Step 2. Eliminate Technically Infeasible Options

For oxidation catalysts to be effective, waste gases must be heated by auxiliary burners to approximately 600 to 800°F before entering the catalyst bed. The maximum design exhaust temperature of the catalyst is

[3] AP-42 Vol. I, Chapter 3.3: Gasoline And Diesel Industrial Engines.

[4] Ibid.

typically 1,000 – 1,250°F.[5] Since the typical exhaust temperature of natural gas-fired boilers is between 350 – 500°F, which is below the operating range for an oxidation catalyst, additional auxiliary fuel would be required to heat the stream to the required temperature, creating additional combustion emissions. Therefore, the use of an oxidation catalyst is not considered feasible.

1.2.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.2.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.2.5 Step 5. Select BACT

Micron intends to purchase natural gas-fired boiler designed to meet a CO emission limit of 50 parts per million by volume on a dry basis (ppmvd) at 3% oxygen (O_2). This is the lowest emission limitation identified as BACT based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will also implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 6,000 hours per year for each boiler.

A BACT limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The boilers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for CO for natural gas-fired steam generating units.

1.3 Natural Gas-Fired Water Bath Vaporizers

This Permit Application 2 separates "natural gas-fired combustion equipment" into boilers and water bath vaporizers. Natural gas-fired water bath vaporizers are used in the semiconductor industry to provide a reliable and efficient source of high-purity nitrogen gas. These water bath vaporizers use natural gas to heat water that is used to vaporize liquified nitrogen used in semiconductor manufacturing.

[5] EPA Air Pollution Control Technology Fact Sheet for Catalytic Incinerators (EPA-452/F-03-018).

The BACT analysis for CO emissions from natural gas-fired water bath vaporizers is presented in this section.

1.3.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing CO emissions from the proposed natural gas-fired water bath vaporizers:

- Good combustion and maintenance practices;
- Oxidation Catalysts; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered BACT for natural gas-fired water bath vaporizers. Proposed BACT emission limits are discussed further in Step 5.

1.3.2 Step 2. Eliminate Technically Infeasible Options

For oxidation catalysts to be effective, waste gases must be heated by auxiliary burners to approximately 600 to 800 °F before entering the catalyst bed. The maximum design exhaust temperature of the catalyst is typically 1,000 – 1,250 °F.[6] This is outside of the range of the proposed natural gas-fired water bath vaporizers, and, therefore, additional auxiliary fuel would be required to heat the stream to the required temperature, creating additional combustion emissions. Additionally, there are no instances of oxidation catalysts being used in practice to control CO emissions from water bath vaporizers of any size based on a search of the RBLC. Therefore, the use of an oxidation catalyst is not considered feasible.

1.3.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.3.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.3.5 Step 5. Select BACT

Micron intends to purchase natural gas-fired water bath vaporizers designed to meet a CO emission limit of 84 pounds per standard cubic feet (lb/MMscf). This is the lowest emission limitation identified as BACT based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete

[6] EPA Air Pollution Control Technology Fact Sheet for Catalytic Incinerators (EPA-452/F-03-018).

documentation of the search results. Micron will also implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 8,000 hours per year for all water bath vaporizers combined, with no more than four units operating at a time.

Note that the emission limit identified is different than Permit Application 1 due to the separation of "natural gas-fired combustion equipment" into boilers and water bath vaporizers.

A BACT limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The water bath vaporizers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for CO for natural gas-fired steam generating units.

1.4 Diesel-Fired Emergency Generator Engines

The Proposed Air Permit Project will utilize diesel-fired emergency generator engines to ensure that critical life safety and process safety systems receive uninterrupted power during power outages. These units will not be designed to run manufacturing operations during major electrical outages and instead will allow equipment and processes to shut down gradually as necessary, protecting sensitive manufacturing operations, preventing unsafe conditions from forming in the fabs, reducing emissions of process gases directly to the atmosphere, and protecting employee safety.

1.4.1 Step 1. Identify All Control Technologies

Diesel-fired emergency generator engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT. These standards are based on the engine's maximum power capacity and the year in which the engine was manufactured. Currently, the EPA has implemented the Tier 4 Final emission standards for non-road diesel engines, which set stringent limits for newly manufactured units.[7] EPA has also set limitations for stationary internal combustion engines under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." For engines with certain power capacity and manufacture year, NSPS Subpart IIII references the engine standards established for nonroad engines under 40 CFR 1039.

In addition, the following control methods have been identified for reducing CO emissions from the proposed diesel-fired emergency generator engines:

[7] 40 CFR 1039.101

- Good combustion and maintenance practices;
- Operating hour limitations; and
- Use of ULSD.

1.4.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for diesel-fired emergency generator engines are technically feasible.

1.4.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.4.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.4.5 Step 5. Select BACT

The following control technologies are proposed to achieve BACT for diesel-fired emergency generator engines:

- The purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine's idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and
  - Conducting periodic maintenance
- Operating hour limitations; and
- The firing of ULSD.

A BACT limit must not be higher than an applicable NSPS emission limit. The diesel-fired generators will be affected facilities under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." NSPS Subpart IIII provides CO emission standards for various engine power and displacement categories. However, these emission standards are less stringent than the Tier 4 Final emission standards.

Therefore, Micron is proposing the Tier 4 Final emission standards outlined in Table 1-2 as the BACT CO limit for diesel-fired emergency generator engines and will procure new engines for the Proposed Air Permit

Project that meet these standards. Control technologies to achieve Tier 4 Final emission standards may vary depending on the engine manufacturer and may include the use of catalytic oxidation where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency generator engines and proposes an operating hours limit of 100 hours per year for each engine.

Table 1-2. 40 CFR §1039.101
Tier 4 Final Exhaust Emission Standards After the 2014 Model Year

Maximum Engine Power	Application	CO Emission Standard g/kW-hr (g/bhp-hr)
kW < 19	All	6.6
19 ≤ kW < 56	All	5.0
56 ≤ kW < 130	All	5.0
130 ≤ kW ≤ 560	All	3.5
	Generator Sets	3.5
kW > 560	All Except Generator Sets	3.5

1.5 Diesel-Fired Emergency Fire Pump Engine

The Proposed Air Permit Project will include one diesel-fired emergency fire pump engine to provide a reliable power source in the event of a fire occurring during a power outage when the electric fire pump would not be available.

1.5.1 Step 1. Identify All Control Technologies

Diesel-fired emergency fire pump engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT. These standards are based on the fire pump engine's maximum power capacity and the year in which the engine was manufactured. EPA has set limitations for stationary internal combustion engines, including fire pump engines, under NSPS Subpart IIII. The EPA has also implemented Tier emission standards (Tier 1 – Tier 4 Final) for non-road diesel engines, which set stringent limits for newly manufactured units. Based on the RBLC search conducted, as well as input from Micron's equipment vendors, Tier 4 compliant fire pump engines are not available. As such, the most stringent emission standards are Tier 3, which align with NSPS IIII emission standards for the proposed fire pump engine for CO.

In addition, the following control methods have been identified for reducing CO emissions from the proposed diesel-fired emergency fire pump engine:

- Good combustion and maintenance practices;
- Operating hours limitations; and
- Use of ULSD.

1.5.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for the diesel-fired emergency fire pump engine are technically feasible.

1.5.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.5.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.5.5 Step 5. Select BACT

The following control technologies are proposed to achieve BACT for the diesel-fired emergency fire pump engine:

- The purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine's idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and
  - Conducting periodic maintenance
- The use of ULSD; and
- Operating hour limitations.

A BACT limit must not be higher than an applicable NSPS emission limit. The diesel-fired emergency fire pump engine will be an affected facility under NSPS Subpart IIII. NSPS Subpart IIII provides CO emission standards for various engine power and displacement categories. For the capacity of the proposed diesel-fired emergency fire pump engine, NSPS IIII emission standards align with Tier 3 emission standards.

Therefore, Micron is proposing compliance with the NSPS IIII and Tier 3 emission standard of 2.6 grams per brake horsepower-hour (g/bhp-hr) as the BACT CO limit for the diesel-fired emergency fire pump engine. Control technologies to achieve this emission standard may vary depending on the engine manufacturer and may include the use of catalytic oxidation where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency fire pump engine and proposes an operating hours limit of 500 hours per year.

1.6 Semiconductor Process Tools and PEECs

Micron is proposing to install semiconductor process equipment, or "tools", as discussed within the Micron Clay Air Permit Application. Carbon monoxide is emitted through the operation of the semiconductor process tools as a result of use as a process material and as a reaction byproduct of carbon-containing raw

materials. In addition, management of carbon-containing materials in process equipment exhaust conditioners (PEECs) generates CO, as does natural gas combustion within those units.[8] CO generated through the semiconductor process tools and PEECs will be exhausted through wet scrubbers. Refer to the process flow diagrams in Appendix E for additional details.

1.6.1 Step 1. Identify All Control Technologies

A review of the EPA's RBLC database did not identify any entries of semiconductor facilities that utilize add-on control devices to abate CO emissions that are generated from semiconductor process tools.

Micron also reviewed relevant semiconductor air permits to evaluate if any control technologies are currently being utilized to abate CO emissions from semiconductor process tools. During the review of these permits, it was determined that no add-on control devices are currently installed to abate such CO emissions.

Good combustion and maintenance practices for PEECs is the only method that has been identified for reducing CO emissions from the semiconductor process tools.

1.6.2 Step 2. Eliminate Technically Infeasible Options

The only control technology identified in Step 1 for semiconductor process tools is technically feasible.

1.6.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

Since the use of good combustion and maintenance practices is the only identified control option, ranking the remaining control technologies by control effectiveness is unnecessary. Therefore, the next step is to evaluate the most effective controls.

1.6.4 Step 4. Evaluate the Most Effective Controls and Document

Since the use of good combustion and maintenance practices is the only identified control option, evaluating the most effective controls is unnecessary. Therefore, the next step is to select BACT.

1.6.5 Step 5. Select BACT

Based on the analysis presented above, Micron is proposing to achieve BACT for CO emitted from semiconductor process tools by using good combustion and maintenance practices for PEECs, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

[8] This discussion does not include Point of Use (POU) control devices. POUs are being permitted as control devices, not process equipment, and thus are addressed in the BACT/LAER discussion for control devices.

Given the diverse processes and complexity of semiconductor manufacturing, Micron is proposing to comply with good combustion and maintenance practices as a work practice standard to achieve BACT for CO emitted from semiconductor process equipment in lieu of a formal limit.

Attachment 1
RACT/BACT/LAER Clearinghouse Search Results

Attachment 2
Bay Area Air Quality Management District Summary

Attachment 3
Semiconductor Permit Review Summary

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/09/2015	PACKAGE BOILER	13.31	GCP	0.08	LB/MMBTU
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/09/2015	2 CALP LINE BOILERS	13.31	GCP	0.08	LB/MMBTU
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-233 Galvanizing Line Boilers	13.31	Good combustion practices	0.084	LB/MMBTU
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-202, 203, 204 Pickle Line Boilers	13.31	Good Combustion Practice	0.084	LB/MMBTU
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Pickle Line #2 Boiler #1 & #2 (EP 21-04 & EP 21-05)	13.31	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	84	LB/MMSCF
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	AUXILLARY BOILER	13.31	EXCLUSIVE USE OF PIPELINE QUALITY NATURAL GAS AND GOOD COMBUSTION PRACTICES	0.036	LB/MMBTU

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	AUXILIARY BOILER	13.31	Good Combustion Practice	0.037	LB/MMBTU
MI-0420	DTE GAS COMPANY--MILFORD COMPRESSOR STATION	MI	185-15	06/03/2016	FGAUXBOILERS	13.31	Good combustion practices and clean burn fuel (pipeline quality natural gas)	0.08	LB/MMBTU
MI-0426	DTE GAS COMPANY - MILFORD COMPRESSOR STATION	MI	185-15A	03/24/2017	FGAUXBOILERS (6 auxiliary boilers EUAUXBOIL2A, EUAUXBOIL3A, EUAUXBOIL2B, EUAUXBOIL3B, EUAUXBOIL2C, EUAUXBOIL3C)	13.31	Good combustion practices and clean burn fuel (pipeline quality natural gas).	84	LB/MMSCF
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Auxiliary Boiler (B001)	13.31	Good combustion controls	1.87	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Auxiliary Boiler (B001)	13.31	Good combustion controls	2.08	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Auxiliary Boiler (B001)	13.31	good combustion controls	2.08	LB/H

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Auxiliary Boiler (B001)	13.31	Good combustion controls	0.99	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Auxiliary Boiler (B001)	13.31	Good combustion practices	1.67	LB/H
OH-0383	PETMIN USA INCORPORATED	OH	P0127678	07/17/2020	Startup boiler (B001)	13.31	good combustion practices and the use of natural gas	1.25	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.31	Good combustion practices and the use of natural gas	33	T/YR
OK-0168	SEMINOLE GNRTNG STA	OK	2010-594-C(M-2)PSD	05/05/2015	NATURAL GAS-FIRED BOILER (100MMBTUH)	13.31	NO CONTROLS FEASIBLE;GOOD COMBUSTION PRACTICES	0.0075	LB/MMBTU
OR-0050	TROUTDALE ENERGY CENTER, LLC	OR	26-0235	03/05/2014	Auxiliary boiler	13.31	Utilize Low-NOx burners and FGR.	0.04	LB/MMBTU
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Auxillary Boiler	13.31	Not Specified	0.037	LB/MMBTU
PA-0316	RENOVO ENERGY CENTER, LLC	PA	18-00033A	01/26/2018	Auxiliary Boiler	13.31	Not Specified	0.036	LB
SC-0192	CANFOR SOUTHERN PINE - CONWAY MILL	SC	1340-0029-CI	05/21/2019	Boiler No. 2	13.31	Work Practice Standards	0.0375	LB/MMBTU

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0772	PORT OF BEAUMONT PETROLEUM TRANSLOAD TERMINAL (PBPTT)	TX	118901, GHGPSDTX108 AND PSDTX1	11/06/2015	Commercial/Institutional-Size Boilers/Furnaces	13.31	Good combustion practice to ensure complete combustion.	50	PPMVD @ 3% O2
WI-0306	WPL- RIVERSIDE ENERGY CENTER	WI	19-POY-212	02/28/2020	Temporary Boiler (B98A)	13.31	Shall be operated for no more than 500 hours and combust only pipeline quality natural gas.	0.04	LB/MMBTU
WY-0075	CHEYENNE PRAIRIE GENERATING STATION	WY	MD-16173	07/16/2014	Auxiliary Boiler	13.31	good combustion	0.0375	LB/MMBTU
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	05/04/2018	Pickle Line Equipment (pickle line no. 3 boilers)	19.6	Good Combustion Practices	84	LB/MMSCF

Process IDs: --
Other Search Criteria: Process Name Contains "Vaporizer"
Process Description: Natural Gas-fired Water Bath Vaporizers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered for Fuel Type as "Natural Gas" or Equivalent

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Air Separation Plant Water Vaporizer	81.29	Combustion of natural gas and good combustion practices	0.0824	LB/MMBTU
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 13-01 - Water Bath Vaporizer	19.9	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan	84	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Water Bath Vaporizer (2 indirect burners) (EP 23-01)	19.6	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	84	LB/MMSCF
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.31	Good combustion practices and the use of natural gas	8.76	T/YR
WV-0034	WEST VIRGINIA STEEL MILL	WV	R14-0039	05/05/2022	Water Bath Vaporizer	81.29	Good Combustion Practices	0.91	LB/HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0082	POINT THOMSON PRODUCTION FACILITY	AK	AQ1201CPT03	01/23/2015	Emergency Camp Generators	17.11	Not Specified	2.6	GRAMS/HP-H
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Black Start and Emergency Internal Cumbustion Engines	17.11	Good Combustion Practices	4.38	G/KW-HR
AL-0301	NUCOR STEEL TUSCALOOSA, INC.	AL	413-0033-X014 - X020	07/22/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	Not Specified	0.0055	LB/HP-H
AR-0177	NUCOR STEEL ARKANSAS	AR	1139-AOP-R27	11/21/2022	SN-230 Galvanizing Line No, 2 Emergency Generator	17.11	Not Specified	3.5	G/KW-HR
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Generators	17.11	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	0.9	G/BHP-HR
FL-0346	LAUDERDALE PLANT	FL	0110037-011-AC	04/22/2014	Four 3100 kW black start emergency generators	17.11	Good combustion practice	3.5	GRAMS PER KW-HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
FL-0347	ANADARKO PETROLEUM CORPORATION - EGOM	FL	OCS-EPA-R4015	09/16/2014	Emergency Diesel Engine	17.11	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	--	--
FL-0356	OKEECHOBEE CLEAN ENERGY CENTER	FL	0930117-001-AC	03/09/2016	Three 3300-kW ULSD emergency generators	17.11	Use of clean engine	3.5	G / KW-HR
FL-0363	DANIA BEACH ENERGY CENTER	FL	0110037-017-AC	12/04/2017	Two 3300 kW emergency generators	17.11	Certified engine	3.5	GRAMS PER KWH
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	1,500 kW Emergency Diesel Generator	17.11	Operate and maintain the engine according to the manufacturer's written instructions	3.5	G/KW-HOUR
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	06/07/2021	1,500 kW Emergency Diesel Generator	17.11	Not Specified	3.5	G/KW-HOUR
IL-0114	CRONUS CHEMICALS, LLC	IL	13060007	09/05/2014	Emergency Generator	17.11	Tier IV standards for non-road engines at 40 CFR 1039.102, Table 7.	3.5	G/KW-H
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Emergency Engine	17.11	Not Specified	3.5	G/KW-HR
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Emergency Engines	17.11	Not Specified	3.5	GRAMS

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Emergency Generator Engine	17.11	Not Specified	3.5	G/KW-HR
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	2.61	G/BHP-H
IN-0180	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	2.61	G/B-HP-H
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	03/23/2017	EMERGENCY GENERATORS (EU014A AND EU-014B)	17.11	GOOD COMBUSTION PRACTICES	2.61	G/HP-H EACH
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Emergency generator EU-6006	17.11	Tier II diesel engine	3.5	G/KWH
IN-0324	MIDWEST FERTILIZER COMPANY LLC	IN	129-44510-00059	05/06/2022	emergency generator EU 014a	17.11	Not Specified	2.61	G/HP-HR
IN-0359	NUCOR STEEL	IN	107-45480-00038	03/30/2023	Emergency Generator (CC-GEN1)	17.11	oxidation catalyst and certified engine	2.61	G/HP-HR
IN-0365	MAPLE CREEK ENERGY LLC	IN	T153-45909-00056	06/19/2023	Emergency generator	17.11	Not Specified	2.6	G/HP-HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0109	FRITZ WINTER NORTH AMERICA, LP	KY	V-16-022 R1	10/24/2016	Emergency Generators #1, #2, & #3 (EU72, EU73, & EU74)	17.11	The permittee shall prepare and maintain for EU72, EU73, and EU74, within 90 days of startup, a good combustion and operation practices plan (GCOP) that defines, measures and verifies the use of operational and design practices determined as BACT for minimizing CO, VOC, PM, PM10, and PM2.5 emissions. Any revisions requested by the Division shall be made and the plan shall be maintained on site. The permittee shall operate according to the provisions of this plan at all times, including periods of startup, shutdown, and malfunction. The plan shall be incorporated into the plant standard operating procedures (SOP) and shall be made available for the Division's inspection. The plan shall include, but not be limited to: i. A list of combustion optimization practices and a means of verifying the practices have occurred. ii. A list of combustion and operation practices to be used to lower energy consumption and a means of verifying the practices have occurred. iii. A list of the design choices determined to be BACT and verification that designs were implemented in the final construction.	2.6	G/HP-HR (EU72 &EU73)
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-02 - North Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	2.61	G/HP-HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-03 - South Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	2.61	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-07 - Air Separation Plant Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	2.61	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-01 - Caster Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	2.61	G/HP-HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	New Pumphouse (XB13) Emergency Generator #1 (EP 08-05)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Tunnel Furnace Emergency Generator (EP 08-06)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Caster B Emergency Generator (EP 08-07)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Emergency Generator (EP 08-08)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	--	--

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	05/23/2014	Emergency Diesel Generators (EQT 629, 639, 838, 966, & 1264)	17.11	Comply with 40 CFR 60 Subpart IIII; operate the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	15.43	LB/HR
LA-0296	LAKE CHARLES CHEMICAL COMPLEX LDPE UNIT	LA	PSD-LA-779	05/23/2014	Emergency Diesel Generators (EQTs 622, 671, 773, 850, 994, 995, 996, 1033, 1077, 1105, & 1202)	17.11	Compliance with 40 CFR 60 Subpart IIII; operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage.	15.43	LB/HR
LA-0305	LAKE CHARLES METHANOL FACILITY	LA	PSD-LA-803(M1)	06/30/2016	Diesel Engines (Emergency)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Emergency Generator Engines	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	DEG1-13 - Diesel Fired Emergency Generator Engine (EQT0012)	17.11	Compliance with NSPS Subpart IIII	0.51	LB/HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Generator 1	17.11	Compliance with NESHAP 40 CFR 63 Subpart ZZZZ and NSPS 40 CFR 60 Subpart IIII, and good combustion practices (use of ultra-low sulfur diesel fuel).	14.81	LB/H
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 1	17.11	Compliance with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	30.86	LB/H
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 2	17.11	Compliance with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	30.86	LB/H
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	emergency generator engines (6 units)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0317	METHANEX - GEISMAR METHANOL PLANT	LA	PSD-LA-761(M4)	12/22/2016	Emergency Generator Engines (4 units)	17.11	complying with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	--	--
LA-0331	CALCASIEU PASS LNG PROJECT	LA	PDS-LA-805	09/21/2018	Large Emergency Engines (>50kW)	17.11	Good Combustion and Operating Practices.	3.5	G/KW-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0364	FG LA COMPLEX	LA	PSD-LA-812	01/06/2020	Emergency Generator Diesel Engines	17.11	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	--	--
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Generator Engine	17.11	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and the use of ultra-low sulfur diesel fuel.	2.6	G/HP-HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	06-22 - AO-5 Emergency Generator	17.11	Use of good combustion practices and compliance with NSPS Subpart IIII	3.81	LB/HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	53-22 - PAO Emergency Generator	17.11	Use of good combustion practices, compliance with NSPS Subpart IIII	3.81	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	EGEN - Plant Emergency Generator	17.11	Compliance with 40 CFR 60 Subpart IIII	20.91	LB/HR
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Emergency Engine/Generator	17.11	Not Specified	2.6	GM/BHP-H
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	EMERGENCY GENERATOR 1	17.11	USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES AND HOURS OF OPERATION LIMITED TO 100 HOURS PER YEAR	2.6	G/HP-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES AND DESIGNED TO MEET EMISSION LIMIT	2.6	G/HP-H
MI-0421	GRAYLING PARTICLEBOARD	MI	59-16	08/26/2016	Emergency Diesel Generator Engine (EUEMRGRICE in FGRICE)	17.11	Good design and combustion practices.	3.5	G/KW-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUEMENGINE (Diesel fuel emergency engine)	17.11	Good combustion practices and meeting NSPS Subpart IIII requirements.	3.5	G/KW-H
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	05/09/2017	EUEMRGRICE1 in FGRICE (Emergency diesel generator engine)	17.11	Good design and combustion practices.	3.5	G/KW-H
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	05/09/2017	EUEMRGRICE2 in FGRICE (Emergency Diesel Generator Engine)	17.11	Good design and combustion practices.	3.5	G/KW-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.11	Good combustion practices and meeting NSPS Subpart IIII requirements.	3.5	G/KW-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.11	Good combustion practices and meeting NSPS IIII requirements.	3.5	G/KW-H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUEMENGINE: Emergency engine	17.11	State of the art combustion design.	3.5	G/KW-H
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD1--A 1500 HP diesel fueled emergency engine	17.11	Good combustion practices and will be NSPS compliant.	3.5	G/KW-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD2--A 6000 HP diesel fuel fired emergency engine	17.11	Good combustion practices and will be NSPS compliant.	3.5	G/KW-H
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGEMENGINE	17.11	Not Specified	0.15	G/HP-H
MI-0447	LBWL--ERICKSON STATION	MI	74-18A	01/07/2021	EUEMGD--emergency engine	17.11	Good combustion practices and will be NSPS compliant.	3.5	G/KW-H
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE1 in FGRICE)	17.11	Good design and combustion practices	3.5	G/KW-H
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE2 in FGRICE)	17.11	Good Design and Combustion Practices	3.5	G/KW-H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUEMENGINE (North Plant): Emergency engine	17.11	Good combustion practices and meeting NSPS IIII requirements.	3.5	G/KW-H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUEMENGINE (South Plant): Emergency engine	17.11	Good Combustion Practices and meeting NSPS Subpart IIII requirements	3.5	G/KW-H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0454	LBWL-ERICKSON STATION	MI	74-18D	12/20/2022	EUEMGD	17.11	Good combustion practices and will be NSPS compliant.	3.5	G/KW-H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Diesel Fired Emergency Generator	17.11	use of ultra low sulfur diesel oil a clean burning fuel	3.5	LB/H
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency generator (P002)	17.11	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	8.49	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency generator (P003)	17.11	State-of-the-art combustion design	13.5	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency generator (P003)	17.11	State-of-the-art combustion design	16.96	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Generator (P009)	17.11	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	28.8	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency generator (P003)	17.11	State-of-the-art combustion design	8.8	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency generator (P003)	17.11	State-of-the-art combustion design	8.8	LB/H
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Generators (2 identical, P004 and P005)	17.11	Certified to the meet the emissions standards in 40 CFR 89.112 and 89.113 pursuant to 40 CFR 60.4205(b) and 60.4202(a)(2). Good combustion practices per the manufacturer's operating manual.	12.69	LB/H
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Emergency Diesel Generator Engine (P001)	17.11	Good combustion design	12.64	LB/H

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Emergency Diesel Fire Pump Engine (P002)	17.11	Good combustion design	4.01	LB/H
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fired generator (P007)	17.11	Comply with NSPS 40 CFR 60 Subpart IIII	15.4	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Emergency Diesel-fired Generator Engine (P007)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer operating manual	19.25	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	1,000 kW Emergency Generators (P008 - P010)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturers operating manual	7.7	LB/H
OH-0383	PETMIN USA INCORPORATED	OH	P0127678	07/17/2020	Emergency Generators (P005 and P006)	17.11	Tier IV engine Good combustion practices	--	--
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	5,051 bhp (3,768 kWm) Diesel-Fired Emergency Generators: P001 through P046	17.11	Certified to meet Tier 2 standards and good combustion practices	3.5	G/KW-H
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	2000 kW Emergency Generator	17.11	Not Specified	0.6	GM/HP-HR
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	09/02/2016	Emergency Generator Engines	17.11	Not Specified	2.61	G/BHP-HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
PA-0311	MOXIE FREEDOM GENERATION PLANT	PA	40-00129A	09/01/2015	Emergency Generator	17.11	Not Specified	0.26	G/HP-HR
PA-0313	FIRST QUALITY TISSUE LOCK HAVEN PLT	PA	18-00030C	07/27/2017	Emergency Generator	17.11	Not Specified	3.5	G
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Generator	17.11	Not Specified	2.6	G/BHP-H
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	04/01/2015	Emergency Diesel Generator	17.11	Minimized hours of operations Tier II engine	0.0126	G/HP HR
TX-0872	CONDENSATE SPLITTER FACILITY	TX	70 PSDTX1398M1 GHGPSD	10/31/2019	Emergency Generators	17.11	Limiting duration and frequency of generator use to 100 hr/yr. Good combustion practices will be used to reduce VOC including maintaining proper air-to-fuel ratio.	0.6	G/KW HR
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	032 PSDTX1598 GHGPSDTX	03/13/2023	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES, LIMITED TO 100 HR/YR	0.006	LB/HP HR
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED EMERGENCY GENERATOR 3000 kW (1)	17.11	Good Combustion Practices/Maintenance	3.5	G/KW
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	04/24/2018	Diesel-Fired Emergency Generators	17.11	Good Combustion Practices	0.6	G/KWH

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2013 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
WI-0286	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-022	04/24/2018	P42 -Diesel Fired Emergency Generator	17.11	Good Combustion Practices	0.6	G/KWH
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Generator (P07)	17.11	Operation limited to 500 hours/year, and operate and maintain generator according to the manufacturer's recommendations.	2.6	G/HP-H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Emergency Generator	17.11	Not Specified	--	--
WV-0033	MAIDSVILLE	WV	R14-0038	01/05/2022	Emergency Generator	17.11	Good Combustion Practices w/ OxCat. Applicant did not justify why an oxcat is infeasible for an emergency engine	1.94	LB/HR
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	03/17/2021	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	3.5	G/KW-HR
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	0.9	G/BHP-HR
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED AUXILIARY (EMERGENCY) ENGINES (TWO)	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES	3.5	G/KW-H

Process IDs: 99.011, 99.006, 99.013
Other Search Criteria: –
Process Description: Semiconductor Manufacturing
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024
Notes & Filtering: Filtered for Process ID and Process Name

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	Semiconductor Fabrication: P179 through P182	99.011	Good combustion practices and the use of natural gas	--	--
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P12, P22, P18, P19, P28, P29 Organic Stripping Systems, Array/Color Filter and Cell Processes	99.006	Regenerative Thermal Oxidizer	0.037	LB/MMBTU
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P15 & P25 VOC System Array Process	99.006	Regenerative Thermal Oxidizer	0.0037	LB/MMBTU
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P13 & P23 Chemical Vapor Deposition System Array Process	99.006	Combustor, Baghouse and Wet Scrubber in series	0.0037	LB/MMBTU
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P14 & P24 Dry Etching System Array Process	99.006	Combustor and Wet Scrubber in series	0.37	LB/MMBTU

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0083	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT06	01/06/2015	Diesel Fired Well Pump	17.21	Limited Operation of 168 hr/yr.	0.95	LB/MMBTU
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Fire Pump Diesel Internal Combustion Engines	17.21	Good Combustion Practices	3.3	G/KW-HR
AK-0085	GAS TREATMENT PLANT	AK	AQ1524CPT01	08/13/2020	Three (3) Firewater Pump Engines and two (2) Emergency Diesel Generators	17.21	Good combustion practices, limit operation to 500 hours per year per engine	3.3	G/HP-HR
AK-0086	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT07	03/26/2021	Diesel Fired Well Pump	17.21	Good Combustion Practices and Limited Use	0.95	LB/MMBTU
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	3.03	G/BHP-HR
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	3.03	G/BHP-HR
FL-0346	LAUDERDALE PLANT	FL	0110037-011-AC	04/22/2014	Emergency fire pump engine (300 HP)	17.21	Good combustion practice.	3.5	GRAM PER KW-HR
FL-0354	LAUDERDALE PLANT	FL	0110037-013-AC	08/25/2015	Emergency fire pump engine, 300 HP	17.21	Low-emitting fuel and certified engine	3.5	G / KWH
FL-0356	OKEECHOBEE CLEAN ENERGY CENTER	FL	0930117-001-AC	03/09/2016	One 422-hp emergency fire pump engine	17.21	Use of clean engine technology	3.5	G / KW-HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
FL-0363	DANIA BEACH ENERGY CENTER	FL	0110037-017-AC	12/04/2017	Emergency Fire Pump Engine (422 hp)	17.21	Certified engine	3.5	G / KWH
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	Emergency Fire Pump Engine (347 HP)	17.21	Operate and maintain the engine according to the manufacturer's written instructions	3.5	G/KW-HOUR
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	06/07/2021	Emergency Fire Pump Engine (347 HP)	17.21	Not Specified	3.5	G/KW-HOUR
IL-0129	CPV THREE RIVERS ENERGY CENTER	IL	16060032	07/30/2018	Firewater Pump Engine	17.21	Not Specified	---	---
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Firewater Pump Engine	17.21	Not Specified	3.5	G/KW-HR
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Fire Water Pump Engine	17.21	Not Specified	3.5	GRAMS
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Firewater Pump Engine	17.21	Not Specified	3.5	G/KW-HR
LA-0301	LAKE CHARLES CHEMICAL COMPLEX ETHYLENE 2 UNIT	LA	PSD-LA-779	05/23/2014	Firewater Pump Nos. 1-3 (EQTs 997, 998, & 999)	17.21	Compliance with 40 CFR 60 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage	2.87	LB/HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Pump Engines DFP-16-1 (EQT036)	17.21	Meet NSPS Subpart IIII Limitations and Good Combustion Practices	1.55	LB/H
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Pump Engine DFP-16-2 (EQT037)	17.21	Meet NSPS Subpart IIII Limitations and Good Combustion Practices	1.55	LB/H
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Firewater Pump Engines	17.21	Complying with 40 CFR 60 Subpart IIII	---	---
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Firewater Pump 1	17.21	Compliance with NESHAP 40 CFR 63 Subpart ZZZZ and NSPS 40 CFR 60 Subpart IIII, and good combustion practices (use of ultra-low sulfur diesel fuel).	1.62	LB/H
LA-0314	INDORAMA LAKE CHARLES FACILITY	LA	PSD-LA-813	08/03/2016	Diesel Firewater pump engines (6 units)	17.21	complying with 40 CFR 63 subpart ZZZZ	---	---
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	firewater pump engines (8 units)	17.21	Complying with 40 CFR 60 Subpart IIII	---	---
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39A	17.21	Compliance with 40 CFR 60 Subpart IIII	3.5	---
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39B	17.21	Compliance with 40 CFR 60 Subpart IIII	3.5	---
LA-0370	WASHINGTON PARISH ENERGY CENTER	LA	PSD-LA-829(M-1)	04/27/2020	Emergency Fire Pump Engine (EQT0021, ENG-1)	17.21	The use of low sulfur fuels and compliance with 40 CFR 60 Subpart IIII	0.4	LB/HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Fired Water Pump Engine	17.21	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and the use of ultra-low sulfur diesel fuel.	2.6	G/HP-HR
LA-0397	WESTLAKE ETHYLENE PLANT	LA	PSD-LA-813(M3)	04/29/2022	Emergency Generators and Fire Water Pumps (EQT0027 - EQT0032, EQT0044, EQT0045)	17.21	Compliance with applicable requirements of 40 CFR 60 Subpart IIII	---	---
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-01 - Firewater Pump Engine No. 1	17.21	Compliance with 40 CFR 60 Subpart IIII	3.44	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-02 - Firewater Pump Engine No. 2	17.21	Compliance with 40 CFR 60 Subpart IIII	3.44	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-03 - Firewater Pump Engine No. 3	17.21	Compliance with the requirements of 40 CFR 60 Subpart IIII	0.5	LB/HR
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Fire Pump Engine	17.21	Not Specified	2.6	GM/BHP-H
MD-0041	CPV ST. CHARLES	MD	PSC CASE NO. 9280	04/23/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	USE OF ULTRA LOW SULFUR DIESEL AND GOOD COMBUSTION PRACTICES	2.6	G/HP-H
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES AND HOURS OF OPERATION LIMITED TO 100 HOURS PER YEAR	2.6	G/HP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	5 EMERGENCY FIRE WATER PUMP ENGINES	17.21	GOOD COMBUSTION PRACTICES AND DESIGNED TO MEET EMISSION LIMIT	3	G/HP-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	USE OF ULTRA LOW SULFUR DIESEL AND GOOD COMBUSTION PRACTICES	3.5	G/KW-H
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED FIRE PUMP ENGINE	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR DIESEL FUEL AND GOOD COMBUSTION PRACTICES	3.5	G/KW-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	2.6	G/BHP-H
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices.	3.7	G/HP-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (South Plant): Fire pump engine	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	2.6	G/BPH-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (North Plant): Fire pump engine	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	2.6	G/BHP-H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUFPENGINE: Fire pump engine	17.21	State of the art combustion design.	3.5	G/KW-H
MI-0445	INDECK NILES, LLC	MI	75-16B	11/26/2019	EUFPENGINE (Emergency engine-diesel fire pump	17.21	Good Combustion Practices and meeting NSPS Subpart IIII requirements	2.6	G/BHP-H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUFPENGINE (North Plant): Fire Pump Engine	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements	2.6	G/B-HP-H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUFPENGINE (South Plant): Fire pump engine	17.21	Good Combustion Practices and meeting NSPS Subpart IIII requirements	2.6	G/B-HP-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MS-0092	EMBERCLEAR GTL MS	MS	0040-00055	05/08/2014	firewater pumps, diesel	17.21	Not Specified	---	---
NJ-0081	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068 -(BOP120002)	03/07/2014	Emergency diesel fire pump	17.21	Not Specified	0.079	LB/H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Emergency Diesel Fire Pump	17.21	use of ULSD a clean burning fuel, and limited hours of operation	1.1	LB/H
NJ-0085	MIDDLESEX ENERGY CENTER, LLC	NJ	19149/PCP150001	07/19/2016	EMERGENCY DIESEL FIRE PUMP	17.21	Use of Ultra Low Sulfur Diesel (ULSD) Oil a clean burning fuel and limited hours of operation	1.87	LB/H
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency Fire Pump Engine (P003)	17.21	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	0.69	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	1.15	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	1.79	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Fire Pump Diesel Engine (P008)	17.21	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	2.6	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	1.73	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency fire pump engine (P004)	17.21	state of the art combustion design	1.73	LB/H
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Fire Pump (P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII. Good combustion practices per the manufacturer's operating manual.	2.36	LB/H
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fueled fire pump (P006)	17.21	Comply with NSPS 40 CFR 60 Subpart IIII	1.4	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Fire Pump (P004)	17.21	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	1.83	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Firewater Pumps (P005 and P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII and employ good combustion practices per the manufacturer's operating manual	2.31	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	275 hp (205 kW) Diesel-Fired Emergency Fire Pump Engine	17.21	Certified to meet the standards in Table 4 of 40 CFR Part 60, Subpart IIII and good combustion practices	3.5	G/KW-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	09/02/2016	Emergency Fire Pump Engine	17.21	Not Specified	2.61	G/BHP-HR
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Fire Pump	17.21	Not Specified	2.6	G/B-HP-H
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED WATER PUMP 376 bhp (1)	17.21	Good Combustion Practices/Maintenance	2.6	G/HP-H
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Emergency Fire Water Pump	17.21	good combustion practices and the use of ultra low sulfur diesel (S15 ULSD) fuel oil with a maximum sulfur content of 15 ppmw.	2.6	G/HP HR
WI-0263	WISCONSIN POWER & LIGHT - NEENAH GENERATING STATION	WI	14-DMM-200	02/15/2016	Fire pump (process P05)	17.21	Good combustion practices, use diesel fuel, and operate <500 hr/yr	---	---
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Fire Pump (P06)	17.21	Operation limited to 500 hours/year and shall be operated and maintained according to the manufacturer's recommendations.	2.6	G/HP-H
WI-0302	WPL- RIVERSIDE ENERGY CENTER	WI	19-DMM-153	02/28/2020	Diesel-Fired Fire Pump Engine (P04)	17.21	Good combustion practices	0.33	LB/H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Fire Pump Engine	17.21	Not Specified	1.44	LB/H

Summary of BAAQMD BACT

					BACT Determination		Typical Technology	
Source Type	**Classification**	**Primary Fuel**	**Reference** [a]	**Date of Reference**	**Feasible /Cost Effective**	**Achieved in Practice**	**Feasible/ Cost Effective**	**Achieved in Practice**
Boiler	5 - 33.5 MMBtu/hr Heat Input	Not Specified	BAAQMD	8/4/2010	50 ppmv @ 3% O_2 Dry	50 ppmv @ 3% O_2 Dry, for Firetube Boilers 100 ppmv @ 3% O_2 Dry, for Watertube Boilers	Good Combustion Practice	Good Combustion Practice
Boiler	33.5 - 50 MMBtu/hr Heat Input	Not Specified	BAAQMD	8/4/2010	No Determination	100 ppmv @ 3% O_2 Dry	No Determination	Good Combustion Practice
Boiler	> 50 MMBtu/hr Heat Input	Not Specified	BAAQMD	8/4/2010	10 ppmv @ 3% O_2 Dry	50 ppmv @ 3% O_2 Dry	Oxidation Catalyst	Good Combustion Practice
Diesel-Fired Emergency Engine	> 50 BHP and < 1000 BHP Output	Diesel	BAAQMD	12/22/2020	Not Specified	CARB ATCM standard for CO at the applicable horsepower rating.	Not Specified	Any engine certified or verified to achieve the applicable standard.
Diesel-Fired Emergency Engine	> 1000 BHP Output	Diesel	BAAQMD	12/22/2020	Not Specified	2.6 g/bhp-hr	Not Specified	Any engine certified or verified to achieve the applicable standard.

					BACT Determination		Typical Technology	
Source Type	**Classification**	**Primary Fuel**	**Reference [a]**	**Date of Reference**	**Feasible /Cost Effective**	**Achieved in Practice**	**Feasible/ Cost Effective**	**Achieved in Practice**
Organic Liquid Storage Tank	< 20,000 Gallons	Not Applicable	BAAQMD	3/3/1995	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Organic Liquid Storage Tank	≥ 20,000 Gallons	Not Applicable	BAAQMD	3/3/1995	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Process Tool Emissions	All	Not Specified	BAAQMD	6/16/1995	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Process Tool Emissions	All	Not Specified	BAAQMD	10/25/1991	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Process Tool Emissions	All	Not Specified	BAAQMD	1/10/1992	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Notes:

a. Data sources include:

BAAQMD - Bay Area Air Quality Management District (https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook);

Summary of Semiconductor Manufacturing Permits

Source Type	Permit Emission Unit Description	Permittee	State	Permit ID	Issue Date	Pollutant	Control Technology	Permit Limit
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	CO	RCTOs Wet Scrubbers	200.3 tons per rolling, 12-month period RCTO average emissions shall not exceed 0.66 lb CO per hour Combined CO emssions from scrubbers shall not exceed 39.9 lb/hr; CO < 0.16 lb/hr for each trimix system
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	CO	RCTOs Wet Scrubbers	200.3 tons per rolling, 12-month period RCTO average emissions shall not exceed 0.66 lb CO per hour Combined CO emssions from scrubbers shall not exceed 39.9 lb/hr; CO < 0.16 lb/hr for each trimix system
Semiconductor Process Tool Emissions	Semiconductor Fab Process Tools	Intel Corp	OR	34-2681-ST-01	1/22/2016	CO	Good Work Practices	---
Semiconductor Process Tool Emissions	Semiconductor Fab Tool Processes	TSMC Arizona Corporation	AZ	P0008497	11/4/2022	CO	Good Combustion Practices in POU Abatement Devices	---

APPENDIX K. PM BACT ANALYSIS

This appendix presents the best available control technology (BACT) determinations for the control of particulate matter (PM) emissions from the proposed emission sources at the Proposed Air Permit Project. Micron has reviewed the RACT/BACT/LAER Clearinghouse (RBLC), documentation from the Bay Area Air Quality Management District (BAAQMD), and relevant semiconductor fab permits to identify appropriate technologies and/or limits for emission source categories. Additional details of the full search are provided in Section 5.4 of the Micron Clay Air Permit Application. As the add-on control technologies and other control mechanisms are similar for many of the sources that Micron operates, types of control technologies identified are summarized in Section 1.1 of this appendix. Not all technologies are applicable to all emissions sources, and such, source-specific considerations for each source category are discussed in the subsequent sections.

Emission sources evaluated in this BACT analysis include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine;
- Semiconductor process tools and other process and support operations that emit PM;
- Cooling towers;
- Bulk Material Storage silos;
- Fugitive emissions from activity on roads; and
- Wastewater treatment plant.

At the time of the Permit Application 1, Micron had not undertaken detailed design the Proposed Air Permit Project's wastewater treatment (WWTP). Based on the current WWTP design details for this Permit Application 2, the PM BACT evaluation has been completed in Section 1.10 of this appendix.

1.1 Available Technology Summary

The technologies identified to mitigate PM emissions are described in the following subsections.

1.1.1 Tier 4 Compliant Emergency Generator Engines

Engines meeting Tier 4 emission standards are designed with a focus on reducing emissions, including PM, to meet stringent environmental and regulatory standards. These engines utilize various engineering and technological advancements to minimize PM emissions while maintaining performance and efficiency.

1.1.2 Good Combustion and Maintenance Practices for Fuel-Fired Equipment

Good combustion and maintenance practices are essential for operating fuel-fired equipment efficiently and effectively while minimizing PM emissions. For this source category, good combustion practices are generally considered to be implementing the manufacturer's recommendations which may include a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Minimizing engine idle time at startup;
- Conducting operator training; and
- Conducting periodic maintenance.

The specific practices available for each source category are discussed in the subsequent sections.

1.1.3 Good Operating and Maintenance Practices for Silos

Implementing good operating and maintenance practices at bulk storage silos, including efficient loading and unloading techniques, optimizing airflow, and avoiding overfilling minimizes the release of PM, leading to cleaner air and improved environmental conditions around the silos.

1.1.4 Use of Ultra-Low-Sulfur Diesel for Emergency Generator Engines

The utilization of ultra-low-sulfur diesel (ULSD) in diesel fuel-fired equipment results in lower PM emissions by promoting cleaner combustion and more efficient utilization of fuel. Sulfur in diesel fuel forms PM during combustion; therefore, minimizing the sulfur content of the fuel through the use of ULSD decreases the amount of PM that can be formed.

1.1.5 Operating Limitations

Limiting the hours of operation for engines, water bath vaporizers, and boilers reduces PM emissions by decreasing the overall time the equipment runs and consumes fuel.

1.1.6 Diesel Particulate Filters

Diesel particulate filters (DPFs) are add-on control devices that consist of a filter positioned in the exhaust stream that can be either passive or active. Use of ULSD must be used in conjunction with DPFs.

1.1.7 Mist/Drift Eliminators

Mist eliminators prevent liquid droplets and mist containing PM from escaping both the scrubbing systems and cooling towers, which lowers PM emissions. Mist and drift eliminators are usually integral into system designs.

1.1.8 Electrostatic Precipitators

An electrostatic precipitator (ESP) is a PM control device that uses electrical forces to remove particles entrained within an exhaust stream. The entrained particles are given an electrical charge when they pass through the ESP, and the charged particles are forced to the collector surfaces (e.g., walls, plates, rods), removing them from the air stream.[1]

[1] Air Pollution Control Technology Fact Sheet, Wet Electrostatic Precipitator (ESP)-Wire-Plate Type, EPA-452/F-03-030

ESPs may either operate dry, or wet when utilizing water within the charging and collection section. According to EPA's Air Pollution Control Technology Fact Sheet, "Wet ESPs [WESPs] are used in situations for which dry [ESPs] are not suited, such as when the material to be collected is wet, sticky, flammable, explosive, or has a high resistivity," and they can achieve design efficiencies greater than 99% for new equipment including PM in the PM_{10} and $PM_{2.5}$ ranges. Furthermore, the same Fact Sheet indicates that WESPs are "often used to control acid mists", which makes them a technically feasible option for controlling process emissions sources for the Proposed Air Permit Project due to acid gases that are controlled by wet scrubbers contributing to PM emissions.[2]

In this appendix and the entire Micron Clay Air Permit Application, the term ESP refers to electrostatic precipitators generally (either dry or wet applications) and the term WESP refers to wet ESP applications.

A specific type of wet scrubber utilizing electrical charges to control PM is an ionizing wet scrubber (IWS). A manufacturer of IWS units that is under consideration by Micron states that control in their IWS designs is achieved when "particulate is charged and collected on ionizer plates and packing via electrostatic principles." Specifically, an IWS "[c]ombines established principles of electrostatic particle charging, image force attraction, inertial impaction, and gas absorption to collect submicron solid particles, liquid particles, and noxious and malodorous gases simultaneously" where image force attraction refers to the phenomena experienced "whenever an electrostatically charged particle comes within the boundary layer … of a neutral surface. As the charged particle comes close to the neutral surface, an electrostatic charge of opposite polarity is induced at the neutral surface."[3] Thus an IWS operates similarly to a traditional WESP in that particulate is charged and attracted to a surface of an opposite charge. A traditional WESP uses electricity to provide an opposite change to the collecting surface whereas in an IWS, the oppositely charged surface is induced by the particulate itself. Due to this similarity in PM control technology, IWSs are addressed as a type of WESP in this appendix.

1.1.9 Baghouse/Fabric Filters for Silos

Baghouses, also known as fabric filters, are designed to reduce PM emissions by using a series of fabric bags or filter media to capture and remove particulates from exhaust streams. As the contaminated air passes through the fabric filters, the particles are physically trapped on the surface of the filter media. Most baghouses and fabric filters have a cleaning system that transfers the fabric filter catch to a container or back to a unit.

Storage silos for bulk materials are typically controlled by fabric filters known as "bin vents". A bin vent is a fabric filter that captures silo material only when the silo is being filled, i.e., displacement air that is being pushed from the silo to ambient air. As the silo is emptied, air is drawn into the silo, and under this condition, emissions from the silo are not occurring.

[2] Ibid.

[3] [redacted]

1.1.10 Packed Bed Scrubber/Wet Scrubbers

A packed bed scrubber is used to control PM emissions by passing exhaust gas through a column filled with structured packing material where PM is captured through mechanical impaction and gas-liquid interaction. In most cases, pollutants are removed by inertial or diffusional impaction, reaction with a sorbent or reagent slurry, or absorption into liquid solvent. This type of technology is often referred to as "wet scrubbers," and, when used to control inorganic gases, they may also be referred to as "acid gas scrubbers."

Wet scrubbers are utilized for a variety of applications and control of many pollutants, including less than PM_{10} and $PM_{2.5}$. However, packed-bed wet scrubbers are limited to applications in which dust loading is low (0.20 grains per standard cubic foot (gr/scf)), and collection efficiencies range from 50% to 95%, depending on the application.[4]

1.1.11 Low Total Dissolved Solids in Cooling Tower Water

Low total dissolved solids (TDS) in cooling tower water contributes to the reduction of PM emissions by minimizing the accumulation of dissolved particulate matter within the tower. When TDS levels are low, there is less material available to form solid particles from mist generated from operation of the tower. A means to control TDS is to control makeup influent rate which affects TDS levels.

1.1.12 Paved Roads

Paved roads decrease the amount of PM emissions that are dispersed into the air when the road is disturbed. Since less PM is dispersed when the road is disturbed, less PM is transferred from the road to the atmosphere.

1.1.13 Waste Minimization and Efficient Design

Reducing the generation of the waste at the source reduces the PM loading of the wastewater and thus lowers PM emissions generated in the wastewater treatment process.

1.1.14 Roadway Surface Treatments

Surface treatments including wet suppression and chemical stabilization/treatment reduce PM emissions from unpaved roads by binding the particles together and preventing them from becoming airborne.

1.1.15 Control Technologies Not Evaluated

Some control technologies have been omitted from the BACT evaluation due to various considerations. These control technologies, and the reasons for their omission, are summarized in Table 1-1.

[4] Air Pollution Control Technology Fact Sheet for Packed-Bed/Packed-Tower Wet Scrubber (EPA-452/F-03-015).

Table 1-1. Summary of Control Technologies Not Evaluated

Emission Source Category	Technology	Reasoning
All Source Categories	Use of Alternate Fuels	The use of different fuel or raw material that would redefine the Proposed Air Permit Project are out of the scope of BACT and LAER evaluations. Where different fuel specifications within the fuel type (i.e., use of ULSD) are feasible for the project, they have been identified above in Section 1.1 and are evaluated in the sections following this table.
Natural Gas-Fired Boilers and Water Bath Vaporizers	Baghouse/Fabric Filter	The control technology search conducted returned only one instance of a baghouse used on natural gas combustion devices. This case involved a boiler that burned both natural gas and carbon black oil. This is not relevant for comparison to the Proposed Air Permit Project as the proposed units will burn solely natural gas; therefore, the use of a baghouse has not been evaluated further.
	ESP	The control technology search conducted did not return any instances of an ESP used on natural gas-fired combustion devices. As such, this control has not been evaluated further.
	Wet Scrubber	The control technology search conducted did not return any instances of a wet scrubber used on natural gas-fired combustion devices. As such, this control has not been evaluated further.
	Cyclone	The control technology search conducted did not return any instances of a cyclone used on natural gas-fired combustion devices. As such, this control has not been evaluated further.
	Inertial Separation Systems	The control technology search conducted did not return any instances of inertial separation systems used on natural gas-fired combustion devices. As such, this control has not been evaluated further.
Diesel-Fired Emergency Generator Engines and Diesel-Fired Emergency Fire Pump Engine	Oxidation Catalyst	The control technology search conducted did not return any instances of oxidation catalysts used on diesel-fired engines for the control of PM. While oxidation catalysts may result in a slight reduction in PM emissions by promoting the oxidation of certain PM precursors, they primarily target gaseous pollutants such as carbon monoxide and volatile organic compounds. As such, this control has not been evaluated further as an effective control of PM.
	ESPs	The control technology search conducted did not return any instances of an ESP used on diesel-fired emergency generator engines or emergency fire pump engines. As such, this control has not been evaluated further.

Emission Source Category	Technology	Reasoning
Semiconductor Process Tools and Process Equipment Exhaust Conditioners (PEECs)	Ceramic Filters	The control technology search conducted did not return any instances of ceramic filters used on semiconductor process tools and PEECs. Furthermore, because submicron particulate matter in the inlet would penetrate the filter media, this type of control is expected to plug relatively quickly. As such, this control has not been evaluated further.
	Baghouse/Fabric Filters	The control technology search conducted did not return any instances of baghouse/fabric filters used on semiconductor process tools and PEECs. In addition, removal efficiency of fabric filters continually decreases for particles that are submicron particulate matter (<0.3 micron) expected to be generated from these operations. As such, this control has not been evaluated further.
	HEPA or ULPA Filters	The control technology search conducted did not return any instances of HEPA or ULPA filters used on semiconductor process tools and PEECs. As such, this control has not been evaluated further.
	Fiber Bed Filters	The control technology search conducted did not return any instances of fiber bed filters used on semiconductor process tools and PEECs. As such, this control has not been evaluated further.
	Venturi Scrubbers	The control technology search conducted did not return any instances of venturi scrubbers used on semiconductor process tools and PEECs. Furthermore, venturi scrubbers do not induce inertial impaction for submicron and nanometer size particulate matter due to low mass of the particles. As such, this control has not been evaluated further.
	Cyclones	The control technology search conducted did not return any instances of cyclones used on semiconductor process tools and PEECs. Cyclone PM control technology is not effective at submicron particle sized. As such, this control has not been evaluated further.
	Packed Bed Scrubbers	The control technology search conducted did not return any instances of packed bed scrubbers used on semiconductor process tools and PEECs. As such, this control has not been evaluated further.
	Exhaust Gas Segregation	The control technology search conducted did not return any instances of exhaust gas segregation used on semiconductor process tools and PEECs as a control technology. As such, this control has not been evaluated further

Emission Source Category	Technology	Reasoning
Bulk Material Storage Silo	ESP	The control technology search conducted did not return any instances of an ESP used on storage silos. As such, this control has not been evaluated further.
	Cyclone	The control technology search conducted did not return any instances of a cyclone used on storage silos. As such, this control has not been evaluated further.
	Wet Scrubber	The control technology search conducted did not return any instances of a wet scrubber used on storage silos. As such, this control has not been evaluated further.
Wastewater Treatment Plant	ESP	The control technology search conducted did not return any instances of an ESP used in wastewater treatment plants. As such, this control has not been evaluated further.
	Cyclone	The control technology search conducted did not return any instances of a cyclone used in wastewater treatment plants. As such, this control has not been evaluated further.
	Wet Scrubber	The control technology search conducted did not return any instances of a wet scrubber used in wastewater treatment plants. As such, this control has not been evaluated further.
	Fabric Filters	The control technology search conducted did not return any instances of fiber bed filters used in wastewater treatment plants. As such, this control has not been evaluated further.

1.2 Natural Gas-Fired Boilers

Natural gas-fired boilers are heating systems used to generate hot water or steam for maintaining precise temperature control for various stages of production, ensuring the efficient operation of machinery. Micron is proposing to use efficient units that are specifically designed to meet the Proposed Air Permit Project's thermal requirements while minimizing energy consumption and emissions.

The BACT analysis for PM emissions from natural gas-fired boilers is presented in this section.

1.2.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing PM emissions from the proposed natural gas-fired boilers:

- Good combustion and maintenance practices; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered BACT for natural gas-fired boilers. Proposed BACT emission limits are discussed further in Step 5.

1.2.2 Step 2. Eliminate Technically Infeasible Options

All control technologies identified in Step 1 for natural gas-fired boilers are technically feasible.

1.2.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.2.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.2.5 Step 5. Select BACT

Micron intends to purchase natural gas-fired boilers designed to meet a PM emission limit of 7.6 pounds per million standard cubic feet (lb/MMscf). This is the lowest emission limitation identified as BACT based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will also implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 6,000 hours per year for each boiler.

1.3 Natural Gas-Fired Water Bath Vaporizers

This Permit Application 2 separates "natural gas-fired combustion equipment" into boilers and water bath vaporizers. Natural gas-fired water bath vaporizers are used in the semiconductor industry to provide a reliable and efficient source of high-purity nitrogen gas. These water bath vaporizers use natural gas to heat water that is used to vaporize liquified nitrogen used in semiconductor manufacturing.

The BACT analysis for PM emissions from natural gas-fired water bath vaporizers is presented in this section.

1.3.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing PM emissions from the proposed natural gas-fired water bath vaporizers:

- Good combustion and maintenance practices; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered BACT for natural gas-fired water bath vaporizers. Proposed BACT emission limits are discussed further in Step 5.

1.3.2 Step 2. Eliminate Technically Infeasible Options

All control technologies identified in Step 1 for natural gas-fired water bath vaporizers are technically feasible.

1.3.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.3.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.3.5 Step 5. Select BACT

Micron intends to purchase natural gas-fired water bath vaporizers designed to meet a PM emission limit of 7.6 lb/MMscf. This is the lowest emission limitation identified as BACT based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will also implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following as BACT:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 8,000 hours per year for all water bath vaporizers combined, with no more than four units operating at a time.

1.4 Diesel-Fired Emergency Generator Engines

The Proposed Air Permit Project will utilize diesel-fired emergency generator engines to ensure that critical life safety and process safety systems receive uninterrupted power during power outages. These units will not be designed to run manufacturing operations during major electrical outages and instead will allow equipment and processes to shut down gradually as necessary, protecting sensitive manufacturing operations, preventing unsafe conditions from forming in the fabs, reducing emissions of process gases directly to the atmosphere, and protecting employee safety.

1.4.1 Step 1. Identify All Control Technologies

Diesel-fired emergency generator engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT. These standards are based on the engine's maximum power capacity and the year in which the engine was manufactured. Currently, the EPA has implemented the Tier 4 Final emission standards for non-road diesel engines, which set stringent limits for newly manufactured units.[5] EPA has also set limitations for stationary internal combustion engines under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." For engines with certain power capacity and manufacture year, NSPS Subpart IIII references the engine standards established for nonroad engines under 40 CFR 1039.

In addition, the following control methods have been identified for reducing PM emissions from the proposed diesel-fired emergency generators engines:

- Good combustion and maintenance practices;
- Operating hours limitations; and
- Use of ULSD.

1.4.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for diesel-fired emergency generator engines are technically feasible.

1.4.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.4.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

[5] 40 CFR 1039.101

1.4.5 Step 5. Select BACT

The following control technologies are proposed to achieve BACT for diesel-fired emergency generator engines:

- The purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine's idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and
  - Conducting periodic maintenance
- The use of ULSD; and
- Operating hour limitations.

A BACT limit must not be higher than an applicable NSPS emission limit. The diesel-fired generators will be affected facilities under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." NSPS Subpart IIII provides PM emission standards for various engine power and displacement categories. However, these emission standards are less stringent than the Tier 4 Final emission standards.

Therefore, Micron is proposing the Tier 4 Final emission standards outlined in Table 1-2 as the BACT PM limit for diesel-fired emergency generator engines and will procure new engines for the Proposed Air Permit Project that meet these standards. Control technologies to achieve Tier 4 Final emission standards may vary depending on the engine manufacturer and may include the use of diesel particulate filters where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency generator engines and proposes an operating hours limit of 100 hours per year for each engine.

Table 1-2. 40 CFR §1039.101
Tier 4 Final Exhaust Emission Standards After the 2014 Model Year, g/kW-hr

Maximum Engine Power (kW)	Application	PM Emission Standard
kW <19	All	0.40
19 ≤kW <56	All	0.03
56 ≤kW <130	All	0.02
130 ≤kW ≤560	All	0.02
kW >560	Generator Sets	0.03
	All Except Generator Sets	0.04

1.5 Diesel-Fired Emergency Fire Pump Engine

The Proposed Air Permit Project will include one diesel-fired emergency fire pump engine to provide a reliable power source in the event of a fire occurring during a power outage when the electric fire pump would not be available.

1.5.1 Step 1. Identify All Control Technologies

Diesel-fired emergency fire pump engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT. These standards are based on the fire pump engine's maximum power capacity and the year in which the engine was manufactured. EPA has set limitations for stationary internal combustion engines, including fire pump engines, under NSPS Subpart IIII. The EPA has also implemented Tier emission standards (Tier 1 – Tier 4 Final) for non-road diesel engines, which set stringent limits for newly manufactured units. Based on the RBLC search conducted, as well as input from Micron's equipment vendors, Tier 4 compliant fire pump engines are not available. As such, the most stringent emission standards are Tier 3, which align with NSPS IIII emission standards for the proposed fire pump engine for PM.

In addition, the following control methods have been identified for reducing PM emissions from the proposed diesel-fired emergency fire pump engine:

- Good combustion and maintenance practices;
- Operating hours limitations; and
- Use of ULSD.

1.5.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for the diesel-fired emergency fire pump engine are technically feasible.

1.5.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.5.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.5.5 Step 5. Select BACT

The following control technologies are proposed to achieve BACT for the diesel-fired emergency fire pump engine:

- The purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine's idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;

- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance

► The use of ULSD; and
► Operating hour limitations.

A BACT limit must not be higher than an applicable NSPS emission limit. The diesel-fired emergency fire pump engine will be an affected facility under NSPS Subpart IIII. NSPS Subpart IIII provides PM emission standards for various engine power and displacement categories. For the capacity of the proposed diesel-fired emergency fire pump engine, NSPS IIII emission standards align with Tier 3 emission standards.

Therefore, Micron is proposing compliance with the NSPS IIII and Tier 3 emission standard of 0.15 grams per brake horsepower-hour (g/bhp-hr) as the BACT PM limit for the diesel-fired emergency fire pump engine. Control technologies to achieve this emission standard may vary depending on the engine manufacturer and may include the use of diesel particulate filters where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency fire pump engine and proposes an operating hours limit of 500 hours per year.

1.6 Semiconductor Process Tools and PEECs

Micron is proposing to install semiconductor process equipment, or "tools", as discussed within the Micron Clay Air Permit Application. Particulate matter is emitted through the operation of the process tools and subsequent management of process materials in PEECs in the exhaust stream that create PM. PEECs that support semiconductor processes also generate PM emissions through natural gas combustion. It is not the primary purpose of these devices to control PM emissions that are emitted from process tools, however, they may incidentally manage PM emissions.

Certain types of process tool emissions (i.e., acid gases, ammonia) are routed to a centralized wet scrubber system, which is employed in semiconductor manufacturing to effectively neutralize and remove gases generated during various fab processes. The type of wet scrubbers employed for acid gas and ammonia control are mass-transfer-based units (i.e., vapor phase into the liquid phase) and are designed to abate water-soluble gases, some of which are PM (i.e., acids gases such as sulfuric acid) and are not designed to efficiently abate non-soluble PM emissions.

Particulate matter emissions include a wide range of particles suspended in the air; however, much of the PM emissions generated in the process tools and PEECs are estimated to be less than one micron (1 µm) – also known as submicron – which adds further complexity in identifying appropriate and effective control devices. To abate particulate matter more effectively, additional control devices have been considered to be added at the exhaust of the centralized acid wet scrubbers.

1.6.1 Step 1. Identify All Control Technologies

Upon review of the RBLC database, BAAQMD BACT guidance, and relevant semiconductor air permits, the following control methods have been identified for reducing PM emissions from the proposed semiconductor manufacturing process tools and their associated emissions:

- Good combustion and maintenance practices for PEECs;
- Use of mist eliminators on wet scrubbers;
- Per requirements established by the BAAQMD, BACT for PM_{10} for Siliconizing Reactors, Furnace Chambers, and Chemical Vapor Deposition (CVD) Reactors in semiconductor fabrication operations is to vent exhaust to a combustion chamber followed by a wet scrubber with a particulate control efficiency of $\geq$99%;[6] and
- WESP technology has been identified as appropriate control technology for emissions from other semiconductor manufacturing operations in air permits reviewed as part of this BACT analysis.

For PM generated in the process tools and PEECs, WESP technology could abate the PM emissions at the exhaust of the centralized acid or ammonia wet scrubber systems. For the Proposed Air Permit Project, all semiconductor manufacturing operations that fall within the categories identified in the third bullet above regarding BAAQMD BACT fall within the CVD operations which will be vented through the CVD scrubbers. Additional details of each of these exhaust types are provided in the Micron Clay Air Permit Application, Section 1.4.3.3.

1.6.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for semiconductor process tools, safety equipment, cleaning operations and POU control devices are technically feasible; however, the BAAQMD BACT included in the third bullet above identifies a 99% PM_{10} control efficiency associated with combustion followed by wet scrubbing. Based on information provided by leading vendors in the semiconductor industry, Micron believes that a 99% PM_{10} control efficiency has not been achieved in practice. For this reason, Micron is evaluating the venting of CVD operations to a combustion chamber followed by a wet scrubber technology as a potential control technology, but is eliminating the associated control efficiency.

1.6.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

The order of effectiveness of the four technically feasible control options listed in Step 1 is as follows (highest efficiency listed first):

- WESP technology for emissions from other (i.e. non-CVD) semiconductor manufacturing operations;
- For CVD processes within the Proposed Air Permit Project, the process exhaust must be vented to a combustion chamber followed by a wet scrubber where appropriate;
- Use of mist eliminators on wet scrubbers; and
- Good combustion and maintenance practices for combustion-based oxidation devices.

Although wet scrubbers and WESPs can achieve high levels of PM control, they require additional electricity to operate which would result in emissions from generation and supply of the electricity to the Micron Campus, and an additional consequence of their use is generation of wastewater that requires management and treatment.

[6] BAAQMD BACT/TBACT Workbook, Semiconductor Manufacturing Operations section, Semiconductor Fab – Siliconizing Reactors, Furnace Chambers, Vapor Deposition; https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook; accessed March 14, 2024.

1.6.4 Step 4. Evaluate the Most Effective Controls and Document

The most effective controls for each semiconductor process exhaust type (which are described in the Micron Clay Air Permit Application, Section 1.4.3.2) vary based on PM generated by specific processes venting to the centralized control equipment, then to atmosphere. Notably, the control must be effective at submicron PM (i.e., less than 1 µm in diameter) emissions as much of the PM emissions generated in the process tools are estimated to fall into this range which adds further complexity in identifying appropriate and effective control devices.

Semiconductor process equipment venting to CVD Exhaust, Acid Exhaust and Ammonia Exhaust systems are addressed below in the remainder of Section 1.6.4.

1.6.4.1 CVD Processes and CVD Scrubbers

For CVD processes within the Proposed Air Permit Project, the combination of the process exhaust being vented to a combustion chamber followed by a wet scrubber is the most effective control identified.

Micron is currently planning to utilize PEECs equipped with combustion chambers as required safety equipment to manage process gases that are pyrophoric, flammable, toxic, or incompatible with other process gases or the ductwork. PEECs may incidentally manage PM emissions that are comingled with these hazardous materials. CVD process exhaust will be routed to PEECs and then to CVD wet scrubbers and ultimately to IWSs to control PM emissions collected in the CVD process header.

1.6.4.2 Processes Vented to Acid Exhaust and Ammonia Exhaust

There is the potential to emit PM from the process tools that vent to the acid scrubbers and ammonia scrubbers. However, unlike the CVD scrubbers, the amount of PM generated in the process tools is generally small, and it is not common in the industry to install PM control at the exhaust of these scrubbers. Nevertheless, Micron has evaluated adding an IWS to the acid scrubbers and the ammonia scrubbers.

As described in Section 1.1.8 above, an IWS is one type of WESP using the same PM removal technology as a traditional WESP control technology. In Micron's experience, the IWS application of WESP technology is most suitable for their semiconductor manufacturing operations. In part, this is due to the ability of an IWS to control submicron particles as described in Section 1.1.8 of this appendix.

An economic feasibility analysis was completed based on a cost estimate for a similar Micron facility and the projected emission rate for the Proposed Air Permit Project. The analysis is presented in Attachment 4, BACT Economic Feasibility Evaluation, and the cost effectiveness of control is presented in Table 1-3. This analysis assumes the lower end of the operating efficiencies listed in EPA's Air Pollution Control Technology Fact Sheet for new WESPs (99% control) to calculate the total cost measured in dollars per ton of PM removed ($/ton PM Removed).[7]

[7] The EPA Air Pollution Control Cost Manual (https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution, Accessed April 2024) provides guidelines for calculating cost effectiveness for use of

Table 1-3. PM BACT Economic Feasibility Summary (IWS)

Exhaust Type	PM Emissions Controlled (ton/yr/stack)	Cost Effectiveness ($/ton PM Removed)
Acid Scrubbers	0.10	$44,882,242
Ammonia Scrubbers	0.06	$78,455,814

Trinity is not aware of a published BACT cost effectiveness value for PM emissions. However, the cost per ton removed presented in Table 1-3 is excessive for the benefit of the control and as such, it is concluded that this technology is not economically feasible.

1.6.4.3 Generation of PM from Operation of Wet Scrubbers

Mist eliminators are a technically and economically feasible control technology to prevent PM carryover from the operation of wet scrubbers.

1.6.5 Step 5. Select BACT

Micron proposes to use IWS units at the CVD scrubber exhaust as BACT for PM emissions from siliconizing reactors, furnace chambers, and CVD reactors.

Micron proposes to equip acid scrubbers and ammonia scrubbers with mist eliminators as a BACT-level control. Because the CVD scrubbers will be equipped with the higher-ranked IWS system, a mist eliminator is unnecessary for these operations.

Micron is also proposing good combustion and maintenance practices as BACT for manufacturing process emission sources equipped with PEECs.

1.7 Cooling Towers

Cooling towers are used to dissipate the large heat loads generated by the factory and condition the incoming air to the correct temperature. Cooling tower demand is high in warmer months and lower in cooler months. Emissions of PM are generated from cooling towers because the water circulating in the tower contains small amounts of dissolved solids (e.g., calcium, magnesium, etc.) that crystallize and form airborne particles as the water drift leaves the cooling tower.

1.7.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing PM emissions from the RCTO:

- Drift/Mist Eliminators; and
- Maintaining low Total Dissolved Solids (TDS) in cooling tower water.

WESPs for PM Control (additional details provided in Attachment 4 to this appendix). However, the Manual does not provide a means to estimate control costs for IWSs. Considering the similarity of control technology, and the considerable cost ($/ton PM removed) calculated using EPA's WESP cost estimation methodology, it is assumed that a cost effectiveness evaluation using actual IWS costs would also conclude that controlling PM from acid scrubber and ammonia scrubber exhaust stacks is not economically feasible.

1.7.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 are technically feasible.

1.7.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.7.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.7.5 Step 5. Select BACT

Micron is proposing the installation of drift/mist eliminators certified to less than 0.0005% drift rate. In addition, Micron will operate the cooling towers to ensure that total dissolved solids are less than 1,200 milligrams / liter (mg/l) at all times as BACT. This proposal is consistent with the results of the RBLC search. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results.

1.8 Bulk Material Storage Silos

Silos are used to store raw materials for semiconductor manufacturing, and raw materials, such as lime, are held in storage until needed for production. The followings sections summarize the BACT analysis for bulk material storage silos.

1.8.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing PM emissions from the fugitive emissions:

- Fabric Filters; and
- Good Operating Practices.

1.8.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 are technically feasible.

1.8.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary and the next step is to evaluate the most effective controls.

1.8.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.8.5 Step 5. Select BACT

Due to the high control efficiency and cost effectiveness, Micron proposes fabric filters (i.e., passive bin vents or dust collectors with an extraction system) certified to meet an exhaust grain loading of 0.005 gr/dscf, along with good operating and maintenance practices, as BACT for the bulk materials storage silos. This is the lowest emission limitation identified as BACT based on the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results.

1.9 Vehicle Traffic Dust Emissions

Particulate matter emissions will be generated from vehicle travel on site. These fugitive emissions contribute to the overall PM emissions from the Proposed Air Permit Project.

1.9.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing PM emissions from road dust:

- Vehicle traffic restrictions;
- Surface improvements; and
- Surface treatments.

1.9.2 Step 2. Eliminate Technically Infeasible Options

Micron has evaluated the locations where regular vehicular traffic is expected based on delivery of materials, shipment of products, employee parking and other foreseeable vehicle use. Each such area will be improved (paved). Refer to Appendix P of the Micron Clay Air Permit Application for a plot plan which illustrates roadways, paved areas around the buildings, etc. Although there may be vehicle traffic in areas that are not paved for maintenance, special purposes that are temporary in nature, or other reasons, additional regular vehicular traffic in areas outside of the paved areas is not expected based on the operation of other Micron facilities.

All remaining control technologies identified in Step 1 are technically feasible for areas expected to experience regular vehicular traffic.

1.9.3 Step 3. Rank Remaining Control Technologies by Effectiveness

All control technologies identified are considered feasible for areas where regular vehicular traffic is expected and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies in areas where regular vehicular traffic is expected to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

While paving surfaces reduces PM from vehicular traffic, it also has other unfavorable environmental impacts. Notably, additional paving will result in additional ground disturbance, and it will cause additional impervious surface areas that are likely to result in additional storm water runoff which would require additional stormwater management infrastructure than already planned. Therefore, minimizing improved/paved surfaces to the extent practicable and addressing areas where regular vehicular traffic is expected is desirable to balance overall potential environmental impacts.

1.9.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered feasible in areas where vehicular traffic is expected and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.9.5 Step 5. Select BACT

Micron proposes BACT for the proposed fugitive emissions of PM in areas where vehicular traffic is expected on the Micron Campus to be the surface improvement (e.g., paving) of roads wherever feasible, the implementation of a speed limit(s), and surface treatments (i.e., watering unpaved areas, localized speed limits) for areas that experience traffic where paving is not feasible.

For areas where vehicular traffic is intermittent and unpredictable, Micron will employ appropriate measures, including surface treatments (i.e., watering unpaved areas) and localized speed limits as necessary to minimize PM generation from vehicular traffic.

1.10 Wastewater Treatment Plant

Micron is proposing to install a wastewater treatment plant as a part of the Proposed Air Permit Project to treat high fluoride wastewater, industrial wastewater, and hydrocarbon in wastewater generated from the semiconductor process tools. Particulate matter generated from the wastewater treatment plant includes [redacted] and tetramethyl ammonium hydroxide. Micron proposes to discharge a portion of the treated wastewater to the nearest waterbody using the outfalls located at the Proposed Air Permit Project and reuse some treated wastewater and stored in the reclaimed water tank.

1.10.1 Step 1. Identify All Control Technologies

A review of the EPA's RBLC database did not identify any entries of facilities that utilize add-on control devices to abate PM emissions that are generated from wastewater treatment plants.

Micron also reviewed relevant semiconductor air permits to evaluate if any control technologies are currently being utilized to abate PM emissions from wastewater treatment plants. During the review of these permits, it was determined that no add-on control devices are currently installed to abate such PM emissions.

Waste minimization and efficient design is the only method that has been identified for reducing PM emissions from the wastewater treatment plant.

1.10.2 Step 2. Eliminate Technically Infeasible Options

The only control technology identified in Step 1 for wastewater treatment plants is technically feasible.

1.10.3 Step 3. Rank Remaining Control Technologies by Effectiveness

Since the use of waste minimization and efficient design is the only identified control option, ranking the remaining control technologies by control effectiveness is unnecessary. Therefore, the next step is to evaluate the most effective controls.

1.10.4 Step 4. Evaluate the Most Effective Controls and Document

Since the use of waste minimization and efficient design is the only identified control option, evaluating the most effective controls is unnecessary. Therefore, the next step is to select BACT.

1.10.5 Step 5. Select BACT

Micron is proposing to comply with waste minimization and efficient design as a work practice standard to achieve BACT for PM emitted from the wastewater treatment plant in lieu of a formal limit.

Attachment 1
RACT/BACT/LAER Clearinghouse Search Results

Attachment 2
Bay Area Air Quality Management District Summary

Attachment 3
Semiconductor Permit Review Summary

Attachment 4
BACT Economic Feasibility Evaluation

Process IDs: 12.310, 13.310, 19.600
Other Search Criteria: Process Name Contains "Boiler"
Process Description Natural Gas-fired Boilers
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas", Heat Input ≤50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-233 Galvanizing Line Boilers	13.31	Good combustion practices	0.0019	LB/MMBTU
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-233 Galvanizing Line Boilers	13.31	Good combustion practices	0.0076	LB/MMBTU
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-202, 203, 204 Pickle Line Boilers	13.31	Good Combustion Practice	0.0019	LB/MMBTU
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-202, 203, 204 Pickle Line Boilers	13.31	Good Combustion Practice	0.0076	GR/DSCF
KS-0029	THE EMPIRE DISTRICT ELECTRIC COMPANY	KS	C-12987	07/14/2015	Auxiliary boiler	13.31	Not Specified	0.005	LB PER MMBTU
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Pickle Line #2 Boiler #1 & #2 (EP 21-04 & EP 21-05)	13.31	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	7.6	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Pickle Line #2 Boiler #1 & #2 (EP 21-04 & EP 21-05)	13.31	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	1.9	LB/MMSCF
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	AUXILLARY BOILER	13.31	EXCLUSIVE USE OF PIPELINE QUALITY NATURAL GAS AND GOOD COMBUSTION PRACTICES	0.0075	LB/MMBTU

Process IDs: 12.310, 13.310, 19.600
Other Search Criteria: Process Name Contains "Boiler"
Process Description Natural Gas-fired Boilers
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas", Heat Input ≤50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	AUXILIARY BOILER	13.31	USE OF PIPELINE QUALITY NATURAL GAS AND GOOD COMBUSTION PRACTICES	0.0019	LB/MMBTU
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	AUXILIARY BOILER	13.31	USE OF PIPELINE QUALITY NATURAL GAS AND GOOD COMBUSTION PRACTICES	0.0075	LB/MMBTU
MI-0420	DTE GAS COMPANY--MILFORD COMPRESSOR STATION	MI	185-15	06/03/2016	FGAUXBOILERS	13.31	Good combustion practices and low sulfur fuel (pipeline quality natural gas).	0.0075	LB/MMBTU
MI-0426	DTE GAS COMPANY - MILFORD COMPRESSOR STATION	MI	185-15A	03/24/2017	FGAUXBOILERS (6 auxiliary boilers EUAUXBOIL2A, EUAUXBOIL3A, EUAUXBOIL2B, EUAUXBOIL3B, EUAUXBOIL2C, EUAUXBOIL3C)	13.31	Good combustion practices and low sulfur fuel (pipeline quality natural gas).	0.52	LB/MMSCF
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Auxiliary Boiler (B001)	13.31	Low sulfur fuel	0.27	LB/H

Process IDs: 12.310, 13.310, 19.600
Other Search Criteria: Process Name Contains "Boiler"
Process Description Natural Gas-fired Boilers
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas", Heat Input ≤50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Auxiliary Boiler (B001)	13.31	Low sulfur fuel	0.3	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Auxiliary Boiler (B001)	13.31	low sulfur fuel	0.3	LB/H
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Auxiliary Boiler (B001)	13.31	Low sulfur fuel	0.27	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Auxiliary Boiler (B001)	13.31	Pipeline quality natural gas	0.33	LB/H
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	02/06/2019	Startup boiler (B001)	13.31	Good combustion practices and the use of natural gas	0.113	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.31	Good combustion practices and the use of natural gas	1.68	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.31	Good combustion practices and the use of natural gas	0.46	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.31	Good combustion practices and the use of natural gas	0.38	T/YR
OR-0050	TROUTDALE ENERGY CENTER, LLC	OR	26-0235	03/05/2014	Auxiliary boiler	13.31	Good combustion practices; Utilize only natural gas.	--	--
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Auxillary Boiler	13.31	Natural gas fired exclusively	0.002	LB/MMBTU
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Auxillary Boiler	13.31	Not Specified	0.007	LB/MMBTU
PA-0316	RENOVO ENERGY CENTER, LLC	PA	18-00033A	01/26/2018	Auxiliary Boiler	13.31	Not Specified	0.0019	LB

Process IDs: 12.310, 13.310, 19.600
Other Search Criteria: Process Name Contains "Boiler"
Process Description Natural Gas-fired Boilers
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas", Heat Input ≤50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
SC-0193	MERCEDES BENZ VANS, LLC	SC	0560-0385-CA	04/15/2016	Energy Center Boilers	13.31	Annual tune ups per 40 CFR 63.7540(a)(10) are required.	7.6	LB/MMSCF
TX-0772	PORT OF BEAUMONT PETROLEUM TRANSLOAD TERMINAL (PBPTT)	TX	118901, GHGPSDTX108 AND PSDTX1	11/06/2015	Commercial/Institutional-Size Boilers/Furnaces	13.31	Good combustion practice to ensure complete combustion.	0.4	T/YR
TX-0772	PORT OF BEAUMONT PETROLEUM TRANSLOAD TERMINAL (PBPTT)	TX	118901, GHGPSDTX108 AND PSDTX1	11/06/2015	Commercial/Institutional-Size Boilers/Furnaces	13.31	Good combustion practice to ensure complete combustion.	4	T/YR
WI-0306	WPL- RIVERSIDE ENERGY CENTER	WI	19-POY-212	02/28/2020	Temporary Boiler (B98A)	13.31	Combust only pipeline quality natural gas, can be operated for no more than 500 hours.	0.008	LB/MMBTU
WV-0031	MOCKINGBIRD HILL COMPRESSOR STATION	WV	R14-0033	06/14/2018	WH-1 - Boiler	13.31	Limited to natural gas.	--	--
WY-0075	CHEYENNE PRAIRIE GENERATING STATION	WY	MD-16173	07/16/2014	Auxiliary Boiler	13.31	good combustion practices	0.0175	LB/MMBTU
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	05/04/2018	Pickle Line Equipment (pickle line no. 3 boilers)	19.6	Good combustion practices	1.9	LB/MMSCF
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	05/04/2018	Pickle Line Equipment (pickle line no. 3 boilers)	19.6	Good Combustion Practices	7.6	LB/MMSCF

Process IDs: --
Other Search Criteria: Process Name Contains "Vaporizer"
Process Description Natural Gas-fired Water Bath Vaporizers
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Fuel type as "Natural Gas" or Equivalent

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Air Separation Plant Water Vaporizer	81.29	Combustion of natural gas and good combustion practices	0.0075	LB/MMBTU
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 13-01 - Water Bath Vaporizer	19.9	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	7.6	LB/MMSCF
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 13-01 - Water Bath Vaporizer	19.9	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	1.9	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Water Bath Vaporizer (2 indirect burners) (EP 23-01)	19.6	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	7.6	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Water Bath Vaporizer (2 indirect burners) (EP 23-01)	19.6	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	1.9	LB/MMSCF
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.31	Good combustion practices and the use of natural gas	0.12	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.31	Good combustion practices and the use of natural gas	0.1	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.31	Good combustion practices and the use of natural gas	0.45	T/YR
WV-0034	WEST VIRGINIA STEEL MILL	WV	R14-0039	05/05/2022	Water Bath Vaporizer	81.29	PNG Good Combustion Practices	0.08	LB/HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0082	POINT THOMSON PRODUCTION FACILITY	AK	AQ1201CPT03	01/23/2015	Emergency Camp Generators	17.11	Not Specified	0.15	GRAMS/HP-H
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Black Start and Emergency Internal Cumbustion Engines	17.11	Clean Fuel and Good Combustion Practices	0.25	G/KW-HR
AL-0301	NUCOR STEEL TUSCALOOSA, INC.	AL	413-0033-X014 - X020	07/22/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	Not Specified	0.0007	LB/HP-H
AR-0177	NUCOR STEEL ARKANSAS	AR	1139-AOP-R27	11/21/2022	SN-230 Galvanizing Line No, 2 Emergency Generator	17.11	Not Specified	0.2	G/KW-HR
*AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Generators	17.11	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	0.1	G/BHP-HR
FL-0346	LAUDERDALE PLANT	FL	0110037-011-AC	04/22/2014	Four 3100 kW black start emergency generators	17.11	Good combustion practice	0.2	GRAMS PER KW-HR
FL-0347	ANADARKO PETROLEUM CORPORATION - EGOM	FL	OCS-EPA-R4015	09/16/2014	Emergency Diesel Engine	17.11	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	--	--
FL-0356	OKEECHOBEE CLEAN ENERGY CENTER	FL	0930117-001-AC	03/09/2016	Three 3300-kW ULSD emergency generators	17.11	Use of clean fuel	0.2	G / KW-HR
FL-0363	DANIA BEACH ENERGY CENTER	FL	0110037-017-AC	12/04/2017	Two 3300 kW emergency generators	17.11	Clean fuel	0.2	GRAMS PER KWH
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	1,500 kW Emergency Diesel Generator	17.11	Operate and maintain the engine according to the manufacturer's written instructions	0.2	G/KW-HOUR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IL-0114	CRONUS CHEMICALS, LLC	IL	13060007	09/05/2014	Emergency Generator	17.11	Tier IV standards for non-road engines at 40 CFR 1039.102, Table 7.	0.1	G/KW-H
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Emergency Engine	17.11	Not Specified	0.2	G/KW-HR
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Emergency Engines	17.11	Not Specified	0.2	GRAMS
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Emergency Generator Engine	17.11	Not Specified	0.2	G/KW-HR
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	0.15	G/BHP-H
IN-0180	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	0.15	G/B-HP-H
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	03/23/2017	EMERGENCY GENERATORS (EU014A AND EU-014B)	17.11	GOOD COMBUSTION PRACTICES	0.15	G/HP-H EACH
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Emergency generator EU-6006	17.11	Tier II diesel engine	0.2	G/KWH
IN-0324	MIDWEST FERTILIZER COMPANY LLC	IN	129-44510-00059	05/06/2022	emergency generator EU 014a	17.11	Not Specified	0.15	G/HP-HR
IN-0359	NUCOR STEEL	IN	107-45480-00038	03/30/2023	Emergency Generator (CC-GEN1)	17.11	certified engine	0.15	G/HP-H
IN-0365	MAPLE CREEK ENERGY LLC	IN	T153-45909-00056	06/19/2023	Emergency generator	17.11	Not Specified	0.15	G PER HP-HR
KS-0040	JOHNS MANVILLE AT MCPHERSON	KS	CSD00081 V1.0	12/03/2019	Emergency Diesel Engines	17.11	Emergency Diesel Engine and Fire Pump Subject to NSPS Subpart IIII - Combustion Control and Limited Operating Hours.	0.2	GR/KWH

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0109	FRITZ WINTER NORTH AMERICA, LP	KY	V-16-022 R1	10/24/2016	Emergency Generators #1, #2, & #3 (EU72, EU73, & EU74)	17.11	The permittee shall prepare and maintain for EU72, EU73, and EU74, within 90 days of startup, a good combustion and operation practices plan (GCOP) that defines, measures and verifies the use of operational and design practices determined as BACT for minimizing CO, VOC, PM, PM10, and PM2.5 emissions. Any revisions requested by the Division shall be made and the plan shall be maintained on site. The permittee shall operate according to the provisions of this plan at all times, including periods of startup, shutdown, and malfunction. The plan shall be incorporated into the plant standard operating procedures (SOP) and shall be made available for the Division's inspection. The plan shall include, but not be limited to: i. A list of combustion optimization practices and a means of verifying the practices have occurred. ii. A list of combustion and operation practices to be used to lower energy consumption and a means of verifying the practices have occurred. iii. A list of the design choices determined to be BACT and verification that designs were implemented in the final construction.	0.149	G/HP-HR (EU72 &EU73)
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-02 - North Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	0.15	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-03 - South Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	0.15	G/HP-HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-07 - Air Separation Plant Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	0.15	G/HP-HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-01 - Caster Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	0.15	G/HP-HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	New Pumphouse (XB13) Emergency Generator #1 (EP 08-05)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan.	0.15	G/HP-HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Tunnel Furnace Emergency Generator (EP 08-06)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	0.15	G/HP-HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Caster B Emergency Generator (EP 08-07)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	0.15	G/HP-HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Emergency Generator (EP 08-08)	17.11	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	0.15	G/HP-HR
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	05/23/2014	Emergency Diesel Generators (EQT 629, 639, 838, 966, & 1264)	17.11	Comply with 40 CFR 60 Subpart IIII; operate the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	0.88	LB/HR
LA-0292	HOLBROOK COMPRESSOR STATION	LA	PSD-LA-769(M-1)	01/22/2016	Emergency Generators No. 1 & No. 2	17.11	Use of a certified engine, low sulfur diesel, and limiting non-emergency use to no more than 100 hours per year	0.44	LB/HR
LA-0296	LAKE CHARLES CHEMICAL COMPLEX LDPE UNIT	LA	PSD-LA-779	05/23/2014	Emergency Diesel Generators (EQTs 622, 671, 773, 850, 994, 995, 996, 1033, 1077, 1105, & 1202)	17.11	Compliance with 40 CFR 60 Subpart IIII; operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage.	0.88	LB/HR
LA-0305	LAKE CHARLES METHANOL FACILITY	LA	PSD-LA-803(M1)	06/30/2016	Diesel Engines (Emergency)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Emergency Generator Engines	17.11	Complying with 40 CFR 60 Subpart IIII	0.2	G/KW-HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	DEG1-13 - Diesel Fired Emergency Generator Engine (EQT0012)	17.11	Compliance with NSPS Subpart IIII	0.08	LB/HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Generator 1	17.11	Compliance with NESHAP 40 CFR 63 Subpart ZZZZ and NSPS 40 CFR 60 Subpart IIII, and good combustion practices (use of ultra-low sulfur diesel fuel).	0.86	LB/H
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 1	17.11	Proper design and operation; use of ultra-low sulfur diesel	1.76	LB/H
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 2	17.11	Proper design and operation; use of ultra-low sulfur diesel	1.76	LB/H
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	emergency generator engines (6 units)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0317	METHANEX - GEISMAR METHANOL PLANT	LA	PSD-LA-761(M4)	12/22/2016	Emergency Generator Engines (4 units)	17.11	complying with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	--	--
LA-0331	CALCASIEU PASS LNG PROJECT	LA	PDS-LA-805	09/21/2018	Large Emergency Engines (>50kW)	17.11	Good combustion and operating practices.	0.2	G/KW-H
LA-0350	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-744(M2)	03/28/2018	emergency generators (3 units) EQT0039, EQT0040, EQT0041	17.11	Comply with 40 CFR 60 Subpart IIII	--	--

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0364	FG LA COMPLEX	LA	PSD-LA-812	01/06/2020	Emergency Generator Diesel Engines	17.11	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	--	--
LA-0379	SHINTECH PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-4)	05/04/2021	VCM Unit Emergency Generator A	17.11	Good combustion practices/gaseous fuel burning.	0.4	G/HP-HR
LA-0379	SHINTECH PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-4)	05/04/2021	C/A Emergency Generator B	17.11	Good combustion practices/gaseous fuel burning.	0.4	G/HP-HR
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Generator Engine	17.11	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and use of ultra-low sulfur diesel fuel.	0.15	G/HP-HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	06-22 - AO-5 Emergency Generator	17.11	Use of good combustion practices and compliance with NSPS Subpart IIII	0.22	LB/HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	53-22 - PAO Emergency Generator	17.11	Use of good combustion practices, compliance with NSPS Subpart IIII, and limiting non-emergency operation to no more than 100 hours per year	0.22	LB/HR
*LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	EGEN - Plant Emergency Generator	17.11	Compliance with 40 CFR 60 Subpart IIII	1.19	LB/HR
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Emergency Engine/Generator	17.11	Not Specified	0.15	GM/BHP-H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	EMERGENCY GENERATOR 1	17.11	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES, LIMITED HOURS OF OPERATION, AND DESIGNED TO ACHIEVE EMISSION LIMITS	0.15	G/HP-H
MD-0043	PERRYMAN GENERATING STATION	MD	PSC CASE NO. 9136	07/01/2014	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES, LIMITED HOURS OF OPERATION, AND EXCLUSIVE USE OF ULSD	0.17	G/HP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	EMERGENCY GENERATOR	17.11	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES AND DESIGNED TO ACHIEVE EMISSION LIMITS	0.15	G/HP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	EMERGENCY GENERATOR	17.11	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES AND DESIGNED TO ACHIEVE EMISSION LIMITS	0.17	G/HP-H
MI-0421	GRAYLING PARTICLEBOARD	MI	59-16	08/26/2016	Emergency Diesel Generator Engine (EUEMRGRICE in FGRICE)	17.11	Certified engines, good design, operation and combustion practices. Operational restrictions/limited use.	1.41	LB/H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUEMENGINE (Diesel fuel emergency engine)	17.11	Good combustion practices and meeting NSPS Subpart IIII requirements.	0.2	G/KW-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUEMENGINE (Diesel fuel emergency engine)	17.11	Good combustion practices.	1.58	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	05/09/2017	EUEMRGRICE1 in FGRICE (Emergency diesel generator engine)	17.11	Certified engines, good design, operation and combustion practices. Operational restrictions/limited use.	0.66	LB/H
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	05/09/2017	EUEMRGRICE2 in FGRICE (Emergency Diesel Generator Engine)	17.11	Certified engines, good design, operation and combustion practices. Operational restrictions/limited use.	0.22	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.2	G/KW-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.54	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.52	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS IIII requirements.	0.2	G/KW-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.54	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.52	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUEMENGINE: Emergency engine	17.11	State of the art combustion design	0.2	G/KW-H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUEMENGINE: Emergency engine	17.11	State of the art combustion design	1.18	LB/H
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD1--A 1500 HP diesel fueled emergency engine	17.11	Good combustion practices, burn ultra-low sulfur diesel fuel and be NSPS compliant.	0.69	LB/H
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD2--A 6000 HP diesel fuel fired emergency engine	17.11	Good combustion practices, burn ultra low sulfur diesel fuel, and be NSPS compliant.	2.7	LB/H
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGEMENGINE	17.11	Good combustion practices and ultra low sulfur diesel	0.04	G/HP-H
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGEMENGINE	17.11	Good combustion practices and ultra low sulfur diesel	7.85	LB/1000 GAL
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGEMENGINE	17.11	Good combustion practices and ultra low sulfur diesel.	7.55	LB/1000 GAL
MI-0447	LBWL--ERICKSON STATION	MI	74-18A	01/07/2021	EUEMGD--emergency engine	17.11	Good combustion practices, burn ultra-low diesel fuel, and will be NSPS compliant.	0.2	G/KW-H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0447	LBWL--ERICKSON STATION	MI	74-18A	01/07/2021	EUEMGD--emergency engine	17.11	Good combustion practices, burn ultra-low diesel fuel and be NSPS compliant.	1	LB/H
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE1 in FGRICE)	17.11	Certified Engines, Good Design, Operation, and Combustion Practices, Operational Restrictions/Limited Use	0.66	LB/H
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE2 in FGRICE)	17.11	Certified Engines, Good Design, Operation, and Combustion Practices, Operational Restrictions/Limited Use	0.22	LB/H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUEMENGINE (North Plant): Emergency engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.2	G/KW-H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUEMENGINE (North Plant): Emergency engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.54	LB/H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUEMENGINE (North Plant): Emergency engine	17.11	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.52	LB/H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUEMENGINE (South Plant): Emergency engine	17.11	Diesel particulate filter, Good Combustion Practices and meeting NSPS Subpart IIII requirements	0.2	G/KW-H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUEMENGINE (South Plant): Emergency engine	17.11	Diesel particulate filter, Good Combustion Practices and meeting NSPS Subpart IIII requirements	0.54	LB/H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUEMENGINE (South Plant): Emergency engine	17.11	Diesel particulate filter, Good Combustion Practices and meeting NSPS Subpart IIII requirements	0.52	LB/H
MI-0454	LBWL-ERICKSON STATION	MI	74-18D	12/20/2022	EUEMGD	17.11	Good combustion practices, burn ultra-low diesel fuel, and will be NSPS compliant.	0.2	G/KWH
MI-0454	LBWL-ERICKSON STATION	MI	74-18D	12/20/2022	EUEMGD	17.11	Good combustion practices, burn ultra-low diesel fuel, and be NSPS compliant.	1	LB/H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Diesel Fired Emergency Generator	17.11	use of ULSD a clean burning fuel, and limited hours of operation	0.26	LB/H
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency generator (P002)	17.11	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	0.77	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency generator (P003)	17.11	State-of-the-art combustion design	0.77	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency generator (P003)	17.11	State-of-the-art combustion design	0.97	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Generator (P009)	17.11	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	0.2	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency generator (P003)	17.11	Ultra low sulfur diesel fuel	0.5	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency generator (P003)	17.11	Ultra low sulfur diesel fuel	0.5	LB/H
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Generators (2 identical, P004 and P005)	17.11	Certified to the meet the emissions standards in 40 CFR 89.112 and 89.113 pursuant to 40 CFR 60.4205(b) and 60.4202(a)(2). Good combustion practices per the manufacturer's operating manual.	0.73	LB/H
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Emergency Diesel Generator Engine (P001)	17.11	Good combustion design	0.73	LB/H
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fired generator (P007)	17.11	Comply with NSPS 40 CFR 60 Subpart IIII	1.01	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Diesel Generator (P003)	17.11	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	0.62	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Emergency Diesel-fired Generator Engine (P007)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer's operating manual	1.1	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	1,000 kW Emergency Generators (P008 - P010)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer's operating manual	0.44	LB/H
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	02/06/2019	Emergency Generators (P005 and P006)	17.11	Tier IV engine Good combustion practices	0.15	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	5,051 bhp (3,768 kWm) Diesel-Fired Emergency Generators: P001 through P046	17.11	Certified to meet Tier 2 standards and good combustion practices	0.2	G/KW-H
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	2000 kW Emergency Generator	17.11	Not Specified	0.025	GM/HP-HR
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	09/02/2016	Emergency Generator Engines	17.11	Not Specified	0.15	G/BHP-HR
PA-0311	MOXIE FREEDOM GENERATION PLANT	PA	40-00129A	09/01/2015	Emergency Generator	17.11	Not Specified	0.04	G/HP-HR
*PA-0313	FIRST QUALITY TISSUE LOCK HAVEN PLT	PA	18-00030C	07/27/2017	Emergency Generator	17.11	Not Specified	0.2	G
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Generator	17.11	Not Specified	0.15	G/B-HP-H
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	04/01/2015	Emergency Diesel Generator	17.11	Minimized hours of operations Tier II engine	0.15	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	166032 PSDTX1598 GHGPSDTX210	03/13/2023	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES, LIMITED TO 100 HR/YR	0.0003	LB/HP HR
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	166032 PSDTX1598 GHGPSDTX210	03/13/2023	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES, LIMITED TO 100 HR/YR	0.003	LB/HP HR
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED EMERGENCY GENERATOR 3000 kW (1)	17.11	Ultra Low Sulfur Diesel/Fuel (15 ppm max)	0.4	G/KW
VA-0333	NORFOLK NAVAL SHIPYARD	VA	60326-36	12/09/2020	One (1) emergency engine generator	17.11	Not Specified	1.1	LB
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	04/24/2018	Diesel-Fired Emergency Generators	17.11	The Use of Ultra-Low Sulfur Fuel and Good Combustion Practices	0.17	G/KWH
WI-0286	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-022	04/24/2018	P42 -Diesel Fired Emergency Generator	17.11	Good Combustion Practices and The Use of Ultra-low Sulfur Fuel	17	G/KWH
WI-0286	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-022	04/24/2018	P42 -Diesel Fired Emergency Generator	17.11	Good Combustion Practices and The Use of Ultra-low Sulfur Fuel	0.17	G/KWH

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input >500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
WI-0294	CARDINAL FG COMPANY	WI	19-POY-012	08/26/2019	P10- Diesel emergency Generator	17.11	Not Specified	0.05	G/B-HP-H
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Generator (P07)	17.11	Limited to operate 500 hours/year, sulfur content of the diesel fuel oil fired may not exceed 15 ppm, and operate and maintain according to the manufacturer's recommendations.	0.15	G/HP-H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Emergency Generator	17.11	Not Specified	--	--
WV-0027	INWOOD	WV	R14-0015M	09/15/2017	Emergency Generator - ESDG14	17.11	ULSD	0.2	G/HP-HR
WV-0033	MAIDSVILLE	WV	R14-0038	01/05/2022	Emergency Generator	17.11	Clean Fuels and Good Combustion Practices.	0.23	LB/HR
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	03/17/2021	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	0.2	G/KW-HR
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	0.1	G/BHP-HR
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED AUXILIARY (EMERGENCY) ENGINES (TWO)	17.21	USE OF ULTRA LOW SULFUR DIESEL AND GOOD COMBUSTION PRACTICES	0.2	G/KW-H
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED AUXILIARY (EMERGENCY) ENGINES (TWO)	17.21	USE OF ULTRA LOW SULFUR DIESEL AND GOOD COMBUSTION PRACTICES.	0.18	G/HP-H

Process IDs: 99.011; 99.006
Other Search Criteria: ---
Process Description Semiconductor Manufacturing
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: None

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	Semiconductor Fabrication: P179 through P182	99.011	Good combustion practices and the use of natural gas.	---	---
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	04/24/2018	P12, P22, P18, P19, P28, P29 Organic Stripping Systems, Array/Color Filter and Cell Processes	99.006	Regenerative Thermal Oxidizer	0.0075	LB/MMBTU
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	04/24/2018	P15 & P25 VOC System Array Process	99.006	Regenerative Thermal Oxidizer	--	--
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	04/24/2018	P13 & P23 Chemical Vapor Deposition System Array Process	99.006	Combustor, Baghouse and Wet Scrubber in series	0.004	GR/ACF
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	04/24/2018	P14 & P24 Dry Etching System Array Process	99.006	Combustor and Wet Scrubber in series	0.0075	LB/MMBTU

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IA-0107	MARSHALLTOWN GENERATING STATION	IA	13-A-499-P	04/14/2014	Cooling tower	99.003	Mist eliminator	1.2	LB/H
MI-0437	KNAUF INSULATION, INC.--ALBION FACILITY	MI	26-15C	10/10/2018	EU-COOLTOWER (Cooling tower)	99.003	Drift eliminators	0.39	T/YR
AR-0161	SUN BIO MATERIAL COMPANY	AR	2384-AOP-R0	09/23/2019	Cooling Towers	99.009	Drift Eliminators Low TDS	0.0005	PERCENT DRIFT RATE
FL-0356	OKEECHOBEE CLEAN ENERGY CENTER	FL	0930117-001-AC	03/09/2016	Mechanical draft cooling tower	99.009	Must have certified drift rate no more than 0.0005%.	0.0005	PERCENT DRIFT RATE
FL-0363	DANIA BEACH ENERGY CENTER	FL	0110037-017-AC	12/04/2017	Mechanical draft cooling system	99.009	Certified drift rate < 0.0005%	0.0005	PERCENT DRIFT RATE
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	Mechanical Draft Auxiliary Cooling System	99.009	Certified drift rate < 0.0005%	0.0005	PERCENT DRIFT RATE
FL-0368	NUCOR STEEL FLORIDA FACILITY	FL	1050472-001-AC	02/14/2019	Two Cooling Towers	99.009	Drift eliminators	0.001	PERCENT DRIFT RATE
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	06/07/2021	Mechanical Draft Auxiliary Cooling System	99.009	Certified drift rate < 0.0005%	0.0005	PERCENT DRIFT RATE
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Cooling Tower	99.009	High efficiency drift eliminators	0.0005	PERCENT DRIFT RATE
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	TEN CELL EVAPORATIVE COOLING TOWER	99.009	HIGH EFFICIENCY DRIFT ELIMINATORS	0.0005	PERCENT DRIFT RATE

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	SIX CELL EVAPORATIVE COOLING TOWER	99.009	HIGH EFFICIENCY DRIFT ELIMINATORS	0.0005	PERCENT DRIFT RATE
IN-0185	MAG PELLET LLC	IN	181-33965-00054	04/24/2014	COOLING TOWERS	99.009	Not Specified	0.07	LB/HR
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Cooling tower EU-6001	99.009	drift eliminator	2395	MG/L
KS-0029	THE EMPIRE DISTRICT ELECTRIC COMPANY	KS	C-12987	07/14/2015	Mechanical draft cooling tower	99.009	high efficiency drift eliminators (integral part of the design)	0.0005	PERCENT DRIFT RATE
KS-0034	ABENGOA BIOENERGY BIOMASS OF KANSAS (ABBK)	KS	C-11396	05/27/2014	Cooling Tower	99.009	Drift Eliminator with 0.0005% Drift Rate	1575	PPM TDS
KS-0040	JOHNS MANVILLE AT MCPHERSON	KS	CSD00081 V1.0	12/03/2019	Cooling Towers	99.009	Drift Rate Control	0.001	PERCENT DRIFT RATE
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-01 - Melt Shop ICW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.36	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-01 - Melt Shop ICW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.27	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-01 - Melt Shop ICW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0008	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-02 - Melt Shop DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.04	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-02 - Melt Shop DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.03	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-02 - Melt Shop DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0001	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-03 - Rolling Mill ICW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.06	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-03 - Rolling Mill ICW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.04	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-03 - Rolling Mill ICW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0001	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-04 - Rolling Mill DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.17	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-04 - Rolling Mill DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.12	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-04 - Rolling Mill DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0004	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-05 - Rolling Mill Quench/ACC Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.78	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-05 - Rolling Mill Quench/ACC Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.54	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-05 - Rolling Mill Quench/ACC Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0017	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-06 - Light Plate Quench DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.06	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-06 - Light Plate Quench DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.04	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-06 - Light Plate Quench DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0001	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-07 - Heavy Plate Quench DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.02	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-07 - Heavy Plate Quench DCW Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0001	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-08 - Air Separation Plant Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.1	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-08 - Air Separation Plant Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.08	LB/HR
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 09-08 - Air Separation Plant Cooling Tower	99.009	High Efficiency Mist Eliminator. The mist eliminator drift loss shall be maintained at 0.001% or less to total gpm.	0.0002	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Laminar Cooling Tower - Hot Mill Cells (EP 03-09)	99.009	Mist Eliminator, 0.001% drift loss	0.27	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Laminar Cooling Tower - Hot Mill Cells (EP 03-09)	99.009	Mist Eliminator, 0.001% drift loss	0.19	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Laminar Cooling Tower - Hot Mill Cells (EP 03-09)	99.009	Mist Eliminator, 0.001% drift loss	0.0006	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Direct Cooling Tower-Caster & Roughing Mill Cells (EP 03-10)	99.009	Mist Eliminator, 0.001% drift loss	0.17	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Direct Cooling Tower-Caster & Roughing Mill Cells (EP 03-10)	99.009	Mist Eliminator, 0.001% drift loss	0.12	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Direct Cooling Tower-Caster & Roughing Mill Cells (EP 03-10)	99.009	Mist Eliminator, 0.001% drift loss	0.0004	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Melt Shop #2 Cooling Tower (indirect) (EP 03-11)	99.009	Mist Eliminator, 0.001% drift loss	0.39	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Melt Shop #2 Cooling Tower (indirect) (EP 03-11)	99.009	Mist Eliminator, 0.001% drift loss	0.29	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Melt Shop #2 Cooling Tower (indirect) (EP 03-11)	99.009	Mist Eliminator, 0.001% drift loss	0.0008	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Cold Mill Cooling Tower (EP 03-12)	99.009	Mist Eliminator, 0.001% drift loss	0.14	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Cold Mill Cooling Tower (EP 03-12)	99.009	Mist Eliminator, 0.001% drift loss	0.094	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Cold Mill Cooling Tower (EP 03-12)	99.009	Mist Eliminator, 0.001% drift loss	0.0003	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Plant Cooling Tower (EP 03-13)	99.009	Mist Eliminator, 0.001% drift loss	0.08	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Plant Cooling Tower (EP 03-13)	99.009	Mist Eliminator, 0.001% drift loss	0.07	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Plant Cooling Tower (EP 03-13)	99.009	Mist Eliminator, 0.001% drift loss	0.0002	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	DCW Auxiliary Cooling Tower (EP 03-14)	99.009	Mist Eliminator, 0.001% drift loss	0.06	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	DCW Auxiliary Cooling Tower (EP 03-14)	99.009	Mist Eliminator, 0.001% drift loss	0.05	LB/HR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	DCW Auxiliary Cooling Tower (EP 03-14)	99.009	Mist Eliminator, 0.001% drift loss	0.0001	LB/HR
KY-0116	NOVELIS CORPORATION - GUTHRIE	KY	V-22-011	07/25/2022	EU 043 - Cooling Tower #1	99.009	Mist Eliminator (0.001% drift loss), Total Dissolved Solids (TDS) concentration limit of 1000 ppm	0.013	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
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Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0116	NOVELIS CORPORATION - GUTHRIE	KY	V-22-011	07/25/2022	EU 043 - Cooling Tower #1	99.009	Mist Eliminator (0.001% drift loss), Total Dissolved Solids (TDS) concentration limit of 1000 ppm	0.006	LB/HR
KY-0116	NOVELIS CORPORATION - GUTHRIE	KY	V-22-011	07/25/2022	EU 043 - Cooling Tower #1	99.009	Mist Eliminator (0.001% drift loss), Total Dissolved Solids (TDS) concentration limit of 1000 ppm	0.001	PERCENT DRIFT LOSS
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	05/23/2014	Process Cooling Towers (EQT 634 & 635)	99.009	High efficiency drift eliminators and low TDS cooling water	6.99	TPY
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	05/23/2014	ASU Cooling Tower (EQT 636)	99.009	High efficiency drift eliminators and low TDS cooling water	7.4	TPY
LA-0301	LAKE CHARLES CHEMICAL COMPLEX ETHYLENE 2 UNIT	LA	PSD-LA-779	05/23/2014	Cooling Tower (EQT 979)	99.009	High efficiency drift eliminators and low TDS cooling water	20.47	TPY
LA-0302	LAKE CHARLES CHEMICAL COMPLEX EO/MEG UNIT	LA	PSD-LA-779	05/23/2014	Cooling Tower (EQT 1011)	99.009	High efficiency drift eliminators and low TDS cooling water	1.71	TPY
LA-0305	LAKE CHARLES METHANOL FACILITY	LA	PSD-LA-803(M1)	06/30/2016	Cooling Towers	99.009	Drift eliminators	0.0005	PERCENT DRIFT RATE
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Cooling Tower CT-16-1 (EQT032)	99.009	High Efficiency Drift Eliminator	0.001	LB/HR
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Cooling Towers	99.009	drift eliminators	0.0005	PERCENT DRIFT RATE
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	ECT-14 - Econamine Cooling Tower (EQT0018)	99.009	High efficiency drift eliminators	0.01	TPY
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	ECT-14 - Econamine Cooling Tower (EQT0018)	99.009	High efficiency drift eliminators	0.44	TPY
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	CT-13 - Cooling Tower (EQT0007)	99.009	High efficiency drift eliminators	0.01	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	CT-13 - Cooling Tower (EQT0007)	99.009	High efficiency drift eliminators	0.96	LB/HR
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Cooling Tower 1	99.009	High efficiency drift eliminators	1.24	LB/HR
LA-0314	INDORAMA LAKE CHARLES FACILITY	LA	PSD-LA-813	08/03/2016	cooling towers - 007	99.009	drift eliminators	0.0005	PERCENT DRIFT RATE
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Cooling Tower	99.009	High efficiency drift eliminators	0.39	LB/HR
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Cooling Tower	99.009	High efficiency drift eliminators	0.24	LB/HR
LA-0317	METHANEX - GEISMAR METHANOL PLANT	LA	PSD-LA-761(M4)	12/22/2016	cooling towers (I-CT-621, II-CT-621)	99.009	Drift eliminators	0.001	PERCENT DRIFT RATE
LA-0318	FLOPAM FACILITY	LA	PSD-LA-747(M5)	01/07/2016	cooling towers	99.009	integrated drift eliminators	---	---
LA-0323	MONSANTO LULING PLANT	LA	PSD-LA-890	01/09/2017	Cooling Water Tower	99.009	Drift Eliminators with Draft Factor of 0.003%	0.003	PERCENT DRIFT RATE
LA-0323	MONSANTO LULING PLANT	LA	PSD-LA-890	01/09/2017	Cooling Water Tower	99.009	Drift Eliminators with Drift Factor of 0.003%	0.003	PERCENT DRIFT RATE
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Cooling Tower	99.009	High-efficiency drift eliminators.	0.0005	PERCENT DRIFT RATE
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	04-22 - AO-5 Cooling Water Tower, W-S5401	99.009	Implementation of a heat exchange leak detection and repair program consistent with 40 CFR 63 Subpart F requirements	0.18	LB/HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	04-22 - AO-5 Cooling Water Tower, W-S5401	99.009	Implementation of a heat exchange leak detection and repair program consistent with 40 CFR 63 Subpart F requirements	0.15	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	CWT - Cooling Water Tower	99.009	Use of High efficiency drift eliminators	---	---

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0402	DESTREHAN OIL PROCESSING FACILITY	LA	PSD-LA-855	12/13/2023	HLK40 - Cooling Towers (EQT0095)	99.009	Drift elimination system	0.06	LB/HR
LA-0402	DESTREHAN OIL PROCESSING FACILITY	LA	PSD-LA-855	12/13/2023	HLK40 - Cooling Towers (EQT0095)	99.009	Drift elimination system	0.02	LB/HR
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUCOOLTWR (Cooling Tower--Wet Mechanical Draft)	99.009	Mist/drift eliminators	2.37	T/YR
MI-0427	FILER CITY STATION	MI	66-17	11/17/2017	EUCOOLTWR (Cooling Tower--Wet Mechanical Drift)	99.009	Mist/Drift Eliminators	0.0006	PERCENT DRIFT RATE
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUCOOLTOWER (North Plant): Cooling Tower	99.009	High efficiency drift/mist eliminators	5.59	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUCOOLTOWER (North Plant): Cooling Tower	99.009	High efficiency drift/mist eliminators	2.85	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUCOOLTOWER (South Plant): Cooling Tower	99.009	High efficiency drift/mist eliminators.	5.59	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUCOOLTOWER (South Plant): Cooling Tower	99.009	High efficiency drift/mist eliminators.	2.85	T/YR
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUCOOLINGTWR: Cooling Tower	99.009	High efficiency drift/mist eliminators	4.03	LB/HR
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUCOOLINGTWR: Cooling Tower	99.009	High efficiency drift/mist eliminators	0.48	LB/HR
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGCOOLTWR	99.009	Particulate in water droplets will be controlled with high efficiency drift/mist eliminators.	4.1	T/YR
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGCOOLTWR	99.009	Particulate in water droplets will be controlled with high efficiency drift/mist eliminators	2.6	T/YR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGCOOLTWR	99.009	Particulate in water droplets will be controlled with high efficiency drift/mist eliminators	0.6	T/YR
MN-0094	CHS OILSEED PROCESSING - FAIRMONT	MN	09100059-101	08/22/2019	Cooling Towers	99.009	Not Specified	0.005	PERCENT DRIFT RATE
MS-0092	EMBERCLEAR GTL MS	MS	0040-00055	05/08/2014	Cooling tower, Induced draft	99.009	high efficiency drift eliminators	0.001	PERCENT DRIFT RATE
NE-0059	AGP SOY	NE	CP14-007	03/25/2015	Cooling Tower	99.009	drift loss design specification and TDS concentration limit	0.0005	PERCENT DRIFT RATE
NE-0064	NORFOLK CRUSH, LLC	NE	CP22-017	11/21/2022	Cooling Tower	99.009	There is a drift loss design specification and a TDS concentration limit.	0.0005	PERCENT DRIFT RATE
NE-0068	AG PROCESSING INC - DAVID CITY	NE	CP22-046	06/27/2023	Cooling Tower 1	99.009	There is a drift loss design specification with the mist eliminator (CE-8000) and a TDS concentration limit.	0.0005	PERCENT DRIFT RATE
NE-0068	AG PROCESSING INC - DAVID CITY	NE	CP22-046	06/27/2023	Cooling Tower 2	99.009	There is a drift loss design specification with the mist eliminator (CE-8001) and a TDS concentration limit.	0.0005	PERCENT DRIFT RATE
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Cooling Tower (P004)	99.009	High efficiency drift eliminators and minimize total dissolved solid (TDS)	2.685	LB/HR
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Cooling Tower (P004)	99.009	High efficiency drift eliminators and minimize total dissolved solid (TDS)	1.7	LB/HR
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Cooling Tower (P004)	99.009	High efficiency drift eliminators and minimize total dissolved solid (TDS)	0.006	LB/HR
OH-0364	OREGON ENERGY CENTER	OH	P0110708	05/20/2015	Cooling Towers #1 & #2 (P009 & P010)	99.009	advanced drift eliminators with a drift rate of less than 0.0005 percent and maintain the total dissolved solids (TDS) content of the circulating cooling water at 5,130 mg/L or less as a 24-hour rolling average	1.48	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Wet Cooling Tower (P005)	99.009	Drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 3,075 milligrams per liter.	1.27	LB/HR
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Wet Cooling Tower (P005)	99.009	Drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 3,075 milligrams per liter.	0.51	LB/HR
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Cooling Towers (2 identical, P005 and P006)	99.009	High efficiency drift eliminators and minimize total dissolved solid (TDS)	1.33	LB/HR
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Cooling Towers (2 identical, P005 and P006)	99.009	High efficiency drift eliminators and minimize total dissolved solid (TDS)	0.534	LB/HR
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Cooling Towers #1 & #2 (P010 & P011)	99.009	drift eliminators with a maximum drift rate specification of 0.0005 percent or less and total dissolved solids (TDS) concentration of the cooling water less than or equal to 5,000 milligrams per liter (mg/l)	0.3	LB/HR
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Cooling Towers #1 & #2 (P010 & P011)	99.009	drift eliminators with a maximum drift rate specification of 0.0005 percent or less and total dissolved solids (TDS) concentration of the cooling water less than or equal to 5,000 milligrams per liter (mg/l)	0.0018	LB/HR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Wastewater Treatment Plant Cooling Water Tower (P012)	99.009	drift eliminators with a maximum drift rate specification of 0.0005 percent or less and total dissolved solids (TDS) concentration of the cooling water less than or equal to 50,000 milligrams per liter (mg/l)	5	X10-4 LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Wet Cooling Tower (P005)	99.009	drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 3,500 milligrams per liter (mg/l).	1.36	LB/HR
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Wet Cooling Tower (P005)	99.009	drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 3,500 milligrams per liter (mg/l).	0.54	LB/HR
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Wet Cooling Tower (P005)	99.009	drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 3,500 milligrams per liter (mg/l).	0.93	LB/HR
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Wet Cooling Tower (P005)	99.009	drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 3,500 milligrams per liter (mg/l).	0.36	LB/HR
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Wet Mechanical Draft Cooling Tower (P003)	99.009	High efficiency drift eliminator designed to achieve a 0.0005% drift rate and total dissolved solids (TDS) content not to exceed 5,000 mg/l.	6.58	T/YR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Wet Mechanical Draft Cooling Tower (P003)	99.009	High efficiency drift eliminator designed to achieve a 0.0005% drift rate and total dissolved solids (TDS) content not to exceed 5,000 mg/l.	4.24	T/YR
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Wet Mechanical Draft Cooling Tower (P003)	99.009	High efficiency drift eliminator designed to achieve a 0.0005% drift rate and total dissolved solids (TDS) content not to exceed 5,000 mg/l.	1.58	T/YR
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Wet Cooling Tower (P005)	99.009	drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 1,100 parts per million by weight (ppmw).	0.02	LB/HR
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Wet Cooling Tower (P005)	99.009	drift eliminator with a maximum drift rate of 0.0005% and total dissolved solids (TDS) concentration of the cooling water less than or equal to 1,100 parts per million by weight (ppmw).	0.01	LB/HR
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Cooling Tower (P011)	99.009	High efficiency drift eliminator designed to achieve a 0.0005% drift rate and maintenance of a total dissolved solids (TDS) content not to exceed 2,000 ppm in the circulating cooling water based on a rolling 12-month average.	5.07	T/YR
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Cooling Tower (P011)	99.009	High efficiency drift eliminator designed to achieve a 0.0005% drift rate and maintenance of a total dissolved solids (TDS) content not to exceed 2,000 ppm in the circulating cooling water based on a rolling 12-month average.	3.22	T/YR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Cooling Tower (P011)	99.009	High efficiency drift eliminator designed to achieve a 0.0005% drift rate and maintenance of a total dissolved solids (TDS) content not to exceed 2,000 ppm in the circulating cooling water based on a rolling 12-month average.	0.01	T/YR
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Contact Cooling Towers - Melt Shop 2 (P027)	99.009	i. Use of drift eliminator(s) designed to achieve a 0.001% drift rate; ii. Maintenance of a total dissolved solids (TDS) content (for the 5 individual cooling towers) not to exceed the ppm in the circulating cooling water based on a rolling 12-month average as indicated in the table below: Cooling Tower - TDS (ppm) Meltshop 2 Cooling Tower - 1000 Caster Mold Water Cooling Tower - 800 Tunnel Furnace Cooling Tower - 800 Caster Non-Contact 2 Cooling Tower - 800 Caster Contact 2 Cooling Tower - 1400	1.17	T/YR
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Contact Cooling Towers - Melt Shop 2 (P027)	99.009	i. Use of drift eliminator(s) designed to achieve a 0.001% drift rate; ii. Maintenance of a total dissolved solids (TDS) content (for the 5 individual cooling towers) not to exceed the ppm in the circulating cooling water based on a rolling 12-month average as indicated in the table below: Cooling Tower - TDS (ppm) Meltshop 2 Cooling Tower - 1000 Caster Mold Water Cooling Tower - 800 Tunnel Furnace Cooling Tower - 800 Caster Non-Contact 2 Cooling Tower - 800 Caster Contact 2 Cooling Tower - 1400	0.93	T/YR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Contact Cooling Towers (P014)	99.009	i. Use of drift eliminator(s) designed to achieve a 0.003% drift rate; ii. Maintenance of a total dissolved solids (TDS) content (for the 5 individual cooling towers) not to exceed the ppm in the circulating cooling water based on a rolling 12-month average as indicated in the table below: Cooling Tower - TDS (ppm) Meltshop Cooling Tower (501) - 800 Caster Non-Contact Cooling Tower (6 Cell) - 800 Caster Contact Cooling Tower (503) - 1100 Mill Contact Cooling Tower (505) - 2000 Laminar Flow Cooling Tower (506) - 1400	8.7	T/YR
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Contact Cooling Towers (P014)	99.009	i. Use of drift eliminator(s) designed to achieve a 0.003% drift rate; ii. Maintenance of a total dissolved solids (TDS) content (for the 5 individual cooling towers) not to exceed the ppm in the circulating cooling water based on a rolling 12-month average as indicated in the table below: Cooling Tower - TDS (ppm) Meltshop Cooling Tower (501) - 800 Caster Non-Contact Cooling Tower (6 Cell) - 800 Caster Contact Cooling Tower (503) - 1100 Mill Contact Cooling Tower (505) - 2000 Laminar Flow Cooling Tower (506) - 1400	6.95	T/YR

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Contact Cooling Towers (P014)	99.009	i. Use of drift eliminator(s) designed to achieve a 0.003% drift rate; ii. Maintenance of a total dissolved solids (TDS) content (for the 5 individual cooling towers) not to exceed the ppm in the circulating cooling water based on a rolling 12-month average as indicated in the table below: Cooling Tower - TDS (ppm) Meltshop Cooling Tower (501) - 800 Caster Non-Contact Cooling Tower (6 Cell) - 800 Caster Contact Cooling Tower (503) - 1100 Mill Contact Cooling Tower (505) - 2000 Laminar Flow Cooling Tower (506) - 1400	0.02	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	Cooling Towers: P054 through P178	99.009	Drift eliminator	0.0005	PERCENT DRIFT RATE
OH-0391	VALENCIA PROJECT LLC	OH	P0133726	10/27/2023	Cooling Towers (P023, P024, P025)	99.009	A drift eliminator achieving drift loss equal to or less than 0.0005 percent	0.05	LB/HR
OH-0391	VALENCIA PROJECT LLC	OH	P0133726	10/27/2023	Cooling Towers (P023, P024, P025)	99.009	A drift eliminator achieving drift loss equal to or less than 0.0005 percent	0.04	LB/HR
OH-0391	VALENCIA PROJECT LLC	OH	P0133726	10/27/2023	Cooling Towers (P023, P024, P025)	99.009	A drift eliminator achieving drift loss equal to or less than 0.0005 percent	0.02	LB/HR
SC-0205	SCOUT MOTORS INC A DELAWARE CORPORATION - BLYTHEWOOD PLANT	SC	PSD-50000007 V1.0	10/31/2023	Cooling Towers	99.009	Drift Eliminator	0.001	PERCENT DRIFT RATE

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0710	VICTORIA POWER STATION	TX	108258 PSDTX1348	12/01/2014	cooling tower	99.009	mist eliminators	0.001	PERCENT DRIFT RATE
TX-0712	TRINIDAD GENERATING FACILITY	TX	111393 PSDTX1368	11/20/2014	cooling tower	99.009	mist eliminators	0.001	PERCENT DRIFT RATE
TX-0713	TENASKA BROWNSVILLE GENERATING STATION	TX	108411 PSDTX1350	04/29/2014	cooling tower	99.009	mist eliminators	0.0005	PERCENT DRIFT RATE
TX-0714	S R BERTRON ELECTRIC GENERATING STATION	TX	102731 PSDTX1294	12/19/2014	cooling tower	99.009	drift eliminators	0.0005	PERCENT DRIFT RATE
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	04/01/2015	Cooling tower	99.009	drift eliminator is 0.0005% efficient	0.35	LB/HR
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	04/01/2015	Cooling tower	99.009	drift eliminator is 0.0005% efficient	0.31	LB/HR
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	04/01/2015	Cooling tower	99.009	drift eliminator is 0.0005% efficient	0.12	LB/HR
TX-0774	BISHOP FACILITY	TX	123216, PSDTX1438 AND GHGPSDTX	11/12/2015	Cooling Tower	99.009	Drift eliminators meeting 0.001% drift	3.07	TPY
TX-0774	BISHOP FACILITY	TX	123216, PSDTX1438 AND GHGPSDTX	11/12/2015	Cooling Tower	99.009	Drift eliminators meeting 0.001% drift	0.01	TPY
TX-0803	PL PROPYLENE HOUSTON OLEFINS PLANT	TX	18999, PSDTX755M1, N216	07/12/2016	Cooling Tower	99.009	drift eliminators	0.001	PERCENT DRIFT RATE
TX-0815	PORT ARTHUR ETHANE SIDE CRACKER	TX	122353, PSDTX1426, GHGPSDTX114	01/17/2017	Cooling Tower	99.009	Drift Eliminators	--	--
TX-0832	EXXONMOBIL BEAUMONT REFINERY	TX	PSDTX768M1, PSDTX799, PSDTX802	01/09/2018	COOLING TOWERS	99.009	DRIFT ELIMINATOR	--	--

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0834	MONTGOMERY COUNTY POWER STATIOIN	TX	N256, PSDTX1510, AND GHGPSDTX1	03/30/2018	COOLING TOWER	99.009	DRIFT ELIMINATORS	--	--
TX-0863	POLYETHYLENE 7 FACILITY	TX	153106 AND N268	09/03/2019	COOLING TOWER	99.009	DRIFT ELIMINATOR	--	--
TX-0864	EQUISTAR CHEMICALS CHANNELVIEW COMPLEX	TX	N266, PSDTX1542, GHGPSDTX183	09/09/2019	Cooling Tower	99.009	drift eliminators	0.005	PERCENT DRIFT RATE
TX-0865	EQUISTAR CHEMICALS CHANNELVIEW COMPLEX	TX	N264, PSDTX1540, GHGPSDTX182	09/09/2019	COOLING TOWER	99.009	DRIFT ELIMINATORS	6000	PPMW
TX-0873	PORT ARTHUR REFINERY	TX	PSDTX1062M3 AND GHGPSDTX121M1	02/04/2020	COOLING TOWER	99.009	DRIFT ELIMINATORS	--	--
TX-0876	PORT ARTHUR ETHANE CRACKER UNIT	TX	PSDTX1546 AND GHGPSDTX186	02/06/2020	COOLING TOWER	99.009	DRIFT ELIMINATORS	1200	PPM
TX-0888	ORANGE POLYETHYLENE PLANT	TX	155952 PSDTX1556 GHGPSDTX192	04/23/2020	COOLING TOWERS	99.009	DRIFT ELIMINATORS	--	--
TX-0904	MOTIVA POLYETHYLENE MANUFACTURING COMPLEX	TX	156571, PSDTX1564, GHGPSDTX195	09/09/2020	COOLING TOWER	99.009	Non-contact design and DRIFT ELIMINATORS	1200	PPMW
TX-0905	DIAMOND GREEN DIESEL PORT ARTHUR FACILITY	TX	160299, PSDTX1576, GHGPSDTX200	09/16/2020	COOLING TOWER	99.009	DRIFT ELIMINATORS 0.001%	0.001	PERCENT DRIFT RATE
TX-0915	UNIT 5	TX	160538, PSDTX1528, GHGPSDTX204	03/17/2021	COOLING TOWER	99.009	Drift eliminators 0.0005%	60000	PPM
TX-0922	HOUSTON PLANT - 46307	TX	46307, PSDTX1580, N288, GHG202	06/13/2022	COOLING TOWER	99.009	Drift eliminators with 0.0005% drift	0.0005	PERCENT DRIFT RATE
TX-0930	CENTURION BROWNSVILLE	TX	147681, PSDTX1522, GHGPSDTX172	10/19/2021	Cooling Tower	99.009	Drift eliminators required. Maximum drift 0.0005 percent. TDS limit of 3,500 ppmw in the cooling water. Daily sampling for TDS required, or weekly TDS sampling is allowed if conductivity is monitored daily and a TDS to conductivity ratio is established.	0.0005	PERCENT DRIFT RATE

Process IDs: 99.003, 99.009
Other Search Criteria: ---
Process Description Cooling Towers
Date Range 1/1/2013 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered Process Types

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0931	ROEHM AMERICA BAY CITY SITE	TX	165103, PSDTX1596, GPSDTX208	12/16/2021	Cooling Tower	99.009	Drift eliminators with 0.001% drift	0.001	PERCENT DRIFT RATE
TX-0938	VALERO CORPUS CHRISTI REFINERY WEST PLANT	TX	38754,PSDTX324M15,GH GPSDTX211	05/03/2024	COOLING TOWER	99.009	Drift eliminators 0.001% drift	0.001	PERCENT DRIFT RATE
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	166032 PSDTX1598 GHGPSDTX210	03/13/2023	COOLING TOWER	99.009	0.001% DRIFT ELIMINATORS	0.001	PERCENT DRIFT RATE
TX-0940	FIBERGLASS MANUFACTURING FACILITY	TX	166392, PSDTX1600	09/06/2022	COOLING TOWER	99.009	DRIFT ELIMINATOR	0.001	PERCENT DRIFT RATE
TX-0964	NEDERLAND FACILITY	TX	172324, PSDTX1620, GHGPSDTX231	10/05/2023	COOLING TOWERS	99.009	Drift eliminators with 0.001% drift	2000	PPMW
TX-0967	QUAIL RUN CARBON CAPTURE PLANT	TX	173197, HAP83, PSDTX1622	02/05/2024	COOLING TOWERS	99.009	drift eliminators 0.0005%	0.0005	PERCENT DRIFT RATE
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Cooling Tower	99.009	Drift rate of 0.00050 percent of the circulating water flow with mist eliminators and a total dissolved solids content of the cooling water, not to exceed 6250 mg.liter.	0.0005	PERCENT DRIFT RATE
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	04/24/2018	P02A-P & P03A-P Cooling Towers	99.009	Drift Eliminator & Cooling Additive Control System	--	--
WI-0311	SUPERIOR REFINING COMPANY LLC	WI	19-RAB-057	09/27/2019	Cooling Tower No.1 (P80)	99.009	Drift eliminator, cooling additive control system that results in a total dissolved solids (TDS) concentration of not more than 3,000 ppm.	0.0005	PERCENT CIRCULATION DRIFT
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Cooling Tower	99.009	Drift Eliminator	0.72	LB/HR

Process IDs: 19.190
Other Search Criteria: Process Name Contains "Roads"
Process Description Roads
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for Process ID "Road"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Vehicle Travel on Paved and Unpaved Roads	99.19	Development and Implementation of Fugitive Dust Control Plan	0.1	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Vehicle Travel on Paved and Unpaved Roads	99.19	Development and Implementation of Fugitive Dust Control Plan	0.2	TPY
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	03/23/2017	PAVED ROADS AND PARKING LOTS	99.19	PAVING ALL PLANT HAUL ROADS, WET SUPPRESSION, PROMPT CLEANUP OF ANY SPILLED MATERIALS.	---	---
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Fugitive Dust from Unpaved Roads	99.15	Water and Chemical Suppressant Spray	3500	TPY
AR-0124	EL DORADO SAWMILL	AR	2348-AOP-R0	08/03/2015	HAUL ROADS SN-09	99.15	ROAD WATERING PLAN + 0% OFF-SITE OPACITY	12.7	LB/H
AR-0164	GP WOOD PRODUCTS SOUTH LLC GURDON PLYWOOD & LUMBER COMPLEX	AR	0463-AOP-R17	11/22/2019	Plant Haul Roads	30.39	Not Specified	8.5	LB/HR
AR-0164	GP WOOD PRODUCTS SOUTH LLC GURDON PLYWOOD & LUMBER COMPLEX	AR	0463-AOP-R17	11/22/2019	Plant Haul Roads	30.39	Not Specified	1.7	LB/HR
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-121 Unpaved Roads	99.15	Dust Control Plan, Wet Spray, and chemical stabilizers	74.8	LB/HR
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-121 Unpaved Roads	99.15	Dust Control Plan Wet spray and chemical stabilizers.	20	LB/HR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-121 Unpaved Roads	99.15	Dust Control Plan Wet spray and chemical stabilizers.	8.8	LB/HR
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-121 SN-211 Unpaved Roads	99.15	Water Sprays, low silt surface	136	LB/HR
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-121 SN-211 Unpaved Roads	99.15	Water Sprays, low silt surface	36.2	LB/HR
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-121 SN-211 Unpaved Roads	99.15	Water Sprays, low silt surface	3.7	LB/HR
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-122 SN-210 Paved Roads	99.14	Water Sprays, sweeping,	15.2	LB/HR
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-122 SN-210 Paved Roads	99.14	Water Sprays, sweeping,	3.9	LB/HR
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-122 SN-210 Paved Roads	99.14	Water Sprays, sweeping,	0.5	LB/HR
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Paved Roadways	99.14	Development and Implementation of Fugitive Dust Control Plan	2.8	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Paved Roadways	99.14	Development and Implementation of Fugitive Dust Control Plan	0.6	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Paved Roadways	99.14	Development and Implementation of Fugitive Dust Control Plan	0.2	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Unpaved Roadways	99.15	Development and Implementation of Fugitive Dust Control Plan	0.81	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Unpaved Roadways	99.15	Development and Implementation of Fugitive Dust Control Plan	0.38	TPY

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Unpaved Roadways	99.15	Development and Implementation of Fugitive Dust Control Plan	0.06	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Vehicle Travel on Paved and Unpaved Roads	99.19	Development and Implementation of Fugitive Dust Control Plan	0.2	TPY
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Vehicle Travel on Paved and Unpaved Roads	99.19	Development and Implementation of Fugitive Dust Control Plan	0.1	TPY
FL-0368	NUCOR STEEL FLORIDA FACILITY	FL	1050472-001-AC	02/14/2019	Roads	99.15	Fugitive Dust Control Plan	--	--
IA-0117	SHELL ROCK SOY PROCESSING	IA	20-A-288-P	03/17/2021	Paved Road Fugitives	99.14	sweeping	2.97	TONS PER YEAR
IL-0126	NUCOR STEEL KANKAKEE, INC.	IL	18060014	11/01/2018	Roadways	81.29	Roadways must be paved; Preventative measures, including posted 15 MPH speed limit and good work practices (e.g., water flushing, vacuuming and sweeping)	2.39	TON/YR
IL-0126	NUCOR STEEL KANKAKEE, INC.	IL	18060014	11/01/2018	Roadways	81.29	Roadways must be paved; Preventative measures, including posted 15 MPH speed limit and good work practices (e.g., water flushing, vacuuming and sweeping)	0.48	TON/YR
IL-0126	NUCOR STEEL KANKAKEE, INC.	IL	18060014	11/01/2018	Roadways	81.29	Roadways must be paved; Preventative measures, including posted 15 MPH speed limit and good work practices (e.g., water flushing, vacuuming and sweeping)	0.12	TON/YR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IL-0129	CPV THREE RIVERS ENERGY CENTER	IL	16060032	07/30/2018	Roadways	99.14	Paving is required for roads used by trucks transporting bulk materials.	10	% OPACITY
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Roadways	99.14	Not Specified	10	PERCENT OPACITY
IL-0132	NUCOR STEEL KANKAKEE, INC.	IL	19120024	01/25/2021	New and Modified Roadways	99.14	Roadways shall be paved; speed limit posting of 15 miles/hour; best management practices to reduce fugitive emissions in accordance with written operating program that provides for cleaning or treatment of roadways	--	--
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Roadways	99.14	Not Specified	10	PERCENT OPACITY
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Roadways	99.14	Paving of all roadways and Fugitive Dust Control Plan, including mitigative measures (sweeping, water sprays, prompt cleanups)	10	PERCENT
IL-0135	NUCOR STEEL KANKAKEE, INC.	IL	19120024	04/30/2024	Roadways (New Roadway Segment)	81.29	Roadways must be paved; implementation of preventative measures, including posting 15 mph speed limit and good work practices (e.g., water flushing, vacuuming, sweeping, and opacity of fugitive emissions not to exceed 10 percent).	27.28	TONS
IL-0135	NUCOR STEEL KANKAKEE, INC.	IL	19120024	04/30/2024	Roadways (New Roadway Segment)	81.29	Roadways must be paved; implementation of preventative measures, including posting 15 mph speed limit and good work practices (e.g., water flushing, vacuuming, sweeping, and opacity of fugitive emissions not to exceed 10 percent).	5.46	TONS

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IL-0135	NUCOR STEEL KANKAKEE, INC.	IL	19120024	04/30/2024	Roadways (New Roadway Segment)	81.29	Roadways must be paved; implementation of preventative measures, including posting 15 mph speed limit and good work practices (e.g., water flushing, vacuuming, sweeping, and opacity of fugitive emissions not to exceed 10 percent).	1.34	TONS
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	FUGITIVE DUST FROM PAVED ROADS AND PARKING LOTS	99.14	PAVE ALL HAUL ROADS, DAILY SWEEPING WITH WET SUPPRESSION, PROMPT CLEANUP OF ANY SPILLED MATERIAL.	90	% CONTROL
IN-0180	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	FUGITIVE DUST FROM PAVED ROADS AND PARKING LOTS	99.14	PAVE ALL HAUL ROADS, DAILY SWEEPING WITH WET SUPPRESSION, PROMPT CLEANUP OF ANY SPILLED MATERIAL.	90	% CONTROL
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	03/23/2017	PAVED ROADS AND PARKING LOTS	99.19	PAVING ALL PLANT HAUL ROADS, WET SUPPRESSION, PROMPT CLEANUP OF ANY SPILLED MATERIALS.	--	--
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Paved roads	99.14	Fugitive dust control plan	1	MIN
IN-0324	MIDWEST FERTILIZER COMPANY LLC	IN	129-44510-00059	05/06/2022	Fugitive dust from paved roads and parking lots	99.14	Not Specified	--	--
IN-0359	NUCOR STEEL	IN	107-45480-00038	03/30/2023	Paved Roads	99.14	comply with fugitive dust control plan	--	--

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IN-0366	CARGILL, INC. - SOYBEAN PROCESSING DIVISION	IN	157-44856-00038	07/05/2023	Paved road fugitives	99.14	Not Specified	--	--
KS-0034	ABENGOA BIOENERGY BIOMASS OF KANSAS (ABBK)	KS	C-11396	05/27/2014	Paved Haul Roads	99.14	Truck traffic fugitive control strategy and monitoring plan, including sweeping and speed limits	148	TRUCKS/DAY
KS-0034	ABENGOA BIOENERGY BIOMASS OF KANSAS (ABBK)	KS	C-11396	05/27/2014	Biomass Laydown Roads (Unpaved)	99.15	Truck traffic fugitive control strategy and monitoring plan, including sweeping and speed limits	109	TRUCKS/DAY
KY-0109	FRITZ WINTER NORTH AMERICA, LP	KY	V-16-022 R1	10/24/2016	Paved Roadways (EU76)	99.14	The permittee shall vacuum sweep the pavement at least weekly, except during recent rain events, or as needed in the event of a spill.	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 14-01 - Paved Roadways	99.14	surface improvements (pavement), sweeping (good work practice) and watering	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 14-02 - Unpaved Roadways	99.15	use of dust suppressants	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Paved Roads & Satellite Coil Yard (EPs 04-01 & 04-04)	99.14	Sweeping & Watering	--	--
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Unpaved Roads (EP 04-02)	99.15	Wetting/Dust suppressants	--	--
KY-0116	NOVELIS CORPORATION - GUTHRIE	KY	V-22-011	07/25/2022	EU 020 - Paved Roads	99.14	Sweeping (minimum of monthly), speed limit, paving, and reasonable precautions.	--	--

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0379	SHINTECH PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-4)	05/04/2021	Fugitive Dust (Paved Roads)	99.14	Paving plant road as much as practicable.	0.08	LB/HR
LA-0382	BIG LAKE FUELS METHANOL PLANT	LA	PSD-LA-781(M1)	04/25/2019	Paved Roads (FUG0004)	99.14	Proper maintenance	--	--
LA-0389	SHINTECH PLAQUEMINE PLANT 3	LA	PSD-LA-817(M-2)	10/20/2022	Road - Fugitive Dust (Paved Road)	63.036	Hard Pavement	--	--
MD-0041	CPV ST. CHARLES	MD	PSC CASE NO. 9280	04/23/2014	ROADWAYS	99.14	Not Specified	--	--
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	PAVED AND UNPAVED ROADS	99.999	REASONABLE PRECAUTIONS TO PREVENT PARTICULATE MATTER FROM BECOMING AIRBORNE	0	NOT SPECIFIED
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	ON-SITE PAVED AND UNPAVED ROADS	99.999	MINIMIZE EMISSIONS BY TAKING REASONABLE PRECAUTIONS TO PREVENT PARTICULATE MATTER FROM BECOMING AIRBORNE BY SWEEPING OR WATER APPLICATION DUST CONTROL, AS NEEDED	--	--
MI-0417	GERDAU MACSTEEL, INC.	MI	102-12A	10/27/2014	EUROADS & PKG01 (Roads and packaging)	81.29	Fugitive Dust Plan	--	--
MI-0429	EAST JORDAN FOUNDRY LLC	MI	185-16	04/27/2017	FGFACILITY--Roadways and Parking Areas	81.49	Work practices within fugitive dust plan.	--	--
MO-0089	OWENS CORNING INSULATION SYSTEMS, LLC	MO	052016-003	05/12/2016	haul roads	99.14	vacuum sweep, wash, etc	--	--

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Paved Roadways (F001)	99.14	i. Paving of all plant roads that will be used for raw material and product transport; ii. Covering, at all times, of open-bodied vehicles when transporting materials likely to become airborne; and iii. Compliance with the opacity limits. Specifically, additional mitigation measures potentially including road sweeping or wet suppression will be implemented on an as-needed basis determined through visual observation of emissions associated with truck movements on the plant site.	13.2	T/YR
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Paved Roadways (F001)	99.14	i. Paving of all plant roads that will be used for raw material and product transport; ii. Covering, at all times, of open-bodied vehicles when transporting materials likely to become airborne; and iii. Compliance with the opacity limits. Specifically, additional mitigation measures potentially including road sweeping or wet suppression will be implemented on an as-needed basis determined through visual observation of emissions associated with truck movements on the plant site.	2.6	T/YR
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Paved roads (F001)	99.14	water flushing and sweeping	0.63	T/YR
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Paved roads (F001)	99.14	water flushing and sweeping	0.15	T/YR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Facility Roadways (F001)	99.14	i. Pave all in-plant haul roads and parking areas; ii. Implement best management practices including posting and limiting vehicle speeds to 20 miles per hour and water spraying or sweeping as needed based on the daily inspections conducted	1.88	T/YR
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Facility Roadways (F001)	99.14	i. Pave all in-plant haul roads and parking areas; ii. Implement best management practices including posting and limiting vehicle speeds to 20 miles per hour and water spraying or sweeping as needed based on the daily inspections conducted	0.38	T/YR
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Facility Roadways (F001)	99.14	i. Pave all in-plant haul roads and parking areas; ii. Implement best management practices including posting and limiting vehicle speeds to 20 miles per hour and water spraying or sweeping as needed based on the daily inspections conducted	0.09	T/YR
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	02/06/2019	Plant Roadways (F001)	99.15	Use of wet suppression and commercial dust suppressants. Develop and implement a site-specific work practice plan designed as described to minimize or eliminate fugitive dust emissions.	0.21	T/YR
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	02/06/2019	Plant Roadways (F001)	99.15	Use of wet suppression and commercial dust suppressants. Develop and implement a site-specific work practice plan designed as described to minimize or eliminate fugitive dust emissions.	0.02	T/YR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0380	AMG VANADIUM LLC	OH	P0125944	08/07/2019	Paved Roadways (F001)	99.14	Pave all in-plant haul roads and parking areas. Implement best management practices including posting and limiting vehicle speeds to 15 miles per hour in production areas. Utilize a vacuum sweeper as needed based on the daily inspections	0.06	T/YR
OH-0380	AMG VANADIUM LLC	OH	P0125944	08/07/2019	Paved Roadways (F001)	99.14	Pave all in-plant haul roads and parking areas. Implement best management practices including posting and limiting vehicle speeds to 15 miles per hour in production areas. Utilize a vacuum sweeper as needed based on the daily inspections	0.01	T/YR
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Plant Roadways & Parking Areas (F005)	99.14	Paved: sweeping, vacuuming, washing with water, and posted speed limits to comply with the applicable requirements. Unpaved: use of dust suppressant as necessary to comply with the applicable requirements.	16.74	T/YR
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Plant Roadways & Parking Areas (F005)	99.14	Paved: sweeping, vacuuming, washing with water, and posted speed limits to comply with the applicable requirements. Unpaved: use of dust suppressant as necessary to comply with the applicable requirements.	3.55	T/YR
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	Plant Roadways & Parking Areas (F005)	99.14	Paved: sweeping, vacuuming, washing with water, and posted speed limits to comply with the applicable requirements. Unpaved: use of dust suppressant as necessary to comply with the applicable requirements.	0.75	T/YR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	Facility paved roadways and parking areas	99.14	Pave all roadways and parking areas and implement best management practices, including limiting vehicle speeds and water spraying or sweeping as needed based on daily inspections.	0.16	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	Facility paved roadways and parking areas	99.14	Pave all roadways and parking areas and implement best management practices, including limiting vehicle speeds and water spraying or sweeping as needed based on daily inspections.	0.8	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	Facility paved roadways and parking areas	99.14	Pave all roadways and parking areas and implement best management practices, including limiting vehicle speeds and water spraying or sweeping as needed based on daily inspections.	0.04	T/YR
OH-0389	TUNNEL HILL RECLAMATION LLC	OH	P0131173	05/08/2023	F001 - Facility unpaved roadways and parking areas	99.15	Develop and implement a site-specific work practice plan with best management practices including the application of water and/or chemical dust suppressants, as needed, based on the inspections conducted in accordance with the requirements of the work practice plan.	119.15	T/YR
OH-0389	TUNNEL HILL RECLAMATION LLC	OH	P0131173	05/08/2023	F001 - Facility unpaved roadways and parking areas	99.15	Develop and implement a site-specific work practice plan with best management practices including the application of water and/or chemical dust suppressants, as needed, based on the inspections conducted in accordance with the requirements of the work practice plan.	32.2	T/YR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0389	TUNNEL HILL RECLAMATION LLC	OH	P0131173	05/08/2023	F001 - Facility unpaved roadways and parking areas	99.15	Develop and implement a site-specific work practice plan with best management practices including the application of water and/or chemical dust suppressants, as needed, based on the inspections conducted in accordance with the requirements of the work practice plan.	3.22	T/YR
OH-0391	VALENCIA PROJECT LLC	OH	P0133726	10/27/2023	Paved Roads (F001)	99.14	Best available control measures â€“ pave all roadways, speed reduction, good housekeeping practices, and/or watering	4.6	T/YR
OH-0391	VALENCIA PROJECT LLC	OH	P0133726	10/27/2023	Paved Roads (F001)	99.14	Best available control measures â€“ pave all roadways, speed reduction, good housekeeping practices, and/or watering	0.92	T/YR
OH-0391	VALENCIA PROJECT LLC	OH	P0133726	10/27/2023	Paved Roads (F001)	99.14	Best available control measures â€“ pave all roadways, speed reduction, good housekeeping practices, and/or watering	0.23	T/YR
OH-0393	WIN WASTE INNOVATIONS OF SENECA COUNTY	OH	P0133348	09/11/2024	Plant Roadways and Parking Areas (F002)	99.15	Best available control measures â€“ pave all roadways when feasible, speed reduction, good housekeeping practices, and/or watering	93.13	T/YR
OH-0393	WIN WASTE INNOVATIONS OF SENECA COUNTY	OH	P0133348	09/11/2024	Plant Roadways and Parking Areas (F002)	99.15	Best available control measures â€“ pave all roadways when feasible, speed reduction, good housekeeping practices, and/or watering	23.33	T/YR
OH-0393	WIN WASTE INNOVATIONS OF SENECA COUNTY	OH	P0133348	09/11/2024	Plant Roadways and Parking Areas (F002)	99.15	Best available control measures pave all roadways when feasible, speed reduction, good housekeeping practices, and/or watering	3.08	T/YR

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RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OK-0173	CMC STEEL OKLAHOMA	OK	2015-0643-C PSD	01/19/2016	Unpaved Roads	99.15	BACT for PM emissions from roads is selected as work-practice standards of paving roads, sweeping them when needed, and setting of speed limits to minimize fugitive dust emissions. Since the PM emissions are fugitive, no numerical limitation is practical.	--	--
SC-0181	RESOLUTE FP US INC. - CATAWBA LUMBER MILL	SC	2440-0216-CA	11/03/2017	Roads	99.14	Good housekeeping practices.	0.13	LB/VMT
SC-0181	RESOLUTE FP US INC. - CATAWBA LUMBER MILL	SC	2440-0216-CA	11/03/2017	Roads	99.14	Good housekeeping practices.	0.03	LB/VMT
SC-0181	RESOLUTE FP US INC. - CATAWBA LUMBER MILL	SC	2440-0216-CA	11/03/2017	Roads	99.14	Good housekeeping practices.	0.01	LB/VMT
SC-0193	MERCEDES BENZ VANS, LLC	SC	0560-0385-CA	04/15/2016	Paved Roads	99.14	Proper Maintenance of all roads. Fugitive dust minimization.	--	--
SC-0205	SCOUT MOTORS INC A DELAWARE CORPORATION - BLYTHEWOOD PLANT	SC	PSD-50000007 V1.0	10/31/2023	Roads	99.14	Paving and maintaining all roads	--	--
TN-0183	SINOVA SILICON LLC	TN	979383	04/25/2022	Raw Material Receiving/ Handling and Road Traffic	82.999	Mist control for transfer points, paved roads and watering for traffic with 7% opacity for fugitive transfer points	--	--
WI-0310	NEMADJI TRAIL ENERGY CENTER	WI	21-MMC-011	07/08/2021	Haul Roads (F01)	99.14	All roads and parking lots within the property boundary must be paved, 5 mph speed limits posted for all vehicles and develop, maintain, and implement a fugitive dust control plan.	520	TRUCK TRIPS/YR
WI-0315	SUPERIOR REFINING COMPANY LLC	WI	20-RAB-080	10/09/2020	Loading Access Road (F103A)	99.15	Not Specified	5	MPH

Process IDs: ---
Other Search Criteria: Process Name Contains "Silos"
Process Description Silos
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for "Silo" and "Lime"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AL-0269	GEORGIA PACIFIC BRETON LLC	AL	502-0001-X047	06/11/2014	Fresh Lime Silo - Lime Storage Silos	30.239	baghouse	0.005	GRAIN/SDCF
AL-0269	GEORGIA PACIFIC BRETON LLC	AL	502-0001-X047	06/11/2014	Re-Burned Lime - Lime Storage Silos	30.239	Bag-house	0.005	GRAIN/SDCF
IN-0235	STEEL DYNAMICS INC. - FLAT ROLL DIVISION	IN	033-34498-00043	11/05/2015	LIME / CARBON STORAGE SILOS	81.29	BIN VENT	0.01	GR/DSCF
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 06-02 A & B - Lime Silos A & B	90.019	For Lime Silos A & B (EP 06-02A & B): The permittee shall install, operate, and maintain a bin vent filter on each silo designed to control particulate grain loading to 0.005 grain/dscf and the flow rate to 900 dscf/min.	0.005	GR/DSCF
KY-0116	NOVELIS CORPORATION - GUTHRIE	KY	V-22-011	07/25/2022	EU 042 - Hot Baghouse Lime Silos #1 & #2	90.019	Bin vent filter, Good Work Practices (GWP) Plan.	0.0014	LB/HR
OH-0380	AMG VANADIUM LLC	OH	P0125944	08/07/2019	Hydrated Lime Silo (P003)	90.021	Bin vent filter with 100% capture efficiency and 0.005 gr/dscf.	0.005	GR/DSCF

Process IDs: ---
Other Search Criteria: Process Name Contains "Silos"
Process Description Silos
Date Range 1/1/2014 - 11/7/2024
Date Conducted 11/7/2024 - 1/14/2025
Notes & Filtering: Filtered for "Silo" and "Lime"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0380	AMG VANADIUM LLC	OH	P0125944	08/07/2019	LimeAdd Silo (P910)	81.59	i. Minimize the drop height of the material at the transfer point to the extent possible; ii. Ensure the transfer chute from the silo to the truck is vented back to the silo and associated bin vent filter with a minimum capture efficiency of 90%; and iii. PM/PM10/PM2.5 from this emissions unit shall be vented to a bin vent filter, which shall be capable of achieving the emissions limitations at all times during operation.	0.005	GR/DSCF
OH-0381	NORTHSTAR BLUESCOPE STEEL, LLC	OH	P0126431	09/27/2019	LMF Silo #2 & Lime/Carbon Silo: P032,P033,P034	81.29	Fabric filter	0.02	GR/DSCF
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	Lime Silos: P048 through P053	90.999	Bin vent filter	0.005	GR/DSCF
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	05/04/2018	Pickle Line Equipment (pickle line no.3 water treatement lime storage silo)	81.29	Bin Vent Filter; Proper Operation and Maintenance through Good Housekeeping	---	---
WI-0282	WISCONSIN PUBLIC SERVICE CORPORATION FOX ENERGY CENTER	WI	18-DMM-174	04/08/2019	P08 & P09 Lime/Soda Ash Silos	99.12	Fabric Filter	0.04	LB/HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0083	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT06	01/06/2015	Diesel Fired Well Pump	17.21	Limited Operation of 168 hr/yr.	0.31	LB/MMBTU
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Fire Pump Diesel Internal Combustion Engines	17.21	Clean Fuel and Good Combustion Practices	0.19	G/KW-HR
AK-0085	GAS TREATMENT PLANT	AK	AQ1524CPT01	08/13/2020	Three (3) Firewater Pump Engines and two (2) Emergency Diesel Generators	17.21	Good combustion practices, ULSD, and limit operation to 500 hours per year per engine	0.19	G/HP-HR
AK-0086	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT07	03/26/2021	Diesel Fired Well Pump	17.21	Good Combustion Practices and Limited Use	0.31	LB/MMBTU
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	1	G/BHP-HR
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	1	G/BHP-HR
FL-0346	LAUDERDALE PLANT	FL	0110037-011-AC	04/22/2014	Emergency fire pump engine (300 HP)	17.21	Good combustion practice	0.2	GRAM PER HP-HR
FL-0354	LAUDERDALE PLANT	FL	0110037-013-AC	08/25/2015	Emergency fire pump engine, 300 HP	17.21	Low-emitting fuel and certified engine	0.2	G / KWH
FL-0356	OKEECHOBEE CLEAN ENERGY CENTER	FL	0930117-001-AC	03/09/2016	One 422-hp emergency fire pump engine	17.21	Use of clean fuel	0.2	G / KW-HR
FL-0363	DANIA BEACH ENERGY CENTER	FL	0110037-017-AC	12/04/2017	Emergency Fire Pump Engine (422 hp)	17.21	Certified engine	0.2	G / KWH
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	Emergency Fire Pump Engine (347 HP)	17.21	Operate and maintain the engine according to the manufacturer's written instructions	0.2	G/KW-HOUR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	06/07/2021	Emergency Fire Pump Engine (347 HP)	17.21	Not Specified	0.2	G/KW-HOUR
IL-0129	CPV THREE RIVERS ENERGY CENTER	IL	16060032	07/30/2018	Firewater Pump Engine	17.21	Not Specified	--	---
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Firewater Pump Engine	17.21	Not Specified	0.2	G/KW-HR
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Fire Water Pump Engine	17.21	Not Specified	0.2	GRAMS
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Firewater Pump Engine	17.21	Not Specified	0.2	G/KW-HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KS-0030	MID-KANSAS ELECTRIC COMPANY, LLC - RUBART STATION	KS	C-13309	03/31/2016	Compression ignition RICE emergency fire pump	17.21	Not Specified	0.15	G/HP-HR
LA-0301	LAKE CHARLES CHEMICAL COMPLEX ETHYLENE 2 UNIT	LA	PSD-LA-779	05/23/2014	Firewater Pump Nos. 1-3 (EQTs 997, 998, & 999)	17.21	Compliance with 40 CFR 60 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage	0.17	LB/HR
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Pump Engines DFP-16-1 (EQT036)	17.21	Meet NSPS Subpart IIII Limitations and Good Combustion Practices	0.09	LB/H
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Pump Engine DFP-16-2 (EQT037)	17.21	Meet NSPS Subpart IIII Limitations and Good Combustion Practices	0.09	LB/H
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Firewater Pump Engines	17.21	Complying with 40 CFR 60 Subpart IIII	0.15	G/BHP-HR
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Firewater Pump 1	17.21	Not Specified	0.09	LB/H
LA-0314	INDORAMA LAKE CHARLES FACILITY	LA	PSD-LA-813	08/03/2016	Diesel Firewater pump engines (6 units)	17.21	complying with 40 CFR 63 subpart ZZZZ	--	---
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	firewater pump engines (8 units)	17.21	Complying with 40 CFR 60 Subpart IIII	--	---
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39A	17.21	Compliance with 40 CFR 60 Subpart IIII.	0.2	g/kW-hr

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39B	17.21	Compliance with 40 CFR 60 Subpart IIII	0.2	g/kW-hr
LA-0370	WASHINGTON PARISH ENERGY CENTER	LA	PSD-LA-829(M-1)	04/27/2020	Emergency Fire Pump Engine (EQT0021, ENG-1)	17.21	The use of low sulfur fuels and compliance with 40 CFR 60 Subpart IIII	0.04	LB/HR
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Fired Water Pump Engine	17.21	Compliance with 40 CFR 60 Subpart IIII standards, good combustion practices, and the use of ultra-low sulfur diesel fuel.	0.15	G/HP-HR
LA-0397	WESTLAKE ETHYLENE PLANT	LA	PSD-LA-813(M3)	04/29/2022	Emergency Generators and Fire Water Pumps (EQT0027 - EQT0032, EQT0044, EQT0045)	17.21	Compliance with applicable requirements of 40 CFR 60 Subpart IIII	--	---
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-01 - Firewater Pump Engine No. 1	17.21	Compliance with 40 CFR 60 Subpart IIII	0.2	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-02 - Firewater Pump Engine No. 2	17.21	Compliance with 40 CFR 60 Subpart IIII	0.2	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-03 - Firewater Pump Engine No. 3	17.21	Compliance with the requirements of 40 CFR 60 Subpart IIII	0.06	LB/HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0402	DESTREHAN OIL PROCESSING FACILITY	LA	PSD-LA-855	12/13/2023	HLK39 - Emergency Diesel Fire Pump Engine (EQT0094)	17.21	Compliance with 40 CFR 60 Subpart IIII	0.14	LB/H
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Fire Pump Engine	17.21	Not Specified	0.15	GM/BHP-H
MD-0041	CPV ST. CHARLES	MD	PSC CASE NO. 9280	04/23/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES	0.15	G/HP-H
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES, LIMITED HOURS OF OPERATION, AND DESIGNED TO ACHIEVE EMISSION LIMITS	0.15	G/HP-H
MD-0043	PERRYMAN GENERATING STATION	MD	PSC CASE NO. 9136		EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	GOOD COMBUSTION PRACTICES, LIMITED HOURS OF OPERATION, AND EXCLUSIVE USE OF ULSD	0.17	G/HP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	5 EMERGENCY FIRE WATER PUMP ENGINES	17.21	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES AND DESIGNED TO ACHIEVE EMISSION LIMITS	0.15	G/BHP-H
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	5 EMERGENCY FIRE WATER PUMP ENGINES	17.21	EXCLUSIVE USE OF ULSD FUEL, GOOD COMBUSTION PRACTICES AND DESIGNED TO ACHIEVE EMISSION LIMITS	0.17	G/BHP-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES.	0.18	G/HP-H
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	EMERGENCY DIESEL ENGINE FOR FIRE WATER PUMP	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR FUEL AND GOOD COMBUSTION PRACTICES	0.2	G/KW-H
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	DIESEL-FIRED FIRE PUMP ENGINE	17.21	EXCLUSIVE USE OF ULTRA LOW SULFUR DIESEL FUEL AND GOOD COMBUSTION PRACTICES	0.2	G/KW-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUFPENGINE (Emergency engine--diesel fire pump)	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements.	0.15	G/BHP-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUFPENGINE (Emergency engine--diesel fire pump)	17.21	Good combustion practices and meeting NSPS Subpart IIII requirements	0.57	LB/H
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUFPENGINE (Emergency engine--diesel fire pump)	17.21	Good combustion practices.	0.22	G/HP-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUFPENGINE (Emergency engine--diesel fire pump)	17.21	Good combustion practices.	0.09	LB/MMBTU
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (South Plant): Fire pump engine	17.21	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.15	G/BHP-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (South Plant): Fire pump engine	17.21	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.66	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (North Plant): Fire pump engine	17.21	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.15	G/BHP-H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (North Plant): Fire pump engine	17.21	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.66	LB/H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUFPENGINE: Fire pump engine	17.21	State of the art combustion design	0.2	G/KW-H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUFPENGINE: Fire pump engine	17.21	State of the art combustion design	0.13	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUFPENGINE (North Plant): Fire Pump Engine	17.21	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.66	LB/H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUFPENGINE (North Plant): Fire Pump Engine	17.21	Diesel particulate filter, good combustion practices and meeting NSPS Subpart IIII requirements.	0.15	G/B-HP-H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUFPENGINE (South Plant): Fire pump engine	17.21	Diesel particulate filter, Good Combustion Practices and meeting NSPS Subpart IIII requirements	0.15	G/B-HP-H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUFPENGINE (South Plant): Fire pump engine	17.21	Diesel particulate filter, Good Combustion Practices and meeting NSPS Subpart IIII requirements	0.66	LB/H
MS-0092	EMBERCLEAR GTL MS	MS	0040-00055	05/08/2014	firewater pumps, diesel	17.21	Not Specified	--	---
NJ-0081	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068 -(BOP120002)	03/07/2014	Emergency diesel fire pump	17.21	Use of Ultra low sulfur distillate oil	0.15	G/B-HP-H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Emergency Diesel Fire Pump	17.21	use of ULSD a clean burning fuel, and limited hours of operation	0.1	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
NJ-0085	MIDDLESEX ENERGY CENTER, LLC	NJ	19149/PCP150001	07/19/2016	EMERGENCY DIESEL FIRE PUMP	17.21	Use of Ultra Low Sulfur Diesel (ULSD) Oil a clean burning fuel and limited hours of operation	0.108	LB/H
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency Fire Pump Engine (P003)	17.21	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	0.09	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.07	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.1	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Fire Pump Diesel Engine (P008)	17.21	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	0.02	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Fire Pump Diesel Engine (P008)	17.21	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	0.02	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency fire pump engine (P004)	17.21	Ultra low sulfur diesel fuel	0.1	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency fire pump engine (P004)	17.21	Ultra low sulfur diesel fuel	0.1	LB/H
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Fire Pump (P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII. Good combustion practices per the manufacturer's operating manual	0.13	LB/H
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fueled fire pump (P006)	17.21	Comply with NSPS 40 CFR 60 Subpart IIII	0.1	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Fire Pump (P004)	17.21	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	0.11	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Firewater Pumps (P005 and P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII and employ good combustion practices per the manufacturer's operating manual	0.13	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	275 hp (205 kW) Diesel-Fired Emergency Fire Pump Engine	17.21	Certified to meet the standards in Table 4 of 40 CFR Part 60, Subpart IIII and good combustion practices	0.2	G/KW-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	09/02/2016	Emergency Fire Pump Engine	17.21	Not Specified	0.15	G/BHP-HR
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Fire Pump	17.21	Not Specified	0.15	G/B-HP-H
VA-0325	GREENSVILLE POWER STATION	VA	52525		DIESEL-FIRED WATER PUMP 376 bph (1)	17.21	Ultra Low Sulfur Diesel/Fuel (15 ppm max)	0.3	G/HP-H
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Emergency Fire Water Pump	17.21	good combustion practices and the use of ultra low sulfur diesel (S15 ULSD) fuel oil with a maximum sulfur content of 15 ppmw.	15	G/HP/HR
WI-0263	WISCONSIN POWER & LIGHT - NEENAH GENERATING STATION	WI	14-DMM-200	02/15/2016	Fire pump (process P05)	17.21	Good combustion practices, use diesel fuel with sulfur content < 15 ppm, and operate <500 hr/yr	--	---
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Fire Pump (P06)	17.21	Operation limited to 500 hours/year, sulfur content of diesel fuel oil fired may not exceed 15 ppm, and shall be operated and maintained according to the manufacturer's recommendations.	0.15	G/HP-H
WI-0302	WPL- RIVERSIDE ENERGY CENTER	WI	19-DMM-153	02/28/2020	Diesel-Fired Fire Pump Engine (P04)	17.21	Good combustion practices, use diesel fuel oil with sulfur content of no greater than 0.0015% by weight	0.11	LB/H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Fire Pump Engine	17.21	Limited to 100 Hours/year.	---	---

					BACT Determination		Typical Technology	
Source Type	**Classification**	**Primary Fuel**	**Reference [a]**	**Date of Reference**	**Feasible/ Cost Effective**	**Achieved in Practice**	**Feasible/ Cost Effective**	**Achieved in Practice**
Diesel-Fired Emergency Engine	> 50 BHP and < 1,000 BHP Output	Diesel	BAAQMD	12/22/2020	Not Specified	0.15 g/bhp-hr	Not Specified	Any engine or technology demonstrated, certified or verified to achieve the applicable standard.
Process-Generated Emissions	All	Not Specified	BAAQMD	6/16/1995	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Process-Generated Emissions	All	Not Specified	BAAQMD	10/25/1991	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Process-Generated Emissions	All	Not Specified	BAAQMD	1/10/1992	No Determination	Exhaust vented to combustion chamber followed by wet scrubber w/ particulate control efficiency ≥99%	Not Applicable	BAAQMD Approved Design and Operation

Notes:
a. Data sources include:
BAAQMD - Bay Area Air Quality Management District
(https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook);

Summary of Semiconductor Manufacturing Permits

Source Type	Permit Emission Unit Description	Permittee	State	Permit ID	Issue Date	Pollutant	Control Technology	Permit Limit	Show
Semiconductor Process Tool Emissions	Semiconductor Manufacturing Fab Processes	Global Foundries	NY	5-4140-00189/00004	11/20/2018	PM	Not Specified	Emission Limit: 0.050 gr/scf of Exhaust	Y
Semiconductor Process Tool Emissions	Semiconductor Manufacturing Fab Processes	Global Foundries	NY	5-4140-00189/00004	11/20/2018	PM	Not Specified	Emission Limit: 0.050 gr/scf of Exhaust	Y
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	PM PM_{10} $PM_{2.5}$	Wet Scrubbers	42.6 tons per rolling, 12-month period Opacity < 20% as 6-minute average PE < 0.020 lb/MMBtu of actual heat input for each indirect-fired burner $PM/PM_{10}/PM_{2.5}$ emissions shall not exceed 1.7 lb/hr from all RCTOs controlling these emission units combined Combined $PM/PM_{10}/PM_{2.5}$ emssions from scrubbers shall not exceed 7.9 lb/hr; $PM/PM_{10}/PM_{2.5}$ < 0.04 lb/hr for each trimix system	Y

Source Type	Permit Emission Unit Description	Permittee	State	Permit ID	Issue Date	Pollutant	Control Technology	Permit Limit	Show
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	PM PM_{10} $PM_{2.5}$	Wet Scrubbers	20.3 tons per rolling, 12-month period Opacity < 20% as 6-minute average PE < 0.020 lb/MMBtu of actual heat input for each indirect-fired burner $PM/PM_{10}/PM_{2.5}$ emissions shall not exceed 1.7 lb/hr from all RCTOs controlling these emission units combined Combined $PM/PM_{10}/PM_{2.5}$ emssions from scrubbers shall not exceed 7.9 lb/hr; $PM/PM_{10}/PM_{2.5}$ < 0.04 lb/hr for each trimix system	Y
Semiconductor Process Tool Emissions	Wafer Fabrication in Building B323 and B323A Collapse Chip Connection (C4) Plating Operation in B320 R&D and Post-Fab Activities	OnSemi	NY	3-1328-00025/01029	11/28/2023	PM	--	Emissions Limit: 0.050 gr/dscf (USEPA Reference Test Method 5)	Y
Semiconductor Process Tool Emissions	Semiconductor Fab Process Tools	Intel Corp	OR	34-2681-ST-01	1/22/2016	PM PM_{10} $PM_{2.5}$	Wet Electrostatic Precipitators (WESPs)	---	Y
Semiconductor Process Tool Emissions	Semiconductor Fab Tool Processes	TSMC Arizona Corporation	AZ	P0008497	11/4/2022	$PM_{2.5}$ PM_{10}	Good Combustion Practices in POU Abatement Devices	---	Y

APPENDIX L. GHG BACT ANALYSIS

This appendix presents the best available control technology (BACT) determinations for the control of greenhouse gas (GHG) emissions from the emission sources at the Proposed Air Permit Project. Micron has reviewed the RACT/BACT/LAER Clearinghouse (RBLC), documentation from the Bay Area Air Quality Management District (BAAQMD), and relevant semiconductor fab permits to identify appropriate control technologies and/or limits for GHG emission source categories. The analysis to determine BACT is described in Section 5.4 of the Micron Clay Air Permit Application. As the add-on control technologies and other control mechanisms are similar for many of the sources that Micron operates, types of control technologies identified are summarized in Section 1.1 of this appendix. Not all technologies are applicable to all emission sources, and as such, source-specific considerations for each source category are discussed in the subsequent sections.

This BACT evaluation addresses GHGs that may be emitted from the Proposed Air Permit Project (i.e., carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) from combustion and other GHGs, including fluorinated GHG (F-GHG) compounds and sulfur hexafluoride (SF_6)) as one category of GHG. This aligns with GHG as the New Source Review (NSR) contaminant that is subject to regulation for the Proposed Air Permit Project. Refer to Section 3.4.9.3 of the Micron Clay Air Permit Application narrative for additional details of this NSR determination. If there are differences between individual GHGs that affect emission control technology or the determination of BACT, they are noted throughout this appendix.

Emission sources include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine;
- Semiconductor process tools and thermal oxidation systems that emit GHGs;
- Use of heat transfer fluids (HTFs) that contain GHGs; and
- Use of Circuit Breakers that contain SF_6.

1.1 Available Technology Summary

The technologies identified to mitigate GHG emissions are described in the following subsections.

1.1.1 Good Design and Combustion Practices for Fuel-Fired Equipment

An efficient design in combustion devices significantly reduces GHG emissions by ensuring that a higher percentage of the fuel is converted into usable energy, thus reducing the total fuel required to achieve the purpose of the fuel-fired equipment and also reducing emissions of other non-GHG air contaminants. For this source category, good combustion practices are generally considered to be implementing the manufacturer's recommendations, which may include a combination of the following:

- Optimizing the air-fuel ratio;

- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

The specific practices available for each source category are discussed in the subsequent sections.

1.1.2 Tool-Level Thermal Oxidation Systems

Thermal oxidation is used as a part of point-of-use (POU) control devices, which are used in conjunction with certain semiconductor process tools (e.g., plasma etch process tools) to mitigate emissions of fluorinated GHG by thermally treating exhaust streams from process tools that utilize F-GHG. These POU control devices also use wet scrubbing systems to control the resultant acid gases.

Thin films process tools often include process equipment exhaust conditioners (PEECs) as required safety equipment to manage process gases that are pyrophoric, flammable, toxic, or incompatible with other process gases or the ductwork. Thin films PEECs may incidentally manage GHG emissions that are comingled with these hazardous materials.

1.1.3 Centralized Regenerative Catalytic Systems

The use of catalytic oxidation via centralized regenerative catalytic systems (RCS) may control emissions of F-GHGs by combining exhausts from several plasma etch process tools rather than operating tool-level thermal-based oxidation systems described in Section 1.1.2 of this analysis. This technology is an alternative to numerous individual POU control devices and would allow treatment of F-GHG process gases emitted from plasma etch process tools in a centralized control device.

1.1.4 Plasma-Based Oxidation

One potential alternative to a burn-wet style oxidation system is an electrically powered "plasma-wet" oxidation system. Instead of using natural gas combustion to oxidize exhaust, plasma-wet oxidation systems create a plasma environment in which these molecules in the exhaust can dissociate.

1.1.5 Process Chemical Substitution

Process chemical substitution in semiconductor manufacturing affects direct use of F-GHG and involves utilizing alternative materials or process chemicals that contain compounds with a lower global warming potential (GWP). To reduce carbon dioxide equivalent (CO_2e) emissions, both factors that determine CO_2e (i.e., mass of GHG and its GWP) must be evaluated. Process chemical substitution in semiconductor manufacturing is evaluated in two different manners in this analysis: (1) processes that have direct contact with semiconductor wafers (e.g., fluorinated process gases), and (2) processes that do not have direct contact with semiconductor wafers (e.g., chemical vapor deposition (CVD) chamber cleaning). Generally, there is more opportunity to evaluate alternatives where the materials do not have direct contact with semiconductor wafers due to the reduced potential impact on the semiconductor manufacturing process.

One example of chemical substitution in the semiconductor industry is through use of alternative substances. As mentioned above, certain fluorinated compounds that are F-GHG are used in the plasma etching processes which remove small quantities of silicon and/or other material as the wafer is etched. The selection of a fluorinated compound used for a particular substrate wafer and process step impacts the effectiveness of the etching process. The potential for emissions of CO_2e from this process is based on the fluorinated compound(s) selected, their GWP, the efficiency of converting the fluorinated compound(s) into F^- ion to etch the wafer and other byproduct F-GHGs. F-GHGs that are not converted to F^- ion within the process are exhausted from the process tool, through thermal oxidation systems to the atmosphere.

In addition, nitrogen trifluoride (NF_3) is utilized in CVD remote plasma clean technologies to replace less efficient CVD in-situ chamber cleaning or thermal cleaning technologies for thin film and diffusion tools. For additional description of this operation, refer to Section 1.4.1.1 of the Micron Clay Air Permit Application related to Thin Films/Diffusion. This can result in substantial reductions in the F-GHG emissions on a CO_2e basis.

1.1.6 Operating Limitations

Limiting the hours of operation for engines, water bath vaporizers, and boilers reduces GHG emissions by decreasing the overall time the equipment runs and consumes fuel.

1.1.7 Good Design and Operation Practices for HTFs

Several HTFs that are GHGs are used in transfer lines and equipment. Good design and operation practices related to the use of GHG-based HTFs include following manufacturer recommendations on the types of valves and fittings and transfer lines to use for connections between equipment. However, due to the nature of these transfer lines, there are no standardized practices as manufacturer recommendations only apply when interfacing with their equipment. Micron has developed a global program to monitor heat transfer fluid volumes at the equipment level for nontypical increases in usage, evaluation of transfer lines and equipment to identify areas of potential inefficient use, and maintenance and repair of those areas. Based on these data, Micron identifies areas of inefficient usage, evaluates ways to minimize potential emissions, and implements emissions minimizations measures. These efforts are beyond the manufacturer's recommendations.

1.1.8 Manufacturing Process Optimization

Micron is proposing to install semiconductor process equipment, or process tools, as discussed within the Micron Clay Air Permit Application. Certain tools require F-GHG to achieve the intended process. For example, fluorine ions (F^-) are generated from the use of F-GHGs in the plasma/dry etching and cleaning processes which removes small quantities of silicon and/or other material from the semiconductor devices and by-products formed in the process equipment. Additional details are provided in Section 1.4 of the Micron Clay Air Permit Application.

This method to achieve BACT involves optimizing the operation of process tools and processes to utilize the GHGs efficiently while considering the complexity of semiconductor device manufacturing. Examples of these efforts may include optimizing process tool operating cycles and efficient utilization of process chemicals.

1.1.9 Carbon Capture and Storage

CCS is a set of technologies that can reduce GHG emissions to atmosphere through capturing CO_2 from emission sources, transporting it to a suitable location and sequestering it in subsurface formations.

An effective CCS system would require three elements:

- Separation technology for the CO_2 exhaust stream (i.e., "carbon capture" technology),
- Transportation of CO_2 to a storage site, and
- A viable location for long-term storage of CO_2.

These three elements work in series. Consequently, to execute a CCS program as BACT, all three elements must be feasible.

CO_2 Capture

CCS involves post-combustion capture of CO_2 from the emission units and sequestration of the CO_2 in some fashion. Carbon capture is typically accomplished with low pressure scrubbing of CO_2 from the exhaust stream with solvents (e.g., amines and ammonia), solid sorbents, or membranes. CO_2 must be compressed from near-atmospheric pressure in the stack to pipeline pressure (around 2,000 psia) prior to transportation to an appropriate sequestration site. CO_2 capture is likely feasible for sources emitting CO_2 in large amounts and high-purity CO_2 streams, such as fossil fuel-fired power plants, cement plants, and ammonia production facilities.

CO_2 Transport

CO_2 that has been captured and compressed is subsequently transported to a site designated for long-term geologic storage or use in enhanced oil recovery (EOR). Pipelines are expected to be the most economical and efficient method of transporting CO_2 for commercial purposes. Once constructed, pipelines reduce uncertainty associated with logistics, fuel costs, and reliance on other infrastructure that could increase the cost of CO_2 transportation. The history of transporting CO_2 via pipelines in the United States spans over 40 years.

As of 2019, there were approximately 32 liquid CO_2 pipeline operators under USDOT regulatory authority in the United States according to the Pipeline and Hazardous Materials Safety Administration (PHMSA). This distribution network consists of approximately 5,200 miles of pipe transporting supercritical fluid CO_2 and a significantly smaller amount (~60 miles) of gas CO_2 pipelines. A report delivered to Congress by the Council of Environmental Quality on CCS identifies priorities including the establishment of an interstate CO_2 pipeline network modeled by the Princeton Net-Zero America study covering portions of the Central States and Midwest regions, but there are no proposed routes in New York at the time of Air Permit Application 2.[1]

CO_2 Storage

CO_2 storage refers to the process of injecting CO_2 into subsurface formations for long-term sequestration. CO_2 storage is currently happening across the U.S. and around the world. To be considered suitable for

[1] Council on Environmental Quality Report to Congress on Carbon Capture, Utilization, and Sequestration (2021, June). Retrieved from https://www.whitehouse.gov/wp-content/uploads/2021/06/CEQ-CCUS-Permitting-Report.pdf

sequestration, sites must have suitable geology. For stable storage of CO_2, sequestration reservoirs must be at least 2,500 feet below the ground surface and generally must have a porosity greater than 5% with adequate permeability to allow for flow between pores. Additionally, there must be a layer of impermeable rock above the sequestration reservoir, referred to as a "cap rock" to prevent migration and potential escape of CO_2.

1.1.10 Use of Different Medium in Circuit Breakers

SF_6 has been the preferred insulating medium in electrical switchgear since the 1950s due to its dielectric strength, arc quenching capability, and thermal stability. These characteristics allow for the use of small circuit breakers at high voltages; however, due to the high GWP of SF_6, researchers have been exploring lower GWP alternatives. Currently gas mixtures containing C4-FN (C4) or C5-FK (C5), Synthetic Air, or air and CO_2 are considered to be the most viable alternatives.

C4 and C5 are mixed with nitrogen (N_2), air and/or CO_2 to create a stable insulating medium. Synthetic air consists of a mixture of 20% oxygen and 80% nitrogen. Both alternatives have a lower GWP when compared to SF_6 and are generally considered feasible in low voltage applications; however, such technologies are not available in the US market for medium and high voltage applications. [2]

1.1.11 Guaranteed Low Leak Rate Circuit Breakers

The use of guaranteed low leak rate circuit breakers would reduce fugitive GHG emissions. For circuit breakers that use SF_6 gas for insulation, the leakage rate of present designs are less than 0.5%.

1.1.12 Leak Detection and Alarms for Circuit Breakers

The use of leak detection systems (including alarms) for circuit breakers minimizes GHG emissions by identifying such leaks and allowing the operator to promptly implement appropriate maintenance and repair.

1.1.13 Control Technologies Not Evaluated

Some control technologies have been omitted from the BACT evaluation due to various considerations. These control technologies, and the reasons for their omission, are summarized in Table 1-1 and in the subsequent sections of this BACT evaluation.

[2] Moving Toward SF6-Free High Voltage Circuit Breakers

Table 1-1. Summary of Control Technologies Not Evaluated

Emission Source Category	Technology	Reasoning
All Source Categories	Use of Alternate Fuels	The use of different fuels or raw materials that would redefine the project are out of the scope of BACT evaluations. Where different fuel specifications within the fuel type (i.e., use of ULSD) are feasible for the project, they have been identified above in Section 1.1 and are evaluated in the sections following this table.
Natural Gas-Fired Combustion Devices	Low NO_X Burners (LNBs) / Ultra-Low-NO_X Burners (ULNBs)	LNBs and ULNBs are primarily designed to minimize the formation of NO_X during the combustion process. In some cases, the addition of NO_X control systems may reduce combustion efficiency, resulting in an increase of fuel use and GHG emissions.[3]
Heat Transfer Fluids	POU Control Devices	Generally, fluorinated HTFs do not exhaust through process tools and, therefore, are not abated by POU control devices.

1.2 Natural Gas-Fired Boilers

Natural gas-fired boilers are heating systems used to generate hot water or steam for maintaining precise temperature control for various stages of production, ensuring the efficient operation of machinery. Micron is proposing to use efficient units that are specifically designed to meet the Proposed Air Permit Project's thermal requirements while minimizing energy consumption and emissions.

The BACT analysis for GHG emissions from natural gas-fired boilers is presented in this section.

1.2.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing GHG emissions from the proposed natural gas-fired boilers:

- Good design and combustion practices
- Operating hour limitations; and
- CCS.

1.2.2 Step 2. Eliminate Technically Infeasible Options

CCS has been demonstrated in practice and is generally considered to be available for facilities emitting CO_2 in large amounts, and for facilities with high-purity CO_2 streams. Such facilities include fossil fuel-fired power plants, cement plants, ammonia production, ethanol production, natural gas processing, and iron and steel manufacturing. In alignment with this, the EPA recently finalized the NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units which requires the implementation of CCS for

[3] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion, Section 1.4.3.

certain existing and new EGUs.[4] The NSPS is applicable to fossil-fired EGUs that have heat input ratings above 250 MMBtu/hr and which serve generators capable of generating greater than 25 MW of electricity.

The boilers at the Proposed Air Permit Project operate intermittently to maintain precise temperature control for various stages of production, ensuring the efficient operation of machinery, and are not considered electric generating units. While the technology for the post-combustion capture of CO_2 may be available in some applications, the process has not been demonstrated for natural gas-fired boilers rated at less than 50 MMBtu/hr as proposed in the Proposed Air Permit Project. The EPA's RBLC database does not include any CCS GHG BACT determinations for natural gas-fired boilers of any size. Recovery and purification of CO_2 from boiler flue gas would require significant additional processing to achieve the necessary CO_2 concentration and purity for effective sequestration. The compression of CO_2 requires a large auxiliary power load, which is expected to result in the use of additional fuel (and associated additional CO_2 emissions) to generate this needed electricity.[5]

As such, CCS is not considered technically or environmentally feasible for reducing GHG emissions from the natural gas-fired boilers and is not considered further in this analysis.

1.2.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.2.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.2.5 Step 5. Select BACT

Based on the analysis presented above, Micron proposes the use of efficient design and combustion practices as BACT for natural gas-fired boilers. Micron will comply the manufacturer's recommendations for good combustion and maintenance practices, which may include a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 6,000 hours per year for each boiler.

[4] NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units

[5] EPA. (2010, August). Report of the Interagency Task Force on Carbon Capture and Storage.

A BACT limit must not be higher than any other applicable state or federal regulation. The boilers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for GHG for natural gas-fired steam generating units.

1.3 Natural Gas-Fired Water Bath Vaporizers

This Permit Application 2 separates "natural gas-fired combustion equipment" into boilers and water bath vaporizers. Natural gas-fired water bath vaporizers are used in the semiconductor industry to provide a reliable and efficient source of high-purity nitrogen gas. These water bath vaporizers use natural gas to heat water that is used to vaporize liquified nitrogen used in semiconductor manufacturing.

The BACT analysis for GHG emissions from natural gas-fired water bath vaporizers is presented in this section.

1.3.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing GHG emissions from the proposed natural gas-fired water bath vaporizers:

- Good design and combustion practices
- Operating hour limitations; and
- CCS.

1.3.2 Step 2. Eliminate Technically Infeasible Options

CCS has been demonstrated in practice and is generally considered to be available for facilities emitting CO_2 in large amounts, and for facilities with high-purity CO_2 streams. Such facilities include fossil fuel-fired power plants, cement plants, ammonia production, ethanol production, natural gas processing and iron and steel manufacturing. In alignment with this, the EPA recently finalized the NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units which requires the implementation of CCS for certain existing and new EGUs.[6] The NSPS is applicable to fossil-fired EGUs that have heat input ratings above 250 MMBtu/hr and which serves generators capable of generating greater than 25 MW of electricity.

The water bath vaporizers at the Proposed Air Permit Project operate intermittently to provide a reliable and efficient source of high-purity nitrogen gas. The water bath vaporizers provide the necessary supply of liquified gases to the fab when demand cannot be met by routing gas directly from an on-site air separations unit. The intermittent nature of the operation increases inefficiencies associated with the potential capture of CO_2 from the exhaust stream.

Additionally, while the technology for the post-combustion capture of CO_2 may be available in some applications, the process has not been demonstrated for natural gas-fired water bath vaporizers. The EPA's

[6] NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units

RBLC database does not include any CCS GHG BACT determinations for natural gas-fired water bath vaporizers of any size. Recovery and purification of CO_2 from water bath vaporizer flue gas would require significant additional processing to achieve the necessary CO_2 concentration and purity for effective sequestration. The compression of CO_2 requires a large auxiliary power load, which is expected to result in the use of additional fuel (and associated additional CO_2 emissions) to generate this needed electricity.[7]

As such, CCS is not considered technically or environmentally feasible for reducing GHG emissions from the natural gas-fired water bath vaporizers and is not considered further in this analysis.

1.3.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.3.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.3.5 Step 5. Select BACT

Based on the analysis presented above, Micron proposes the use of efficient design and combustion practices as BACT for natural gas-fired vaporizers. Micron will comply with the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 8,000 hours per year for all water bath vaporizers combined, with no more than four units operating at a time.

A BACT limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The water bath vaporizers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for GHG for natural gas-fired steam generating units.

[7] EPA. (2010, August). Report of the Interagency Task Force on Carbon Capture and Storage.

1.4 Diesel-Fired Emergency Generator Engines

The Proposed Air Permit Project will utilize diesel-fired emergency generator engines to ensure that critical life safety and process safety systems receive uninterrupted power during power outages. These units will not be designed to run manufacturing operations during major electrical outages and instead will allow equipment and processes to shut down gradually as necessary, protecting sensitive manufacturing operations, preventing unsafe conditions from forming in the fabs, reducing emissions of process gases directly to the atmosphere, and protecting employee safety.

1.4.1 Step 1. Identify All Control Technologies

The control methods bulleted below have been identified for reducing GHG emissions from the proposed diesel-fired emergency generators.

- Good design and combustion practices;
- Operating hour limitations; and
- CCS.

1.4.2 Step 2. Eliminate Technically Infeasible Options

CCS has been demonstrated in practice and is generally considered to be available for facilities emitting CO_2 in large amounts, and for facilities with high-purity CO_2 streams. Such facilities include fossil fuel-fired power plants, cement plants, ammonia production, ethanol production, and iron and steel manufacturing. In alignment with this, the EPA recently finalized the NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units which requires the implementation of CCS for certain existing and new EGUs.[8] The NSPS is applicable to fossil-fired EGUs that have heat input ratings above 250 MMBtu/hr and which serves a generators capable of generating greater than 25 MW of electricity.

The emergency generator engines operate infrequently to support the fabs to safely shutdown in the event of loss of power and reduce process gases vented to the atmosphere. The intermittent nature of the operation increases inefficiencies associated with the potential capture of CO_2 from the exhaust stream.

Additionally, while the technology for the post-combustion capture of CO_2 may be available in some applications, the process has not been demonstrated for diesel-fired emergency generator engines as proposed in the Proposed Air Permit Project. The EPA's RBLC database does not include any CCS GHG BACT determinations for emergency generator engines of any size. Recovery and purification of CO_2 from emergency engine flue gas would require significant additional processing to achieve the necessary CO_2 concentration and purity for effective sequestration. The compression of CO_2 requires a large auxiliary power load, which is expected to result in the use of additional fuel (and associated additional CO_2 emissions) to generate this needed electricity.[9]

[8] NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units

[9] EPA. (2010, August). Report of the Interagency Task Force on Carbon Capture and Storage.

As such, CCS is not considered technically or environmentally feasible for reducing GHG emissions from the diesel-fired emergency generator engines and is not considered further in this analysis.

1.4.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.4.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.4.5 Step 5. Select BACT

Based on the analysis presented above, Micron proposes the use of efficient design and combustion practices as BACT for diesel-fired emergency generator engines. Micron will comply with the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Minimizing engine's idle time at startup;
- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 100 hours per year for each engine.

1.5 Diesel-Fired Emergency Fire Pump Engine

The Proposed Air Permit Project will include one diesel-fired emergency fire pump engine to provide a reliable power source in the event of a fire occurring during a power outage when the electric fire pump would not be available.

1.5.1 Step 1. Identify All Control Technologies

The control methods bulleted below have been identified for reducing GHG emissions from the proposed diesel-fired emergency fire pumps.

- Good design and combustion practices;
- Operating hour limitations; and
- CCS.

1.5.2 Step 2. Eliminate Technically Infeasible Options

CCS has been demonstrated in practice and is generally considered to be available for facilities emitting CO_2 in large amounts, and for facilities with high-purity CO_2 streams. Such facilities include fossil fuel-fired power plants, cement plants, ammonia production, ethanol production, and iron and steel manufacturing. In alignment with this, the EPA recently finalized the NSPS for GHG Emissions from New, Modified, and Reconstructed Electric Utility Generating Units which requires the implementation of CCS for certain existing and new EGUs. The NSPS is applicable to fossil-fired EGUs that have heat input ratings above 250 MMBtu/hr and which serves a generators capable of generating greater than 25 MW of electricity.

The emergency fire pump engine will operate infrequently to provide reliable power in the event of a power outage. The intermittent nature of the operation increases inefficiencies associated with the potential capture of CO_2 from the exhaust stream.

Additionally, while the technology for the post-combustion capture of CO_2 may be available in some applications, the process has not been demonstrated for diesel-fired emergency fire pump engines as proposed in the Proposed Air Permit Project. The EPA's RBLC database does not include any CCS GHG BACT determinations for emergency fire pump engines of any size. Recovery and purification of CO_2 from emergency engine flue gas would require significant additional processing to achieve the necessary CO_2 concentration and purity for effective sequestration. The compression of CO_2 requires a large auxiliary power load, which is expected to result in the use of additional fuel (and associated additional CO_2 emissions) to generate this needed electricity.

As such, CCS is not considered technically or environmentally feasible for reducing GHG emissions from the diesel-fired emergency fire pump engines and is not considered further in this analysis.

1.5.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.5.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.5.5 Step 5. Select BACT

Based on the analysis presented above, Micron proposes the use of efficient design and combustion practices as BACT for diesel-fired emergency fire pump engines. Micron will comply with the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Minimizing engine's idle time at startup;
- Optimizing the air-fuel ratio;
- Maintaining proper insulation;

- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 500 hours per year.

1.6 Semiconductor Process Tools and PEECS

High-purity silicon wafers serve as the fundamental components for all semiconductor products that will be manufactured at the Proposed Air Permit Project, and wafers undergo numerous process steps in clean room environments to construct intricate semiconductor devices. During semiconductor fabrication and cleaning, several fluorinated process gases that are F-GHG are utilized. Fluorinated GHGs are used in semiconductor fabs because they are essential to the fabrication of modern semiconductors, provide uniquely effective process performance when etching, and are a reliable source of fluorine ion which is required for cleaning semiconductor process chambers. N_2O also is used as a process gas. Finally, a small amount of CO_2 and CH_4 are used as a process input material, but direct emissions of CO_2 and CH_4 from this use accounts for a minimal (<0.10% as 100-year CO_2e) impact on fab GHG emissions and not considered further in this evaluation.[10]

These high-purity gases are used in several different process steps:

- Dry etching and wafer cleaning process tools use plasma-generated fluorine ion with exposed wafer surface (e.g., dielectric, silicon, metals) or to remove residual material from wafer surfaces.
- Process chambers that are used for depositing thin films are cleaned periodically using fluorine ion that is generated in a chamber separate from the tool and then transferred into the tool to achieve the cleaning process. Hence, this is referred to as ”remote cleaning.”
- Additional process chambers are cleaned periodically using fluorine ions that are generated in the same process chamber. These processes are ”in-situ cleaning,” or “thermal cleaning.”
- The thin film process tools and diffusion process tools use N_2O primarily for deposition.

Tool-level thermal oxidation systems that utilize natural gas are used to oxidize F-GHGs exhausted from the manufacturing processes. Due to natural gas combustion within these thermal oxidation systems, GHGs products of combustion are generated. Thin films PEECs are part are considered to be a part of the emission source and have therefore been considered as a part of the BACT analysis. POU control devices are not considered to be a part of the emission source, but rather are classified as control devices and are therefore excluded from this analysis.

1.6.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing GHG emissions from the proposed semiconductor process tools and thermal oxidation systems:

- Good design and combustion practices for thermal oxidation systems;

[10] Refer to Appendix F of the permit application, Table 6-1 for CO_2 and CH_4 usage and Table 1-1 for total GHG emissions on a 100-year CO_2e basis.

- Centralized RCS;
- Process chemical substitution;
- Process optimization;
- Use of tool-level thermal oxidation systems;
- Process chemical substitution through use of NF_3 remote plasma cleaning; and
- CCS.

1.6.2 Step 2. Eliminate Technically Infeasible Options

In some cases, the control technologies listed in Step 1 are infeasible for use for the Proposed Air Permit Project. These instances have been discussed further in the following sections.

1.6.2.1 Infeasibility of Process Chemical Substitution

Process chemical substitution in semiconductor manufacturing requires careful consideration of the gases' performance, safety implications, and overall reduction potential in GHG emissions. The CVD chamber cleaning process has been identified as an opportunity for chemical substitution. For CVD chamber clean processes, NF_3 remote chamber cleaning has been demonstrated in practice to emit significantly less overall CO_2e emissions due to the process' high utilization and conversion rate as described in Section 1.1.4.

However, replacement of high-GWP gases with gases that present lower or no GWP in process tools that have direct contact with the wafers has not proven feasible due to the complexity of the wafer fabrication process, including in plasma etch process tools from which F-GHGs are emitted. Processing requirements for high-aspect ratio plasma etching continue to become more stringent, requiring both fluorine ion to etch and the right carbon-to-fluorine ratio to ensure successful etching results. While a significant amount of research has been conducted on alternative etchants and other raw materials, the chemicals that have been tested have not been found to be viable by Micron in the manufacturing environment due to excess polymerization, lack of etch selectivity, difficulties in delivering gases to the process chamber, and potentially increased employee exposure and safety risks. Therefore, process chemical substitution beyond what has already been demonstrated in practice on a commercial scale is considered technically infeasible.

1.6.2.2 Use of RCS With Metal Etch Process Tools

Metal etch tools, a subset of plasma etch tools that etch metal substrates, can generate metal oxide particulate matter in ductwork. The presence of metal oxide particulate in the exhaust would result in the fouling of the catalytic oxidation portion of an RCS unit. For this reason, the use of a centralized RCS is considered technically infeasible for the control of F-GHG from metal etch tools.

1.6.2.3 Plasma-Based Oxidation

GHG emissions are generated from combustion that occurs within thin films PEECs. Micron continues to explore alternatives to combustion-based thermal oxidation systems (i.e., "burn/wet" devices) to reduce the GHG emissions that are created through combustion. One potential alternative to a combustion-based thermal oxidation system is an electrically-powered "plasma/wet" oxidation system. Instead of using natural gas combustion to oxidize materials in the process exhaust, plasma/wet oxidation systems create a plasma environment in which materials can dissociate.

Micron is evaluating installing plasma-wet PEECs; however, the plasma technology is less proven for use in conjunction with the thin films tools exhausting to PEECs than it is with the plasma etch tools routing to POUs. One of the main compounds generated in thin films tools that PEECs are intended to manage is F_2. In a burn-wet style oxidation system, F_2 is efficiently converted into hydrogen fluoride (HF) in the burner, which is then removed in the second stage of the system. Fluorine gas itself is not effectively dissolved into water, so it must be managed in the burner in order to be removed from the exhaust to prevent safety issues. In a plasma-wet PEEC, there is a lack of free hydrogen ions in the plasma environment as compared to the combustion zone of a burn-wet PEEC. Therefore, F_2 is not as easily converted to HF, and can linger in the exhaust at the outlet of the system and be emitted.

For this reason, plasma-wet style PEECs are not considered a feasible alternative to burn-wet style PEECs at this time for the Proposed Air Permit Project.

1.6.2.4 Carbon Capture and Storage Technology

As discussed in Section 1.1.9, CCS has been demonstrated in practice and is generally considered to be available for facilities emitting CO_2 in large amounts, and for facilities with high-purity CO_2 streams. Such facilities include fossil fuel-fired power plants, cement plants, ammonia production, ethanol production, and iron and steel manufacturing. While CO_2 is emitted from the semiconductor process tools and PEECs, the majority of GHG emissions on a CO_2e-basis are from N_2O, CF_4, and NF_3. CO_2 is expected to make up less than 2% of the CO_2e emissions emitted from the semiconductor process tools and PEECs. This is significantly lower than the CO_2 exhaust concentration expected from sources currently utilizing CCS. The membranes used in the CCS technology are very sensitive to chemicals and could potentially be fouled when used for these combustion exhausts.

Recovery and purification of CO_2 from the exhaust gas would require significant additional processing to achieve the necessary CO_2 concentration and purity for effective sequestration. The compression of CO_2 requires a large auxiliary power load, which is expected to result in the use of additional fuel (and associated additional CO_2 emissions) to generate this needed electricity.[11]

As such, CCS is not considered technically or environmentally feasible for reducing GHG emissions from semiconductor process tools and PPECs and is not considered further in this analysis.

1.6.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all technically feasible identified control technologies to meet BACT control technology requirements. As a result, ranking the remaining control technologies is unnecessary.

1.6.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 5, Micron is proposing to use all identified control technologies to achieve BACT

[11] EPA. (2010, August). Report of the Interagency Task Force on Carbon Capture and Storage.

control technology requirements. BACT-level control efficiency for one type of process tool (plasma etch) is achieved using the same control technology and implementing specific work practices. As a result, evaluating the most effective controls is unnecessary.

1.6.5 Step 5. Select BACT

The remaining technically feasible technologies include:

- Good design and combustion practices for tool-level thermal oxidation systems;
- Manufacturing process optimization;
- Use of tool-level thermal oxidation systems;
- Use of catalytic oxidation through a centralized RCS for the non-metal plasma etch process tools; and
- Process chemical substitution through use of NF_3 remote plasma cleaning.

1.6.5.1 Plasma Etch and Thin Films Process Tools

In the RBLC search results and other semiconductor permits reviewed as part of this BACT analysis, it was observed that GHG control requirements for semiconductor manufacturing processes commonly indicated that thermal oxidation-based devices have been utilized as a control technology to achieve BACT. As such, GHG BACT for metal etch and thin films process tools has currently been determined to be tool-level thermal oxidation systems that are used to oxidize GHG compounds. For non-metal plasma etch tools, GHG BACT has been determined to be the use of catalytic oxidation via centralized RCS.

In addition, one permit was identified in the RBLC search (RBLC ID WI-0287 and permit ID 18-JJW-036) in Attachment 1 to this GHG BACT analysis that indicated 75% control of GHG was achieved for plasma etch processes. In their 2019 Refinement to the 2006 the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (the "2019 Refinement"),[12] the IPPC established default emission factors and default destruction and removal efficiencies (DREs) for multiple process tools. The DREs that apply to the plasma etch process are listed in Table 6.17 of the 2019 Refinement. As illustrated on Appendix F to the Proposed Air Permit Project application, Table 4-1, plasma etch processes will emit compounds listed on IPCC's 2019 Refinement Table 6.17, including CF_4, CH_3F, C_2F_6 and other F-GHGs. As demonstrated in Table 6.16 of the 2019 Refinement, combustion is a suitable means to achieve the default DREs.[13] Table 6.17 of the same report illustrates that the default DREs for all GHG compounds listed and emitted from the process exceeds 75%. Methane is emitted from the plasma etch process but is not listed on Table 6.17. However, it is assumed that methane in the process tool exhaust will be combusted at an efficiency higher than 75% in a properly operating POU control device. Therefore, BACT for plasma etch processes is designated as following the work practice standards established by the IPPC in the 2019 Refinement. Following these work practices will confirm that the IPCC's 2019 Refinement Table 6.17 default DREs for emissions of GHG from plasma etch process tools will be met.

[12] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6 – Electronics Industry Emissions.

[13] As described in Section 1.5.2.2 of this GHG BACT analysis, Micron may elect to employ centralized RCS system(s) to control GHG if the technology is demonstrated in practice in the future. The RCS technology would be considered "New Technology" in the context of Table 6.16 and, as such, the RCS would also be able to demonstrate compliance with the proposed BACT work practice standards if the conditions of Table 6.16 were met by Micron's vendors.

To demonstrate that the default DREs apply to a specific process, the 2019 Refinement articulates work practice standards that a facility must meet to confirm that the default DREs are met for POU control devices and the centralized RCS.

Micron is proposing the following work practice standards for POU control devices and the centralized RCS to demonstrate compliance with the default DREs for the plasma etch process:

- Obtain POU control device and RCS supplier DRE certification that states each can at a minimum meet default DREs or higher.
- Maintain a site maintenance plan that meets the POU control device and RCS supplier's installation, operation, and maintenance requirements.
- Track uptime of POU control devices and RCS when fab processes are running. DRE is assumed 0% (unless demonstrated otherwise) when these devices/systems are not running per site maintenance plan while process is running.
- Certify annually that each POU control device and RCS claiming default DRE followed the site maintenance plan.

In summary, Micron is proposing GHG BACT as the following for plasma etch and thin films process tools:

- Use of tool-level thermal oxidation systems that are used to oxidize F-GHGs.
- In addition, achieving BACT-level GHG destruction and removal efficiency for plasma etch will be achieved by meeting work practice standards listed above that align with 2019 IPPC work practice standards to meet the default DREs listed in the 2019 Refinement Table 6.17.

Micron will optimize the operation of semiconductor fab equipment and processes to utilize the GHG raw materials as efficiently as possible. This may include optimizing tool operating cycles and efficient utilization of process chemicals.

For cleaning CVD chambers between production cycles, NF_3 will replace the use of carbon-based F-GHGs except in limited cases where in-situ or thermal cleaning are technically required.

1.6.5.2 Thin Films PEECs

Given the diverse processes and complexity of semiconductor manufacturing, Micron is proposing to comply with good combustion and maintenance practices as a work practice standard to achieve BACT for GHG generated through combustion of natural gas used to mitigate emissions from semiconductor process operations in lieu of a formal limit. Micron will comply with the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

1.7 Use of Heat Transfer Fluids

Fluorinated HTFs refer primarily to F-GHG-containing materials that are used to regulate the temperature of semiconductor process tools and are a necessary component of safe and effective manufacturing in the industry. HTFs serve as coolants in chillers, removing excess heat during manufacturing processes. Through all these processes, HTFs may emit the F-GHGs used fugitively inside the fab through leaking components in the transfer lines and equipment.

Note that these chillers use engineered HTFs, which transfer energy efficiently without undergoing a refrigerant phase change cycle, which distinguishes these HTFs from refrigerants regulated by 40 CFR 82.

The following sections address the BACT analysis for the proposed HTFs to be used at the Proposed Air Permit Project.

1.7.1 Step 1. Identify All Control Technologies

Good operating and maintenance practices have been identified as potential control technologies for reducing GHG emissions from the proposed HTFs. Good operation and maintenance practices for HTFs include regular evaluation of consumption records to confirm efficient usage, evaluation of transfer lines and equipment to identify areas of potential inefficient use, and maintenance and repair of those areas.

Chemical substitution to utilize HTFs that have a lower GWP is also a potential control technology. Micron is evaluating which alternative low-GWP HTFs are technically viable to meet the heat transfer needs of each desired application.

1.7.2 Step 2. Eliminate Technically Infeasible Options

The control technologies identified in Step 1 for the use of HTFs are technically feasible.

1.7.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered feasible and can be used in combination. As discussed in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, ranking the remaining control technologies is unnecessary, and the next step is to evaluate the most effective controls.

1.7.4 Step 4. Evaluate the Most Effective Controls and Document

All control technologies identified are considered feasible and can be used in combination. As discussed in Step 5, Micron is proposing to use all identified control technologies to achieve BACT. As a result, evaluating the most effective controls is unnecessary, and the next step is to select BACT.

1.7.5 Step 5. Select BACT

Micron is proposing BACT for the proposed HTFs to be the use of good design and maintenance practices and will continue to evaluate the opportunity to use the low-GWP HTFs that are technically viable to meet the heat transfer needs of each desired application and will use the alternative low-GWP HTFs identified

through this evaluation. Good operating and maintenance practices include regular evaluation of consumption records to confirm efficient usage, evaluation of transfer lines and equipment to identify areas of potential inefficient use, and maintenance and repair of those areas.

Due to the nature of the good operating and maintenance practices for the HTF distribution system, Micron is not proposing to meet an emission limit for operation of the systems that utilize HTFs.

1.8 Circuit Breakers

Micron plans to install circuit breakers rated at 38 kV and 420 kV at the Proposed Air Permit Project. SF_6 is the primary insulating medium used in electric switchgear; however, SF_6 is a GHG and as such a BACT analysis for the proposed circuit breakers has been completed. Note that Micron also intends to use air-insulated circuit breakers rated at 15kV and below which has been excluded from the BACT analysis.

1.8.1 Step 1. Identify All Control Technologies

The control methods bulleted below have been identified for reducing GHG emissions from the proposed circuit breakers.

- Use of a different medium in circuit breakers;
- Use of manufacturer-guaranteed low leak rate circuit breakers; and
- Leak detection systems (with alarms).

1.8.2 Step 2. Eliminate Technically Infeasible Options

For 38 kV circuit breakers, while alternative insulating mediums, including mixtures of air and CO_2, are available, there are significant operational safety, reliability, and maintenance constraints associated with their use. These circuit breakers have potential arc flash risk during operations and maintenance and testing activities, as well as fire and smoke risks when exposed to atmospheric conditions. These air insulated units are also subject to environmental factors such as dust, humidity, and liquid leaks and therefore, would require frequent shutdown maintenance and would not meet reliability requirement for the operations of the Proposed Air Permit Project. For these reasons, circuit breakers utilizing alternative insulating mediums are considered technically infeasible.

There are significant technical barriers in high-voltage applications, including the proposed 420 kV circuit breakers. When compared to SF_6, alternatives such as synthetic air provide limited dielectric strength, resulting in the need for a 25% larger equipment footprint and also possess maintenance risks as discussed above for the 38kV units. While C4 and C5 provide similar performance and equipment footprint as traditional SF_6 gas, they may be categorized as per-and polyfluoroalkyl substances (PFAS), depending on the definition used. Regulations restricting the use of intentionally-added PFAS have recently been proposed at the state and federal level, and further regulation is possible. Micron is also evaluating ways to minimize uses of PFAS. For these reasons, circuit breakers utilizing alternative insulating mediums are considered technically and environmentally infeasible.

In addition, non-SF_6 gas insulated switchgears are not available yet in the US market. Micron is working closely with Original Equipment Manufacturers to perform feasibility studies as soon as one becomes available.

The NYSDEC adopted 6 NYCRR Part 495, Sulfur Hexafluoride Standards and Reporting, in December 2024, which includes a program to phasedown the use of SF_6 in gas insulated equipment used by the electricity sector, an emissions limit for gas insulated equipment owners, limitations on the use of SF_6, and reporting requirements for certain users and suppliers of SF_6 and other fluorinated greenhouse gases. Part 495 proposes a periodic phase out plan for SF_6 gas insulated equipment starting January 1, 2028, for equipment rated equal to 38kV and continuing through January 1, 2033, for equipment rated above 245kV. The delayed phase out of high voltage equipment aligns with the conclusion that at the time of this Permit Application 2, alternative insulating mediums are not technically feasible. Micron will continue to evaluate SF_6 alternatives available in the future and will comply with the applicable phase out requirements.

1.8.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to evaluate the most effective controls.

1.8.4 Step 4. Evaluate the Most Effective Controls and Document

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, evaluating the most effective controls is unnecessary and the next step is to select BACT.

1.8.5 Step 5. Select BACT

Based on the analysis presented above, for the circuit breakers rated at 38 kV and 420 kV, Micron proposes the use of manufacturer-guaranteed circuit breakers with SF_6 leak rates less than 0.5% and the use of leak detection systems (with alarms).

Attachment 1
RACT/BACT/LAER Clearinghouse Search Results

Attachment 2
Semiconductor Permit Review Summary

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas Combustion Equipment
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/09/2015	PACKAGE BOILER	13.310	Carbon Dioxide Equivalent (CO2e)	Not Specified	34,189	T/YR
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/09/2015	2 CALP LINE BOILERS	13.310	Carbon Dioxide Equivalent (CO2e)	Not Specified	34,189	T/YR
AR-0159	BIG RIVER STEEL LLC	AR	2305-AOP-R4	04/05/2019	BOILER, PICKLE LINE	13.310	Nitrous Oxide (N2O)	GOOD OPERATING PRACTICES MINIMUM BOILER EFFICIENCY 75%	0.0002	LB/MMBTU
AR-0159	BIG RIVER STEEL LLC	AR	2305-AOP-R4	04/05/2019	BOILER, ANNEALING PICKLE LINE	13.310	Nitrous Oxide (N2O)	GOOD OPERATING PRACTICES MINIMUM BOILER EFFICIENCY 75%	0.0002	LB/MMBTU
AR-0159	BIG RIVER STEEL LLC	AR	2305-AOP-R4	04/05/2019	BOILERS SN-26 AND SN-27, GALVANIZING LINE	13.310	Nitrous Oxide (N2O)	GOOD OPERATING PRACTICES MINIMUM BOILER EFFICIENCY 75%	0.0002	LB/MMBTU
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-233 Galvanizing Line Boilers	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion practices	121	LB/MMBTU
IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	01/11/2024	Auxiliary Boiler (AB-3)	13.310	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices	117	LB/MMBTU
KS-0029	THE EMPIRE DISTRICT ELECTRIC COMPANY	KS	C-12987	07/14/2015	Auxiliary boiler	13.310	Carbon Dioxide Equivalent (CO2e)	Not Specified	9,521.5	TONS PER YEAR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Pickle Line #2 Boiler #1 & #2 (EP 21-04 & EP 21-05)	13.310	Carbon Dioxide Equivalent (CO2e)	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan and implement various design and operational efficiency requirements.	12,675	TONS/YR
MI-0420	DTE GAS COMPANY--MILFORD COMPRESSOR STATION	MI	185-15	06/03/2016	FGAUXBOILERS	13.310	Carbon Dioxide Equivalent (CO2e)	Use of pipeline quality natural gas and energy efficiency measures.	6,155	T/YR

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas Combustion Equipment
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
MI-0426	DTE GAS COMPANY - MILFORD COMPRESSOR STATION	MI	185-15A	03/24/2017	FGAUXBOILERS (6 auxiliary boilers EUAUXBOIL2A, EUAUXBOIL3A, EUAUXBOIL2B, EUAUXBOIL3B, EUAUXBOIL2C, EUAUXBOIL3C)	13.310	Carbon Dioxide Equivalent (CO2e)	Use of pipeline quality natural gas and energy efficiency measures.	7,324	T/YR
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Auxiliary Boiler (B001)	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion controls/natural gas combustion	4,008	T/YR
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Auxiliary Boiler (B001)	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion controls/natural gas combustion	4,456	T/YR
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Auxiliary Boiler (B001)	13.310	Carbon Dioxide Equivalent (CO2e)	use of natural gas, good combustion controls	4,502	T/YR
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Auxiliary Boiler (B001)	13.310	Carbon Dioxide Equivalent (CO2e)	Natural gas as the sole fuel	7,845	T/YR
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Auxiliary Boiler (B001)	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion practices and pipeline quality natural gas	2,817.6	T/YR
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	02/06/2019	Startup boiler (B001)	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion practices and the use of natural gas	1,784	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.310	Carbon Dioxide	Good combustion practices and the use of natural gas	106,048	T/YR

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas Combustion Equipment
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
OR-0050	TROUTDALE ENERGY CENTER, LLC	OR	26-0235	03/05/2014	Auxiliary boiler	13.310	Carbon Dioxide Equivalent (CO2e)	Clean fuels	117	LB CO2/MMBTU
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Auxiliary Boiler	13.310	Carbon Dioxide Equivalent (CO2e)	Not Specified	44,107	TON
TX-0772	PORT OF BEAUMONT PETROLEUM TRANSLOAD TERMINAL (PBPTT)	TX	118901, GHGPSDTX108 AND PSDTX1	11/06/2015	Commercial/Institutional-Size Boilers/Furnaces	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion practice to ensure complete combustion.	6,850	T/YR
WI-0266	GREEN BAY PACKAGING, INC. - SHIPPING CONTAINER DIVISION	WI	18-DMM-077	09/06/2018	Natural gas-fired boiler (Boiler B01)	13.310	Carbon Dioxide Equivalent (CO2e)	Good combustion practices, use only natural gas, equip with Low NOx burners and flue gas recirculation	160	LBCO2E/1000 LB STEAM
WI-0303	GREEN BAY PACKAGING INC.- GB MILL DIV.	WI	20-DMM-055	07/14/2020	Natural Gas-Fired Boiler (B01)	13.310	Carbon Dioxide Equivalent (CO2e)	Only burn natural gas, good combustion practices, low NOx burner, and flue gas recirculation.	16,771	T/Y
WI-0306	WPL- RIVERSIDE ENERGY CENTER	WI	19-POY-212	02/28/2020	Temporary Boiler (B98A)	13.310	Carbon Dioxide Equivalent (CO2e)	Combust only pipeline quality natural gas.	118	LB CO2/MMBTU
WV-0031	MOCKINGBIRD HILL COMPRESSOR STATION	WV	R14-0033	06/14/2018	WH-1 - Boiler	13.310	Carbon Dioxide Equivalent (CO2e)	Limited to natural gas; and tune-up the boiler once every five years.	--	--
WY-0075	CHEYENNE PRAIRIE GENERATING STATION	WY	MD-16173	07/16/2014	Auxiliary Boiler	13.310	Carbon Dioxide Equivalent (CO2e)	good combustion practices and energy efficiency	12,855	TONS

Process IDs: 12.31, 13.31, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas Combustion Equipment
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input <50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	5/4/2018	Pickle Line Equipment (pickle line no. 3 boilers)	19.600	Carbon Dioxide Equivalent (CO2e)	Use of natural gas and efficient combustion technology through good combustion practices	15,965	TPY

Process IDs: ---
Other Search Criteria: Process Name Contains "Vaporizer"
Process Description: Natural Gas Combustion Equipment
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Air Separation Plant Water Vaporizer	81.290	Carbon Dioxide Equivalent (CO2e)	Good operating practices	117	LB/MMBTU
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 13-01 - Water Bath Vaporizer	19.900	Carbon Dioxide Equivalent (CO2e)	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan and implement design standards.	11,404	TON/YR
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Water Bath Vaporizer (2 indirect burners) (EP 23-01)	19.600	Carbon Dioxide Equivalent (CO2e)	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan and implement various design and operational efficiency requirements.	15,032	TONS/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.310	Carbon Dioxide	Good combustion practices and the use of natural gas	28,200	T/YR
WV-0034	WEST VIRGINIA STEEL MILL	WV	R14-0039	05/05/2022	Water Bath Vaporizer	81.290	Carbon Dioxide Equivalent (CO2e)	PNG Good Combustion Practices	1,288	LB/HR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
AK-0082	POINT THOMSON PRODUCTION FACILITY	AK	AQ1201CPT03	01/23/2015	Emergency Camp Generators	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	2,332	TONS/YEAR
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Black Start and Emergency Internal Combustion Engines	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices	2,781	TPY
AR-0163	BIG RIVER STEEL LLC	AR	2305-AOP-R6	06/09/2019	Emergency Engines	17.110	Carbon Dioxide	Good Combustion Practices	163	LB/MMBTU
AR-0163	BIG RIVER STEEL LLC	AR	2305-AOP-R6	06/09/2019	Emergency Engines	17.110	Methane	Good Combustion Practices	0.0061	LB/MMBTU
AR-0163	BIG RIVER STEEL LLC	AR	2305-AOP-R6	06/09/2019	Emergency Engines	17.110	Nitrous Oxide (N2O)	Good Combustion Practices	0.0013	LB/MMBTU
AR-0177	NUCOR STEEL ARKANSAS	AR	1139-AOP-R27	11/21/2022	SN-230 Galvanizing Line No, 2 Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	163	LB/MMBTU
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Generators	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices	164	LB/MMBTU
IL-0114	CRONUS CHEMICALS, LLC	IL	13060007	09/05/2014	Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Tier IV standards for non-road engines at 40 CFR 1039.102, Table 7.	432	TPY
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Emergency Engine	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	225	TONS/YEAR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Emergency Engines	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	508	TONS/YEAR
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Emergency Generator Engine	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	160	TONS/YEAR
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.110	Carbon Dioxide	GOOD COMBUSTION PRACTICES	526.39	G/BHP-H
IN-0180	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.110	Carbon Dioxide	GOOD COMBUSTION PRACTICES	526.39	G/B-HP-H
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	03/23/2017	EMERGENCY GENERATORS (EU014A AND EU-014B)	17.110	Carbon Dioxide	GOOD COMBUSTION PRACTICES	1,044	TON/12 CONSEC. MONTH
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Emergency generator EU-6006	17.110	Carbon Dioxide Equivalent (CO2e)	Tier II diesel engine	811	TONS
IN-0324	MIDWEST FERTILIZER COMPANY LLC	IN	129-44510-00059	05/06/2022	emergency generator EU 014a	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	1,044	TON/YR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
IN-0359	NUCOR STEEL	IN	107-45480-00038	03/30/2023	Emergency Generator (CC-GEN1)	17.110	Carbon Dioxide Equivalent (CO2e)	Good engineering design and manufacturer's recommended operating and maintenance procedures.	163.6	LB/MMBTU
IN-0365	MAPLE CREEK ENERGY LLC	IN	T153-45909-00056	06/19/2023	Emergency generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	625	TONS PER YEAR
IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	01/11/2024	Emergency Generator (400 kW)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices	180	TONS
IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	01/11/2024	Emergency Generator (1000 kW)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices	389	TONS
IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	01/11/2024	Emergency Generator (2000 kW)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices	778	TONS
IN-0371	WABASH VALLEY RESOURCES, LLC	IN	167-45208-00091	01/11/2024	Ammonia Plant Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices	219	TONS
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-02 - North Water System Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-03 - South Water System Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-07 - Air Separation Plant Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-01 - Caster Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	05/23/2014	Emergency Diesel Generators (EQT 629, 639, 838, 966, 1264)	17.110	Carbon Dioxide Equivalent (CO2e)	Comply with 40 CFR 60 Subpart IIII; operate the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	56	TPY
LA-0292	HOLBROOK COMPRESSOR STATION	LA	PSD-LA-769(M-1)	01/22/2016	Emergency Generators No. 1; No. 2	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	77	TPY
LA-0296	LAKE CHARLES CHEMICAL COMPLEX LDPE UNIT	LA	PSD-LA-779	05/23/2014	Emergency Diesel Generators (EQTs 622, 671, 773, 850, 994, 995, 996, 1033, 1077, 1105, 1202)	17.110	Carbon Dioxide Equivalent (CO2e)	Compliance with 40 CFR 60 Subpart IIII; operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage.	56	TPY

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
LA-0305	LAKE CHARLES METHANOL FACILITY	LA	PSD-LA-803(M1)	06/30/2016	Diesel Engines (Emergency)	17.110	Carbon Dioxide Equivalent (CO2e)	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Emergency Generator Engines	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	--	--
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	DEG1-13 - Diesel Fired Emergency Generator Engine (EQT0012)	17.110	Carbon Dioxide Equivalent (CO2e)	Compliance with NSPS Subpart IIII	84	TPY
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Generator 1	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices	--	--
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 1	17.110	Carbon Dioxide Equivalent (CO2e)	Proper design and operation; energy efficiency measures	--	--
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 2	17.110	Carbon Dioxide Equivalent (CO2e)	Proper design and operation; energy efficiency measures	--	--
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	emergency generator engines (6 units)	17.110	Carbon Dioxide Equivalent (CO2e)	good combustion practices	--	--

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
LA-0317	METHANEX - GEISMAR METHANOL PLANT	LA	PSD-LA-761(M4)	12/22/2016	Emergency Generator Engines (4 units)	17.110	Carbon Dioxide Equivalent (CO2e)	complying with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	--	--
LA-0331	CALCASIEU PASS LNG PROJECT	LA	PDS-LA-805	09/21/2018	Large Emergency Engines (>50kW)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion of Practices and Good Operation and Maintenance Practices	1,481	T/YR
LA-0364	FG LA COMPLEX	LA	PSD-LA-812	01/06/2020	Emergency Generator Diesel Engines	17.110	Carbon Dioxide Equivalent (CO2e)	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	--	--
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Generator Engine	17.110	Carbon Dioxide Equivalent (CO2e)	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and the use of ultra-low sulfur diesel fuel.	74.21	KG/MM BTU
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	06-22 - AO-5 Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Use of good combustion practices and compliance with NSPS Subpart IIII	--	--
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	53-22 - PAO Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Use of good combustion practices, compliance with NSPS Subpart IIII	--	--
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Emergency Engine/Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	162.85	LB/MMBTU

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
MI-0421	GRAYLING PARTICLEBOARD	MI	59-16	08/26/2016	Emergency Diesel Generator Engine (EUEMRGRICE in FGRICE)	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion and design practices.	223	T/YR
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUEMENGINE (Diesel fuel emergency engine)	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices	928	T/YR
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	05/09/2017	EUEMRGRICE1 in FGRICE (Emergency diesel generator engine)	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion and design practices.	209	T/YR
MI-0425	GRAYLING PARTICLEBOARD	MI	59-16A	05/09/2017	EUEMRGRICE2 in FGRICE (Emergency Diesel Generator Engine)	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion and design practices.	70	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices.	383	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices.	383	T/YR
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUEMENGINE: Emergency engine	17.110	Carbon Dioxide Equivalent (CO2e)	Energy efficient design.	161	T/YR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD1--A 1500 HP diesel fueled emergency engine	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices and energy efficiency measures.	406	T/YR
MI-0441	LBWL--ERICKSON STATION	MI	74-18	12/21/2018	EUEMGD2--A 6000 HP diesel fuel fired emergency engine	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices and energy efficiency measures.	1,590	T/YR
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGEMENGINE	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	444	T/YR
MI-0447	LBWL--ERICKSON STATION	MI	74-18A	01/07/2021	EUEMGD--emergency engine	17.110	Carbon Dioxide Equivalent (CO2e)	low carbon fuel (pipeline quality natural gas), good combustion practices, and energy efficiency measures.	590	T/YR
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE1 in FGRICE)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion and Design Practices	590	T/YR
MI-0448	GRAYLING PARTICLEBOARD	MI	59-16E	12/18/2020	Emergency diesel generator engine (EUEMRGRICE2 in FGRICE)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion and Design Practices	209	T/YR
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUEMENGINE (North Plant): Emergency engine	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices	383	T/YR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUEMENGINE (South Plant): Emergency engine	17.110	Carbon Dioxide Equivalent (CO2e)	Good combustion practices	383	T/YR
MI-0454	LBWL-ERICKSON STATION	MI	74-18D	12/20/2022	EUEMGD	17.110	Carbon Dioxide Equivalent (CO2e)	low carbon fuel (pipeline quality natural gas), good combustion practices, and energy efficiency measures.	590	T/YR
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency generator (P002)	17.110	Carbon Dioxide Equivalent (CO2e)	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	474	T/YR
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency generator (P003)	17.110	Carbon Dioxide Equivalent (CO2e)	Efficient design	683	T/YR
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency generator (P003)	17.110	Carbon Dioxide Equivalent (CO2e)	Efficient design	858	T/YR
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Generator (P009)	17.110	Carbon Dioxide Equivalent (CO2e)	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	1,289	T/YR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency generator (P003)	17.110	Carbon Dioxide Equivalent (CO2e)	Efficient design	445	T/YR
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency generator (P003)	17.110	Carbon Dioxide Equivalent (CO2e)	state of the art combustion design	445	T/YR
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Generators (2 identical, P004 and P005)	17.110	Carbon Dioxide Equivalent (CO2e)	good operating practices (proper maintenance and operation)	120	T/YR
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Emergency Diesel Generator Engine (P001)	17.110	Carbon Dioxide Equivalent (CO2e)	Efficient design	116.8	T/YR
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Emergency Diesel Fire Pump Engine (P002)	17.110	Carbon Dioxide Equivalent (CO2e)	Efficient design	40.1	T/YR
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fired generator (P007)	17.110	Carbon Dioxide Equivalent (CO2e)	Equipment design and maintenance requirements	163.6	LB/MMBTU
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Diesel Generator (P003)	17.110	Carbon Dioxide Equivalent (CO2e)	Efficient design and proper maintenance and operation	109.2	T/YR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Emergency Diesel-fired Generator Engine (P007)	17.110	Carbon Dioxide Equivalent (CO2e)	good operating practices (proper maintenance and operation)	200	T/YR
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	1,000 kW Emergency Generators (P008 - P010)	17.110	Carbon Dioxide Equivalent (CO2e)	good operating practices (proper maintenance and operation)	80	T/YR
OH-0379	PETMIN USA INCORPORATED	OH	P0125024	02/06/2019	Emergency Generators (P005 and P006)	17.110	Carbon Dioxide Equivalent (CO2e)	Tier IV engine Good combustion practices	3,632	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	5,051 bhp (3,768 kWm) Diesel-Fired Emergency Generators: P001 through P046	17.110	Carbon Dioxide	Good combustion practices and proper maintenance and operation	162.7	LB/MMBTU
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	2000 kW Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	81	TONS
PA-0311	MOXIE FREEDOM GENERATION PLANT	PA	40-00129A	09/01/2015	Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	44	TPY
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	183	T/YR
TX-0766	GOLDEN PASS LNG EXPORT TERMINAL	TX	116055, PSDTX1386, GHGPSDTX100	09/11/2015	Emergency Engine Generators	17.110	Carbon Dioxide Equivalent (CO2e)	Equipment specifications & work practices - Good combustion practices and limited operational hours	40	HR/YR

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
TX-0872	CONDENSATE SPLITTER FACILITY	TX	118270 PSDTX1398M1 GHGPSDTX62	10/31/2019	Emergency Generators	17.110	Carbon Dioxide Equivalent (CO2e)	Limiting duration and frequency of generator use to 100 hr/yr. Good combustion practices will be used to reduce VOC including maintaining proper air-to-fuel ratio.	--	--
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	166032 PSDTX1598 GHGPSDTX210	03/13/2023	EMERGENCY GENERATOR	17.110	Carbon Dioxide Equivalent (CO2e)	GOOD COMBUSTION PRACTICES, LIMITED TO 100 HR/YR	--	--
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED EMERGENCY GENERATOR 3000 kW (1)	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices/Maintenance	163.6	LB/MMBTU
VA-0333	NORFOLK NAVAL SHIPYARD	VA	60326-36	12/09/2020	One (1) emergency engine generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	2.543	LB
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	04/24/2018	Diesel-Fired Emergency Generators	17.110	Carbon Dioxide Equivalent (CO2e)	The Use of Ultra-Low Sulfur Fuel and Good Combustion Practices	--	--
WI-0286	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-022	04/24/2018	P42 -Diesel Fired Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Good Combustion Practices and The Use of Ultra-low Sulfur Fuel	--	--
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Generator (P07)	17.110	Carbon Dioxide Equivalent (CO2e)	Certified to at least meet EPA's criteria for Tier 2 reciprocating internal combustion engines and the 40 CFR 60, Subpart IIII emission limitations, operation limited to 500 hours/year, and operate and maintain generator according to the manufacturer's recommendations.	--	--

Process IDs: 17.11
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Emergency Generator	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	2,416	LB/H
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	03/17/2021	Emergency Engines	17.210	Carbon Dioxide	Good Combustion Practices	163	LB/MMBTU
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	03/17/2021	Emergency Engines	17.210	Methane	Good Combustion Practices	0.0061	LB/MMBTU
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	03/17/2021	Emergency Engines	17.210	Nitrous Oxide (N2O)	Good Combustion Practices	0.0013	LB/MMBTU
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Engines	17.210	Carbon Dioxide Equivalent (CO2e)	Good Operating Practices	164	LB/MMBTU
LA-0292	HOLBROOK COMPRESSOR STATION	LA	PSD-LA-769(M-1)	01/22/2016	Emergency Generators No. 1 & No. 2	17.110	Carbon Dioxide Equivalent (CO2e)	Not Specified	77	TPY
LA-0364	FG LA COMPLEX	LA	PSD-LA-812	01/06/2020	Emergency Generator Diesel Engines	17.110	Carbon Dioxide Equivalent (CO2e)	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	--	--

Process IDs: 99.011, 99.006
Other Search Criteria: ---
Process Description: Semiconductor Manufacturing
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID and Process Name

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	Semiconductor Fabrication: P179 through P182	99.011	Carbon Dioxide Equivalent (CO2e)	Point-of-use (POU) devices that are specifically designed for fluorinated GHG and/or N_2O destruction, good combustion practices, and the use of natural gas	774,419	T/YR
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P12, P22, P18, P19, P28, P29 Organic Stripping Systems, Array/Color Filter and Cell Processes	99.006	Carbon Dioxide Equivalent (CO2e)	Regenerative Thermal Oxidizer	--	--
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P15 & P25 VOC System Array Process	99.006	Carbon Dioxide Equivalent (CO2e)	Regenerative Thermal Oxidizer	--	--
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P13 & P23 Chemical Vapor Deposition System Array Process	99.006	Carbon Dioxide Equivalent (CO2e)	Combustor, Baghouse and Wet Scrubber in series	--	--
WI-0287	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-036	4/24/2018	P14 & P24 Dry Etching System Array Process	99.006	Carbon Dioxide Equivalent (CO2e)	Combustor and Wet Scrubber in series	75	%

Process IDs: 99.999
Other Search Criteria: Process Name Contains "Circuit Breakers"
Process Description: Circuit Breakers
Date Range: 1/1/2014 - 12/5/2024
Date Conducted: 12/6/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Filtered Process Name for "Circuit Breakers"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
FL-0354	LAUDERDALE PLANT	FL	0110037-013-AC	08/25/2015	Circuit Breakers	99.999	Sulfur Hexafluoride	Limitation on leaks	0.5	% PER YEAR
FL-0355	FORT MYERS PLANT	FL	0710002-022-AC	09/10/2015	Circuit breakers	99.999	Sulfur Hexafluoride	Limitation on leak of SF6 from circuit breakers	0.5	PERCENT
FL-0356	OKEECHOBEE CLEAN ENERGY CENTER	FL	0930117-001-AC	03/09/2016	Circuit breakers	99.999	Sulfur Hexafluoride	Leak prevention. Must have manufacturer-guaranteed leak rate no more than 0.5% per year. Must be equipped with leakage detection systems and alarms.	--	--
FL-0363	DANIA BEACH ENERGY CENTER	FL	0110037-017-AC	12/04/2017	Circuit breakers (two)	99.999	Sulfur Hexafluoride	Certified leak rate < 0.5% per year	0.5	% LEAK PER YEAR
FL-0367	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-001-AC	07/27/2018	Two Circuit Breakers	99.999	Sulfur Hexafluoride	Certified leak rate < 0.5% per year	0.5	% LEAK PER YEAR
FL-0371	SHADY HILLS COMBINED CYCLE FACILITY	FL	1010524-003-AC (PSD-FL-444A)	06/07/2021	Two Circuit Breakers	99.999	Sulfur Hexafluoride	Certified leak rate < 0.5% per year	0.5	% LEAK PER YEAR
IA-0107	MARSHALLTOWN GENERATING STATION	IA	13-A-499-P	04/14/2014	circuit breakers	99.999	Sulfur Hexafluoride	Not Specified	0.5	PERCENT LOSS
IL-0129	CPV THREE RIVERS ENERGY CENTER	IL	16060032	07/30/2018	Circuit Breakers	99.999	Sulfur Hexafluoride	Not Specified	0.5	% LEAK RATE
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Circuit Breakers	99.999	Sulfur Hexafluoride	Not Specified	0.5	PERCENT LEAK RATE
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Circuit Breakers	99.999	Sulfur Hexafluoride	Not Specified	0.5	PERCENT LEAK RATE
IN-0294	ST. JOSEPH ENERGY CENTER, LLC	IN	141-39839-00579	08/08/2018	Circuit Breakers SF6	99.999	Sulfur Hexafluoride	Not Specified	--	--

Process IDs: 99.999
Other Search Criteria: Process Name Contains "Circuit Breakers"
Process Description: Circuit Breakers
Date Range: 1/1/2014 - 12/5/2024
Date Conducted: 12/6/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Filtered Process Name for "Circuit Breakers"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
KS-0029	THE EMPIRE DISTRICT ELECTRIC COMPANY	KS	C-12987	07/14/2015	Insulated circuit breaker	99.999	Carbon Dioxide Equivalent (CO2e)	Installation of modern, totally enclosed SF6 circuit breakers with density (leak detection) alarms and a guaranteed loss rate of < 0.5 % by weight per year.	6.9	TONS PER YEAR
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Circuit Breakers	99.999	Carbon Dioxide Equivalent (CO2e)	Enclosed pressure design with a low pressure detection system with an alarm to limit SF6 leak rate to 0.5 % per year.	85	T/YR
MD-0041	CPV ST. CHARLES	MD	PSC CASE NO. 9280	04/23/2014	CIRCUIT BREAKERS	99.999	Sulfur Hexafluoride	Not Specified	--	--
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	CIRCUIT BREAKERS	99.999	Sulfur Hexafluoride	INSTALLATION OF STATE-OF-THE-ART CIRCUIT BREAKERS THAT ARE DESIGNED TO MEET ANSI C37.013 OR EQUIVALENT TO DETECT AND MINIMIZE SF6 LEAKS	--	--
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	CIRCUIT BREAKERS	99.999	Carbon Dioxide Equivalent (CO2e)	GHG BACT FOR THE CIRCUIT BREAKERS SHALL BE INSTALLATION OF STATE-OF-THE-ART CIRCUIT BREAKERS THAT ARE DESIGNED TO MEET ANSI C37.013 OR EQUIVALENT TO DETECT AND MINIMIZE SF6 LEAKS	--	--
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	CIRCUIT BREAKERS	99.999	Sulfur Hexafluoride	Not Specified	--	--

Process IDs: 99.999
Other Search Criteria: Process Name Contains "Circuit Breakers"
Process Description: Circuit Breakers
Date Range: 1/1/2014 - 12/5/2024
Date Conducted: 12/6/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Filtered Process Name for "Circuit Breakers"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	CIRCUIT BREAKERS	99.999	Carbon Dioxide Equivalent (CO2e)	GHG BACT FOR THE CIRCUIT BREAKERS SHALL BE INSTALLATION OF STATE-OF-THE-ART CIRCUIT BREAKERS THAT ARE DESIGNED TO MEET ANSI C37.013 OR EQUIVALENT TO DETECT AND MINIMIZE SF6 LEAKS	--	--
MD-0046	KEYS ENERGY CENTER	MD	PSC CASE NO. 9297	10/31/2014	CIRCUIT BREAKERS	99.999	Sulfur Hexafluoride	Not Specified	--	--
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Circuit breakers with SF6	99.999	Sulfur Hexafluoride	low pressure alarms and low pressure lockout system	6	LB/12MO
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Circuit breakers with SF6	99.999	Carbon Dioxide Equivalent (CO2e)	Not Specified	79.8	TONS
PA-0310	CPV FAIRVIEW ENERGY CENTER	PA	11-00536A	09/02/2016	Circuit breakers	99.999	Sulfur Hexafluoride	State-of-the-art sealed enclosed-pressure circuit breakers with leak detection	1500	PPM
TX-0749	GOLDEN SPREAD ELECTRIC COOPERATIVE, ANTELOPE STATION	TX	PSD-TX-1358-GHG	06/02/2014	Fugitive Emissions from SF6 Circuit Breakers	99.999	Carbon Dioxide Equivalent (CO2e)	Not Specified	--	--
TX-0753	GUADALUPE GENERATING STATION	TX	PSD-TX-1310-GHG	12/02/2014	Fugitive SF6 Circuit Breaker Emissions	99.999	Carbon Dioxide Equivalent (CO2e)	Not Specified	--	--
TX-0757	INDECK WHARTON ENERGY CENTER	TX	PSD-TX-1374-GHG	05/12/2014	Fugitive SF6 Circuit Breaker Emissions	99.999	Carbon Dioxide Equivalent (CO2e)	Not Specified	--	--
TX-0758	ECTOR COUNTY ENERGY CENTER	TX	GHGPSDTX1366	08/01/2014	Fugitive SF6 Circuit Breaker Emissions	99.999	Carbon Dioxide Equivalent (CO2e)	Not Specified	--	--

Process IDs: 99.999
Other Search Criteria: Process Name Contains "Circuit Breakers"
Process Description: Circuit Breakers
Date Range: 1/1/2014 - 12/5/2024
Date Conducted: 12/6/2024 - 12/09/2024
Notes & Filtering: Filtered for Process ID; Filtered Process Name for "Circuit Breakers"

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Pollutant	Control Technology Definition	Emission Limit	
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	CIRCUIT BREAKERS (3)	99.999	Carbon Dioxide Equivalent (CO2e)	Enclosed pressure type breaker and leak detector	19	T/YR
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	CIRCUIT BREAKERS (11)	99.999	Carbon Dioxide Equivalent (CO2e)	Enclosed pressure type breaker and leak detection	1032	T/YR
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Circuit Breakers - 6	99.999	Carbon Dioxide Equivalent (CO2e)	Enclosed-pressure design with low-pressure detection system (with alarm).	--	--
VA-0332	CHICKAHOMINY POWER LLC	VA	52610-1	06/24/2019	Circuit Breakers	99.999	Carbon Dioxide Equivalent (CO2e)	Enclosed-pressure design with low-pressure detection system (with alarm).	--	--
WI-0299	WPL- RIVERSIDE ENERGY CENTER	WI	19-POY-151	08/20/2020	Sulfur Hexafluoride Containing Circuit Breakers and Transformers (F90)	99.999	Sulfur Hexafluoride	Not Specified	0.5	% LEAK RATE, BY WGHT
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Low-Side Generator Enclosed Pressure SF6 Circuit Breakers (F03)	99.999	Carbon Dioxide Equivalent (CO2e)	Not Specified	0.5	% BY WEIGHT/YEAR
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	166032 PSDTX1598 GHGPSDTX210	3/13/2023	CIRCUIT BREAKER FUGITIVES	15.210	Carbon Dioxide Equivalent (CO2e)	State-of-the-art circuit breakers that are gas-tight and require minimal SF6 are used. An AVO monitoring program is used to detect circuit breaker leaks.	--	--

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0083	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT06	01/06/2015	Diesel Fired Well Pump	17.21	Limited Operation of 168 hr/yr.	37.2	TONS/YEAR
AK-0084	DONLIN GOLD PROJECT	AK	AQ0934CPT01	06/30/2017	Fire Pump Diesel Internal Combustion Engines	17.21	Good Combustion Practices	216	TPY (COMBINED)
AK-0085	GAS TREATMENT PLANT	AK	AQ1524CPT01	08/13/2020	Three (3) Firewater Pump Engines and two (2) Emergency Diesel Generators	17.21	Good combustion practices and limit operation to 500 hours per year per engine	163.6	LB/MMBTU
AK-0086	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT07	03/26/2021	Diesel Fired Well Pump	17.21	Good Combustion Practices and Limited Use	164	LB/MMBTU
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Water Pumps	17.21	Good Operating Practices	164	LB/MMBTU
AR-0180	HYBAR LLC	AR	2470-AOP-R0	04/28/2023	Emergency Water Pumps	17.21	Good combustion practices	164	LB/MMBTU
FL-0354	LAUDERDALE PLANT	FL	0110037-013-AC	08/25/2015	Emergency fire pump engine, 300 HP	17.21	Lowest-emitting available fuel	---	---
ID-0021	MAGNIDA	ID	P-2013.0030	04/21/2014	FIRE WATER PUMP ENGINE	17.21	Not Specified	22.6	LBS.

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
IL-0129	CPV THREE RIVERS ENERGY CENTER	IL	16060032	07/30/2018	Firewater Pump Engine	17.21	Not Specified	---	---
IL-0130	JACKSON ENERGY CENTER	IL	17040013	12/31/2018	Firewater Pump Engine	17.21	Not Specified	241	TONS/YEAR
IL-0133	LINCOLN LAND ENERGY CENTER	IL	18040008	07/29/2022	Fire Water Pump Engine	17.21	Not Specified	92	TONS/YEAR
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Firewater Pump Engine	17.21	Not Specified	25	TONS/YEAR
KS-0030	MID-KANSAS ELECTRIC COMPANY, LLC - RUBART STATION	KS	C-13309	03/31/2016	Compression ignition RICE emergency fire pump	17.21	Not Specified	2.6	G/HP-HR
LA-0301	LAKE CHARLES CHEMICAL COMPLEX ETHYLENE 2 UNIT	LA	PSD-LA-779	05/23/2014	Firewater Pump Nos. 1-3 (EQTs 997, 998, & 999)	17.21	Compliance with 40 CFR 60 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage	10	TPY
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Pump Engines DFP-16-1 (EQT036)	17.21	Good Combustion Practices	13	T/YR
LA-0306	TOPCHEM POLLOCK, LLC	LA	PSD-LA-815	12/20/2016	Pump Engine DFP-16-2 (EQT037)	17.21	Good Combustion Practices	13	T/YR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Firewater Pump Engines	17.21	Not Specified	---	---
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Firewater Pump 1	17.21	Good combustion practices	---	---
LA-0314	INDORAMA LAKE CHARLES FACILITY	LA	PSD-LA-813	08/03/2016	Diesel Firewater pump engines (6 units)	17.21	Not Specified	---	---
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	firewater pump engines (8 units)	17.21	good combustion practices	---	---
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39A	17.21	Good Combustion Practices	28	T/YR
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39B	17.21	Good Combustion Practices	28	T/YR
LA-0370	WASHINGTON PARISH ENERGY CENTER	LA	PSD-LA-829(M-1)	04/27/2020	Emergency Fire Pump Engine (EQT0021, ENG-1)	17.21	Good combustion practices in order to comply with 40 CFR 60 Subpart IIII	9	TPY
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Fired Water Pump Engine	17.21	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and the use of ultra-low sulfur diesel fuel.	74.21	KG/MM BTU
LA-0402	DESTREHAN OIL PROCESSING FACILITY	LA	PSD-LA-855	12/13/2023	HLK39 - Emergency Diesel Fire Pump Engine (EQT0094)	17.21	Good Combustion Practices	12	T/YR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MA-0039	SALEM HARBOR STATION REDEVELOPMENT	MA	NE-12-022	01/30/2014	Fire Pump Engine	17.21	Not Specified	162.85	LB/MMBTU
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices	13.58	T/YR
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices.	55.6	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (South Plant): Fire pump engine	17.21	Good combustion practices.	85.6	T/YR
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (North Plant): Fire pump engine	17.21	Good combustion practices.	85.6	T/YR
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUFPENGINE: Fire pump engine	17.21	Energy efficient design	86	T/YR
MI-0445	INDECK NILES, LLC	MI	75-16B	11/26/2019	EUFPENGINE (Emergency engine-diesel fire pump	17.21	Good combustion practices	13.58	T/YR
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUFPENGINE (North Plant): Fire Pump Engine	17.21	Good combustion practices	85.6	T/YR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUFPENGINE (South Plant): Fire pump engine	17.21	Good combustion practices.	85.6	T/YR
OH-0363	NTE OHIO, LLC	OH	P0116610	11/05/2014	Emergency Fire Pump Engine (P003)	17.21	Emergency operation only, < 500 hours/year each for maintenance checks and readiness testing designed to meet NSPS Subpart IIII	75	T/YR
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency fire pump engine (P004)	17.21	Efficient design	41	T/YR
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency fire pump engine (P004)	17.21	Efficient design	90	T/YR
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Fire Pump Diesel Engine (P008)	17.21	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	123	T/YR
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency fire pump engine (P004)	17.21	Efficient design	87	T/YR
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	87	T/YR
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Fire Pump (P006)	17.21	good operating practices (proper maintenance and operation)	29	T/YR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0376	IRONUNITS LLC - TOLEDO HBI	OH	P0123395	02/09/2018	Emergency diesel-fueled fire pump (P006)	17.21	Equipment design and maintenance requirements	163.6	LB/MMBTU
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Fire Pump (P004)	17.21	Efficient design and proper maintenance and operation	18.67	T/YR
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Firewater Pumps (P005 and P006)	17.21	good operating practices (proper maintenance and operation)	23	T/YR
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	275 hp (205 kW) Diesel-Fired Emergency Fire Pump Engine	17.21	Good combustion practices and proper maintenance and operation	162.7	LB/MMBTU
OK-0164	MIDWEST CITY AIR DEPOT	OK	2009-394-C(M-2)PSD	01/08/2015	Diesel-Fueled Fire Pump Engines	17.21	1. Good Combustion Practices. 2. Efficient Design.	44	TONS PER YEAR
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Fire pump engine	17.21	Not Specified	9	TON
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Fire Pump	17.21	Not Specified	91.3	T/YR
TX-0753	GUADALUPE GENERATING STATION	TX	PSD-TX-1310-GHG	12/02/2014	Fire Water Pump Engine	17.21	Not Specified	15.71	TPY CO2E

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0757	INDECK WHARTON ENERGY CENTER	TX	PSD-TX-1374-GHG	05/12/2014	Firewater Pump Engine	17.21	Not Specified	5.34	TPY CO2E
TX-0758	ECTOR COUNTY ENERGY CENTER	TX	GHGPSDTX1366	08/01/2014	Firewater Pump Engine	17.21	Not Specified	5	TPY CO2E
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED WATER PUMP 376 bph (1)	17.21	Good Combustion Practices/Maintenance	104	T/YR
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Emergency Fire Water Pump	17.21	good combustion practices and the use of ultra low sulfur diesel (S15 ULSD) fuel oil with a maximum sulfur content of 15 ppmw.	1040	T/YR
WI-0292	GREEN BAY PACKAGING INC. MILL DIVISION	WI	19-DMM-001	04/01/2019	P37 Diesel-Fired Emergency Fire Pump	17.21	Hours of Operation	200	HOURS
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Fire Pump (P06)	17.21	Be certified by manufacturer to EPA's criteria for Tier 3 reciprocating internal combustion engines and to the 40 CFR 60, Subpart IIII emission limitations, operation limited to 500 hours/year, and operate and maintain according to the manufacturer's recommendations.	---	---
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Fire Pump Engine	17.21	Not Specified	309	LB/H
WY-0076	ROCK SPRINGS FERTILIZER COMPLEX	WY	MD-14824	07/01/2014	Fire Water Pump Engine	17.21	limited to 500 hours of operation per year	58	T/YR

Summary of Semiconductor Manufacturing Permits

Source Type	Permit Emission Unit Description	Permittee	State	Permit ID	Issue Date	Pollutant	Control Technology	Permit Limit
Semiconductor Process Tool Emissions	Semiconductor Fab Tool Processes	Intel Corp	AZ	P0009315	1/11/2016	GHG	POU Abatement Devices	---
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	GHG	POU Abatement Devices	---
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	GHG	POU Abatement Devices	---
Semiconductor Process Tool Emissions	Semiconductor Fabrication	Intel Corp	OH	P0132323	9/20/2022	CO2e		774,419 tons per rolling, 12-month period
Semiconductor Process Tool Emissions	Wafer Fabrication in Building B323 and B323A Collapse Chip Connection (C4) Plating Operation in B320 R&D and Post-Fab Activities	OnSemi	NY	3-1328-00025/01029	11/28/2023	GHG	All sources of per fluorinated gases (F-gases) are equipped with point-of-use (POU) abatement.	--

APPENDIX M. VOC LAER ANALYSIS

This appendix presents the lowest achievable emission rate (LAER) determinations for the control of volatile organic compound (VOC) emissions from the emission sources at the Proposed Air Permit Project. Micron has reviewed the RACT/BACT/LAER Clearinghouse (RBLC), documentation from the Bay Area Air Quality Management District (BAAQMD), and relevant semiconductor fab permits to identify appropriate technologies and/or limits for emission source categories. Additional details of the full search are provided in Section 5.4 of the Micron Clay Air Permit Application. As the add-on control technologies and other control mechanisms are similar for many of the sources that Micron operates, types of control technologies identified are summarized in Section 1.1 of this appendix. Not all technologies are applicable to all emission sources, and as such, source-specific considerations for each source category are discussed in the subsequent sections.

Emission sources evaluated in this LAER analysis include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine;
- Semiconductor process tools and other process and support operations that emit VOC;
- Volatile organic liquid storage tanks; and
- Wastewater Treatment Processes.

At the time of the Permit Application 1, Micron had not undertaken detailed design of the Proposed Air Permit Project's wastewater treatment (WWTP). Based on the current WWTP design details for the Permit Application 2, the VOC LAER evaluation has been completed in Section 1.7 of this appendix.

Note that there are a small number of tanks planned for the Proposed Air Permit Project that contain trace amounts of VOC and/or will emit a very small amount of VOC. Generally, the liquids in these tanks have a very low vapor pressure and, thus, are significantly less volatile. Collectively, these tanks have a low impact on the site's overall VOC emissions (<15 pounds per year); therefore, these emission sources have not been included in this LAER analysis. Tanks that have been excluded from this LAER evaluation are included in Table 23-2 of Appendix F along with their vapor pressure and potential emissions.

1.1 Available Technology Summary

The technologies identified to mitigate VOC emissions are described in the following subsections.

1.1.1 Tier 4 Compliant Emergency Generator Engines

Engines meeting Tier 4 emission standards are designed with a focus on reducing emissions, including VOC, to meet stringent environmental and regulatory standards. These engines utilize various engineering and technological advancements to minimize VOC emissions while maintaining performance and efficiency.

1.1.2 Good Combustion and Maintenance Practices for Fuel-Fired Equipment

Good combustion and maintenance practices are essential for operating fuel-fired equipment efficiently and effectively while minimizing VOC emissions. For this source category, good combustion practices are generally considered to be implementing the manufacturer's recommendations which may include a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Minimizing emergency generator engine idle time at startup;
- Conducting operator training; and
- Conducting periodic maintenance.

1.1.3 Oxidation Catalyst, Catalytic Controls, or Catalytic Oxidation Systems

Catalytic oxidation (also known as catalytic controls or catalytic incineration) can be used to oxidize an oxidizable compound in an air stream, including VOC. As such, the use of catalytic oxidation is an effective method for reducing VOC emissions.[1]

1.1.4 VOC Capture and Control Systems

VOC capture and control systems are designed to control VOC emissions by intercepting and containing or treating air contaminants before they are released into the atmosphere. In these systems, the exhaust stream is directed to treatment units, such as adsorption beds or condensation systems, where VOCs are removed or recovered before clean air is released into the environment. Capture systems employ various types of technologies to effectively collect and contain VOC emissions, including different types of adsorption materials as well as systems with recovery or regeneration.

While there are several adsorption material options, zeolite or carbon-based adsorption systems are most often used. The choice between zeolite and activated carbon for capturing VOC emissions depends on various factors, including the specific characteristics of the VOCs, the process conditions, and the overall objectives of the emission control system. Zeolite rotary concentrators are particularly favored in the semiconductor industry due to their high adsorption capacity, energy efficiency, and ability to handle fluctuating VOC concentrations.

In the semiconductor industry, zeolite rotary concentrators are strategically placed on process vent streams that generate VOCs, and the concentrator's rotating wheel adsorbs VOCs from the air stream. Then, the zeolite rotor rotates into a desorption zone where the captured compounds are released in a lower flowrate, higher concentration stream and collected for further treatment or recovery. Increasing the concentration of VOC in the stream prior to treatment reduces the energy and quantity of fuel required for effective treatment. Zeolite-based adsorption systems coupled with a recuperative thermal oxidation system, referred to collectively as rotor-concentrator thermal oxidizers (RCTOs), are commonly used in the semiconductor industry to treat VOC.

[1] EPA Cost reports and Guidance for Air Pollution Regulations, Section 3 – VOC Controls, Chapter 2 - Incinerators and Oxidizers", U.S. Environmental Protection Agency, EPA-450/3-79-006.

1.1.5 Tool-Level Thermal Oxidation Systems

In thermal oxidation systems, VOC-laden process exhaust is heated to high temperatures, causing the air contaminants to combust and convert into carbon dioxide (CO_2) and water vapor. Point-of-use (POU) control devices mitigate emissions of certain process gases (e.g., fluorinated greenhouse gases [F-GHG]), some of which are also classified as VOCs.

Thin films process tools often include process equipment exhaust conditioners (PEECs) as required safety equipment to manage process gases that are pyrophoric, flammable, toxic, or incompatible with other process gases or the ductwork. Thin films PEECs may incidentally manage VOC emissions that are comingled with these hazardous materials.

1.1.6 Centralized Regenerative Catalytic Systems

The use of catalytic oxidation via centralized regenerative catalytic systems (RCS) may control emissions of F-GHGs, some of which are also classified as VOCs, by combining exhausts from several plasma etch process tools rather than operating tool-level thermal-based oxidation systems described in Section 1.1.5 of this analysis.

1.1.7 Process Chemical Substitution

Chemical substitution in semiconductor manufacturing involves using alternative chemicals with lower VOC emissions. For instance, selecting photoresists and developers with lower VOC content and opting for alternative cleaning solvents and etchants can significantly reduce the release of VOC-containing compounds.

1.1.8 Use of Ultra-Low-Sulfur Diesel for Emergency Generator Engines

The utilization of ultra-low-sulfur diesel (ULSD) in diesel-fired engines effectively controls VOC emissions through reduced sulfur-related VOCs and by promoting cleaner combustion and more efficient utilization of fuel.

1.1.9 Operating Limitations

Limiting the hours of operation for engines, water bath vaporizers, and boilers reduces VOC emissions by decreasing the overall time the equipment runs and consumes fuel.

1.1.10 Good Operating and Maintenance Practices for Storage Tanks

Good operating and maintenance practices for volatile organic liquid (VOL) storage tanks and waste organic tanks that contain or contact hazardous wastes reduce VOC emissions by ensuring proper tank sealing, regular inspections to detect and repair leaks promptly, and implementing preventive maintenance to minimize equipment failures and emissions.

1.1.11 Efficient Tank Design to Minimize VOC Emissions

For the purposes of VOL storage tanks, efficient design to reduce VOC emissions is typically based on the size of the storage tank. For tanks $\leq$20,000 gallons storage capacity, the RBLC search indicated that closed

tanks equipped with submerged fill pipes represent the best available control design technology. The RBLC results also included painting tanks a light color, which is understood to reduce solar insolation and therefore reduce the impacts of diurnal breathing of the tank (also referred to as standing losses).[2] This applies to tanks located outside and subject to solar insolation.

1.1.12 Waste Minimization and Efficient Design

Reducing the generation of the waste at the source reduces the VOC loading of the wastewater and thus lowers VOC emissions generated in the wastewater treatment process. Additionally, the use of a biological treatment unit results in the degradation of VOC in the wastewater and reduces VOCs.

1.1.13 Control Technologies Not Evaluated

Some control technologies have been omitted from the LAER evaluation due to various considerations. These control technologies, and the reasons for their omission, are summarized in Table 1-1.

Table 1-1. Summary of Control Technologies Not Evaluated

Emission Source Category	Technology	Reasoning
All Source Categories	Use of Alternate Fuels	The use of different fuel or raw material that would redefine the Proposed Air Permit Project are out of the scope of BACT and LAER evaluations. Where different fuel specifications within the fuel type (i.e., use of ULSD) are feasible for the project, they have been identified above in Section 1.1 and are evaluated in the sections following this table.
Natural Gas-Fired Combustion Devices	Low-NO_X Burners (LNB) / Ultra Low-NO_X Burners (ULNB)	LNBs and ULNBs are used to reduce NO_X emissions and are not used to reduce VOC emissions. In some cases, they may lead to an increase of VOC emissions due to reduced combustion efficiency; therefore, they are not evaluated further in this LAER analysis.[3]
	Flue Gas Recirculation (FGR)	FGR is used to reduce NO_X emissions and is not used to reduce VOC emissions. In some cases, it may lead to an increase of VOC emissions due to reduced combustion efficiency; therefore, it is not evaluated further in this LAER analysis.[4]
Diesel-Fired Emergency Generator Engines and Diesel-Fired Emergency Fire Pump Engine	Turbocharger	EPA documentation suggests that turbocharging does not impact VOC emissions for fuel-fired engines; therefore, this technology is not evaluated further.[5]

[2] AP-42 Vol. I, Chapter 7: Liquid Storage Tanks, Section 7.1.3.1 Routine Losses From Fixed Roof Tanks, June 2020.

[3] AP-42 Vol. I, Chapter 1.4: Natural Gas Combustion.

[4] Ibid.

[5] AP-42 Vol. I, Chapter 3.3: Gasoline And Diesel Industrial Engines.

Emission Source Category	Technology	Reasoning
Diesel-Fired Emergency Generator Engines and Diesel-Fired Emergency Fire Pump Engine	Intercooler/Aftercooler	EPA documentation suggests that intercoolers and aftercoolers do not impact VOC emissions for fuel-fired engines; therefore, this technology is not evaluated further.[6]
Semiconductor Process Tools, PEECs, and Cleaning Operations	Wet Scrubbers	The primary purpose of wet scrubbers is to control acid and alkaline gases, not VOC emissions. Further, use of wet scrubbing systems to specifically control VOC emissions from semiconductor process tools has not been demonstrated in practice in the semiconductor industry. For these reasons, this control technology is not evaluated further in this LAER evaluation.
	Catalytic Oxidation	The use of a catalytic oxidizer to control VOC emissions from semiconductor process tools and PEECs has not been demonstrated on a commercial scale. Further, catalytic oxidation poses significant catalyst poisoning and plugging problems. For example, PM generated through combustion of silicon-containing compounds, which can be oxidized to silicon dioxide in the preheater, would quickly foul the catalyst. Therefore, it is not discussed further here.
Volatile Organic Liquid Storage Tanks	Catalytic Oxidation	Based on the resources reviewed described in the introduction to this appendix, the use of a catalytic oxidizer to control VOC emissions from organic liquid storage tanks has not been demonstrated in practice on a commercial scale. Therefore, it is not discussed further here.
	Wet Scrubbers	In the semiconductor industry, exhaust gases from storage tanks may be routed to centralized wet scrubbers, depending on the composition of the material stored within the tank. The primary purpose of these centralized wet scrubbers is to control acid and alkaline gases, not VOC emissions. There have not been any use cases of VOC control using wet scrubbers on storage tanks in the semiconductor industry. For these reasons, this control technology is not evaluated further.
	Stage I Vapor Recovery	Stage I Vapor Recovery generally applies to filling gasoline storage vessels for motor vehicle fuel dispensing facilities. Since this does not relate to the semiconductor fab operations at the Proposed Air Permit Project, it is not evaluated further.[7]

[6] Ibid.
[7] TCEQ Guidance on Stage I Vapor Recovery.

Emission Source Category	Technology	Reasoning
Volatile Organic Liquid Storage Tanks	Flare	Flaring is a combustion control process in which gases are piped to a remote, usually elevated, location and burned in an open flame in the open air using a specially designed burner tip, auxiliary fuel, and steam or air to promote mixing for nearly complete destruction. It is commonly used in the petroleum and petrochemical industry[8] where vent streams are variable in VOC concentration and flow, and use of a flare to control VOC emissions from storage tanks has not been demonstrated in practice in the semiconductor industry; therefore, it is not discussed further here.
Wastewater Treatment Plant	Catalytic Oxidation	Based on the resources reviewed described in the introduction to this appendix, the use of a catalytic oxidizer to control VOC emissions from wastewater treatment plants has not been demonstrated in practice on a commercial scale. Therefore, it is not discussed further here.
	Combustion in Boiler and/or Process Heater	Organic vapors could be destructed through combustion in a boiler or process heater by either premixing the vapors with a gaseous fuel prior to combustion in the burner or by firing the organic vapor through a separate retrofit burner. The use of process gas as fuel would redefine the scope of the Proposed Air Permit Project and is therefore out of the scope of BACT and LAER evaluations. Further, while this technique has been demonstrated in practice for vent gases from chemical manufacturing, petroleum refining, and pulp and paper manufacturing process units, it has not been demonstrated in practice for the semiconductor industry based on the resources reviewed described in the introduction to this appendix.

[8] EPA Chapter 2: Incinerators and Oxidizers, November 2017.

Emission Source Category	Technology	Reasoning
Wastewater Treatment Plant	Flare	Flaring is a combustion control process in which gases are piped to a remote, usually elevated, location and burned in an open flame in the open air using a specially designed burner tip, auxiliary fuel, and steam or air to promote mixing for nearly complete destruction. It is commonly used in the petroleum and petrochemical industry.[9] The use of flares have not been demonstrated in practice in the semiconductor industry; therefore, it is not discussed further here.
	Steam Stripper and Condenser	Steam stripping involves the fractional distillation of wastewater to remove VOC. The steam heat comes in contact with wastewater and vaporizes VOCs, which are further condensed and separated. While the use of a steam stripper to control VOC emissions from wastewater treatment plants has been used for a few industries, it has not been demonstrated in the semiconductor industry due to differences in wastewater composition; therefore, it is not discussed further here.
	Air Stripper	Air stripping involves using vapor-liquid equilibrium to increase the transfer rate of VOC into the vapor phase. The demonstrated applications for the air stripper include the treatment of contaminated ground water, landfill leachate, and contaminated drinking water. However, the Proposed Air Permit project does not include treatment of such categories and therefore is not demonstrated to treat industrial wastewater (including from semiconductor industry) and is not discussed further here.

1.2 Natural Gas-Fired Boilers

Natural gas-fired boilers are heating systems used to generate hot water or steam for maintaining precise temperature control for various stages of production, ensuring the efficient operation of machinery. Micron is proposing to use efficient units that are specifically designed to meet the Proposed Air Permit Project's thermal requirements while minimizing energy consumption and emissions.

The LAER analysis for VOC emissions from natural gas-fired boilers is presented in this section.

[9] EPA Guidance "Control of Volatile Organic Compound Emissions from Industrial Wastewater". Accessed January 2025, https://www.epa.gov/sites/production/files/2020-09/documents/199404_voc_nrid_industrial_wastewateract.pdf

1.2.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing VOC emissions from the proposed natural gas-fired boilers:

- Good combustion and maintenance practices;
- Oxidation catalysts; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered LAER for natural gas-fired boilers. Proposed LAER emission limits are discussed further in Step 4.

1.2.2 Step 2. Eliminate Technically Infeasible Options

For oxidation catalysts to be effective, waste gases must be heated by auxiliary burners to approximately 600 to 800°F before entering the catalyst bed. The maximum design exhaust temperature of the catalyst is typically 1,000 – 1,250°F.[10] Since the typical exhaust temperature of natural gas-fired boilers is between 350 – 500°F, which is below the operating range for an oxidation catalyst, additional auxiliary fuel would be required to heat the stream to the required temperature, creating additional combustion emissions. Therefore, the use of an oxidation catalyst is not considered feasible.

1.2.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking remaining control technologies by control effectiveness is unnecessary and the next step is to select LAER.

1.2.4 Step 4. Select LAER

Micron intends to purchase natural gas-fired boilers designed to meet a VOC emission limit of 0.0017 lb/MMBtu as LAER. This is the lowest emission limitation identified in the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will also implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 6,000 hours per year for each boiler.

[10] EPA Air Pollution Control Technology Fact Sheet for Catalytic Incinerators (EPA-452/F-03-018).

Note that the emission limit identified is different than Permit Application 1 due the separation of "natural gas-fired combustion equipment" into boilers and water bath vaporizers.

A LAER limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The boilers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for VOC for natural gas-fired steam generating units.

1.3 Natural Gas-Fired Water Bath Vaporizers

This Permit Application 2 separates "natural gas-fired combustion equipment" into boilers and water bath vaporizers. Natural gas-fired water bath vaporizers are used in the semiconductor industry to provide a reliable and efficient source of high-purity nitrogen gas. These water bath vaporizers use natural gas to heat water that is used to vaporize liquified nitrogen used in semiconductor manufacturing.

The LAER analysis for VOC emissions from natural gas-fired water bath vaporizers is presented in this section.

1.3.1 Step 1. Identify All Control Technologies

The following control methods have been identified reducing VOC emissions from the proposed natural gas-fired water bath vaporizers:

- Good combustion and maintenance practices;
- Oxidation catalysts; and
- Operating hour limitations.

In addition to identifying specific control technologies, Micron has identified potentially relevant numerical emission limits that could be considered LAER for natural gas-fired water bath vaporizers. Proposed LAER emission limits are discussed further in Step 4.

1.3.2 Step 2. Eliminate Technically Infeasible Options

For oxidation catalysts to be effective, waste gases must be heated by auxiliary burners to approximately 600 to 800 °F before entering the catalyst bed. The maximum design exhaust temperature of the catalyst is typically 1,000 – 1,250 °F.[11] This is outside of the range of the proposed natural gas-fired water bath vaporizers, and, therefore, additional auxiliary fuel would be required to heat the stream to the required temperature, creating additional combustion emissions. Additionally, there are no instances of oxidation catalysts being used in practice to control CO emissions from water bath vaporizers of any size based on the RBLC search conducted. Therefore, the use of an oxidation catalyst is not considered feasible.

[11] EPA Air Pollution Control Technology Fact Sheet for Catalytic Incinerators (EPA-452/F-03-018).

1.3.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All remaining control technologies identified are considered technically feasible and can be used in combination. As a result, ranking the remaining control technologies by control effectiveness is unnecessary and the next step is to select LAER.

1.3.4 Step 4. Select LAER

Micron intends to purchase natural gas-fired water bath vaporizers designed to meet a VOC emission limit of 0.0054 lb/MMBtu as LAER. This is the lowest emission limitation identified in the RBLC search conducted. Refer to Attachments 1 through 3 of this Appendix for complete documentation of the search results. Micron will also implement the manufacturer's recommendations for good combustion and maintenance practices, including a combination of the following:

- Optimizing the air-fuel ratio;
- Maintaining proper insulation;
- Establishing proper combustion zone temperature control;
- Conducting operator training; and
- Conducting periodic maintenance.

In addition, Micron proposes an operating hours limit of 8,000 hours per year for all water bath vaporizers (combined) with no more than four units operating at a time.

Note that the emission limit identified is different than Permit Application 1 due to the separation of "natural gas-fired combustion equipment" into boilers and water bath vaporizers.

A LAER limit must not be higher than an applicable New Source Performance Standard (NSPS) emission limit. The water bath vaporizers will be affected facilities under 40 CFR Part 60 Subpart Dc (NSPS Subpart Dc), "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units." However, NSPS Subpart Dc does not include an emission limit for VOC for natural gas-fired steam generating units.

1.4 Diesel-Fired Emergency Generator Engines

The Proposed Air Permit Project will utilize diesel-fired emergency generator engines to ensure that critical life safety and process safety systems receive uninterrupted power during power outages. These units will not be designed to run manufacturing operations during major electrical outages and instead will allow equipment and processes to shut down gradually as necessary, protecting sensitive manufacturing operations, preventing unsafe conditions from forming in the fabs, reducing emissions of process gases directly to the atmosphere, and protecting employee safety.

1.4.1 Step 1. Identify All Control Technologies

Diesel-fired emergency generator engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet LAER. These standards are based on the engine's maximum power capacity and the year in which the engine was manufactured. Currently, the

EPA has implemented the Tier 4 Final emission standards for non-road diesel engines, which set stringent limits for newly-manufactured units.[12] EPA has also set limitations for stationary internal combustion engines under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." For engines with certain power capacity and manufacture year, NSPS Subpart IIII references the engine standards established for nonroad engines under 40 CFR 1039.

In addition, the following control methods have been identified for reducing VOC emissions from the proposed diesel-fired emergency generator engines:

- Good combustion and maintenance practices;
- Operating hour limitations; and
- Use of ULSD.

1.4.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for diesel-fired emergency generator engines are technically feasible.

1.4.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 4, Micron is proposing to use all identified control technologies to achieve LAER. As a result, ranking the remaining control technologies is unnecessary.

1.4.4 Step 4. Select LAER

The following control technologies are proposed to achieve LAER for diesel-fired emergency generator engines:

- Purchase of an engine compliant with Tier 4 emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and
  - Conducting periodic maintenance
- Operating hour limitations; and
- Use of ULSD.

A LAER limit must not be higher than an applicable NSPS emission limit. The diesel-fired generators will be affected facilities under 40 CFR Part 60 Subpart IIII (NSPS Subpart IIII), "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." NSPS Subpart IIII provides non-methane

[12] 40 CFR 1039.101

hydrocarbon (NMHC) emission standards for various engine power and displacement categories. However, these emission standards are less stringent than the diesel Tier 4 Final emission standards.

Therefore, Micron is proposing the Tier 4 Final emission standards outlined in Table 1-2 as the LAER VOC limits for diesel-fired emergency generator engines and will procure new engines for the Proposed Air Permit Project that meet these standards. Control technologies to achieve Tier 4 Final emission standards may vary depending on the engine manufacturer and may include the use of catalytic oxidation, where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency generator engines and proposes an operating hours limit of 100 hours per year for each engine.

Table 1-2. 40 CFR §1039.101
Tier 4 Final Exhaust Emission Standards After the 2014 Model Year, g/kW-hr (g/bhp-hr)

Maximum Engine Power	Application	NMHC Emission Standard	NO_X + NMHC Emission Standard
kW <19	All	---	7.5
19 ≤ kW <56	All	---	4.7
56 ≤ kW <130	All	0.19	---
130 ≤ kW ≤560	All	0.19	---
	Generator Sets	0.19 (0.14)	---
kW >560	All Except Generator Sets	0.19	---

1.5 Diesel-Fired Emergency Fire Pump Engine

The Proposed Air Permit Project will include one diesel-fired emergency fire pump engine to provide a reliable power source in the event of a fire occurring during a power outage when the electric fire pump would not be available.

1.5.1 Step 1. Identify All Control Technologies

Diesel-fired emergency fire pump engine technology and associated emission standard requirements are well known and are considered by many regulatory entities to meet BACT. These standards are based on the fire pump engine's maximum power capacity and the year in which the engine was manufactured. EPA has set limitations for stationary internal combustion engines, including fire pump engines, under NSPS Subpart IIII. The EPA has also implemented Tier emission standards (Tier 1 – Tier 4 Final) for non-road diesel engines, which set stringent limits for newly manufactured units. Based on the RBLC search conducted, as well as input from Micron's equipment vendors, Tier 4 compliant fire pump engines are not available. As such, the most stringent emission standards are Tier 3, which align with NSPS IIII emission standards for the proposed fire pump engine for VOC.

In addition, the following control methods have been identified for reducing VOC emissions from the proposed diesel-fired emergency generator engines:

- Good combustion and maintenance practices;
- Operating hour limitations; and
- Use of ULSD.

1.5.2 Step 2. Eliminate Technically Infeasible Options

All of the control technologies identified in Step 1 for diesel-fired emergency generator engines are technically feasible.

1.5.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

All control technologies identified are considered technically feasible and can be used in combination. As discussed further in Step 4, Micron is proposing to use all identified control technologies to achieve LAER. As a result, ranking the remaining control technologies is unnecessary.

1.5.4 Step 4. Select LAER

The following control technologies are proposed to achieve LAER for diesel-fired emergency generator engines:

- Purchase of an engine compliant with emission standards;
- Good combustion and maintenance practices, including a combination of the following:
  - Minimizing engine idle time at startup;
  - Optimizing the air-fuel ratio;
  - Maintaining proper insulation;
  - Establishing proper combustion zone temperature control;
  - Conducting operator training; and
  - Conducting periodic maintenance
- Operating hour limitations; and
- Use of ULSD.

A LAER limit must not be higher than an applicable NSPS emission limit. The diesel-fired emergency fire pump engine will be an affected facility under NSPS Subpart IIII. NSPS Subpart IIII provides NMHC emission standards for various engine power and displacement categories. For the capacity of the proposed diesel-fired emergency fire pump engine, NSPS IIII emission standards align with Tier 3 emission standards.

Therefore, Micron is proposing compliance with the NSPS IIII and Tier 3 emission standard (which is inclusive of NO_X and NMHC) of 3.0 grams per brake horsepower-hour (g/bhp-hr) as LAER for the diesel-fired emergency fire pump engine. Control technologies to achieve the emission standard may vary depending on the engine manufacturer and may include the use of catalytic oxidation, where that technology is available and appropriate. In addition, Micron will fire only ULSD in the diesel-fired emergency fire pump engine and proposes an operating hours limit of 500 hours per year.

1.6 Semiconductor Process Tools, PEECs, and Cleaning Operations

Micron is proposing to install semiconductor process equipment, or "tools", as discussed within the Micron Clay Air Permit Application. VOC-containing materials are utilized in these semiconductor fab process tools and emitted through various operations, including VOC-containing solvents in photoresist operations, gases and liquid precursors in deposition processes, etching and stripping chemicals, cleaning solutions, solvents, measurement processes and more. Micron is also proposing to use isopropanol (IPA) for cleaning of tools,

workspaces, and other surfaces within the semiconductor fab. Methanol will also be used for a specific cleaning application as part of the photolithography process. Micron will also employ heat transfer fluids (HTFs) (some of which are VOCs) in closed loop process chillers to cool process equipment. As cleaning solvents and HTFs will be used throughout the fab, much of the VOC emissions generated from the IPA and HTF usage will originate in the cleanroom environment and be drawn through various cleanroom exhaust systems, including process and general exhaust. For that reason, cleaning is evaluated as part of the total VOC emissions in addition to those contributed by directly processing wafers in tools. Methanol used for cleaning as part of the photolithography process will exhaust to the solvent exhaust only and will be considered part of process tool emissions in this analysis.

Thin films PEECs generate VOC emissions through natural gas combustion and oxidation of process materials which are routed to process exhaust stacks.

Micron is also proposing to utilize a Spin On Dielectric (SOD) process which generates waste containing organic compounds. Micron will utilize a SOD waste collection and neutralization system to stabilize the waste to reduce its gas-producing potential before shipment to a Treatment, Storage, and Disposal Facility (TSDF).

The LAER analysis for VOC emissions from all the semiconductor processes mentioned above is presented in this section.

1.6.1 Step 1. Identify All Control Technologies

Upon review of the RBLC database, BAAQMD LAER guidance, and relevant semiconductor air permits, the following control methods have been identified for reducing VOC emissions from the proposed semiconductor manufacturing process tools and their associated emissions:[13]

- Good combustion and maintenance practices for thermal oxidation systems;
- Centralized RCS;
- VOC capture and control systems;
- Use of tool-level thermal oxidation systems; and
- Chemical substitution.

1.6.2 Step 2. Eliminate Technically Infeasible Options

VOC emissions control for semiconductor processes is complex. Some of the emissions control technologies identified are considered infeasible. These are discussed in the following sections.

1.6.2.1 VOC Capture and Control Systems

Capture systems without recovery/regeneration generate a considerable amount of waste and require frequent maintenance. Fixed-bed adsorbent-based systems without regeneration capacity have a finite

[13] As acknowledged in the introduction to the BAAQMD BACT guidance, BAAQMD's definition of BACT is more stringent than the federal definition of BACT and aligns more closely with the federal definition of LAER. As such, BAAQMD LAER is used in place of BAAQMD BACT throughout this analysis.

adsorption capacity, meaning they can only adsorb a certain mass of VOCs before becoming saturated. These systems require frequent replacement or disposal, leading to increased waste generation and operational costs. Further, these systems would rely on either process downtime or redundant systems to ensure continuous control of VOC emissions. For these reasons, fixed-bed capture systems with no regeneration are considered technically infeasible.

Capture systems with liquid recovery via refrigeration or condensation systems which condense VOC in a vent stream are only functional for high-concentration VOC streams, typically in excess of 5,000 parts per million by volume (ppmv).[14] Exhaust VOC concentrations resulting from the Proposed Air Permit Project are expected to be significantly less than 5,000 ppmv and therefore capture systems with liquid recovery are not considered a feasible control option.

Capture systems relying on adsorption can be used for high-volumetric air flow streams over a range of inlet concentrations.[15] Adsorption based control equipment with recovery/regeneration is considered to be feasible.

A summary of different types of capture systems along with a summary of their infeasibility is discussed further in Table 1-4.

Table 1-4. Examples of Adsorption Systems and Feasibility Determination

System Type	Feasibility	Infeasibility Discussion
Fixed-Bed Capture Systems (No Regeneration)	Infeasible	► Finite Adsorption Capacity ► Significant Waste Generation ► Frequent Maintenance
Capture Systems with Liquid Recovery via Condensation	Infeasible	► Low VOC Concentration in Vent Stream
Capture Systems Equipped with Adsorption and Recovery/Regeneration (RCTO)	Feasible	► N/A

1.6.2.2 Chemical Substitution

The VOC chemicals that are used in Micron's technologies are based on multiyear process development. Each chemical serves a very specific role in the process (e.g., cleaning residue, adding layers to

[14] EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001, Section 3.1, Chapter 2 Refrigerated Condensers, January 2017

[15] EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001, Section 3.1, Chapter 1 Carbon Adsorbers, October 2018

semiconductor wafers, etc.) and, in some cases, chemicals react to form other chemicals or control equipment forms VOC as byproducts. Micron is always evaluating the opportunity to optimize process chemical selection for its function and to minimize environmental effects, and the current plans for the proposed operations include use of chemicals that Micron has determined will minimize potential environmental effects and that can be used in fab operations. Micron has not identified any additional material substitutions at this time and thus has concluded that chemical substitution is not technically feasible for the Proposed Air Permit Project. However, Micron will continue to explore opportunities to utilize alternative processes and raw materials that result in lower VOC emissions.

1.6.2.3 Use of RCS With Metal Etch Process Tools

Metal etch tools, a subset of plasma etch tools that etch metal substrates, can generate metal oxide particulate matter in ductwork. The presence of metal oxide particulate in the exhaust would result in the fouling of the catalytic oxidation portion of an RCS unit. For this reason, the use of a centralized RCS is considered technically infeasible for the control of F-GHG from metal etch tools.

1.6.2.4 Exhaust Stream Incompatibilities

Some of the VOCs emitted from the process tools or created through combustion in thermal oxidation devices pose additional hazards, including toxicity, varying levels of acidity, and more. These air contaminants would have properties that would make it infeasible to combine certain exhaust streams. In addition, the process requires exhaust streams to be routed to control device(s) appropriate for the air contaminant to effectively control the primary air contaminants generated, such as wet scrubbers and process tool-specific control devices.

1.6.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

The use of all remaining control technologies is considered technically feasible. As discussed in more detail in Step 4, Micron is proposing to use a combination of all technically feasible control technologies to comply with the control efficiency limits identified as LAER. As a result, ranking the remaining control technologies is unnecessary.

1.6.4 Step 4. Select LAER

California's BAAQMD has adopted stringent limits for photolithography process tools, based on using highly-efficient controls that are appropriate for processes and emissions sources. The BAAQMD defines LAER for photolithography operations as described in the bullets below. Note that the term photoresist is used in the BAAQMD's LAER determination rather than photolithography; however, it is understood that these terms are intended to refer to the same process tools as photolithography utilizes photoresist material. [16]

- ≥98.5% destruction/recovery efficiency if inlet VOC ≥2,000 ppmv (as methane);
- ≥97% efficiency if inlet VOC ≥200 to <2,000 ppmv (as methane);
- ≥90% efficiency if inlet VOC <200 ppmv (as methane); or

[16] As acknowledged in the introduction to the BAAQMD BACT guidance, BAAQMD's definition of BACT is more stringent than the federal definition of BACT and aligns more closely with the federal definition of LAER. As such, BAAQMD LAER is used in place of BAAQMD BACT throughout this analysis.

- ≤10 ppmv (as methane) at outlet.

These BAAQMD LAER limits were found to be the most stringent emission limitations achieved in practice. These limits, or similar but less prescriptive limits, have been incorporated into the permits of semiconductor manufacturing facilities reviewed as part of this LAER evaluation. Micron is therefore proposing compliance with these limits as LAER for VOC.

The following control technologies have been determined to be feasible for semiconductor process tool and PEEC VOC emissions:

- Good combustion and maintenance practices for thermal oxidation systems;
- Adsorption-based VOC capture and control systems; and
- Use of tool-level thermal oxidation systems.

The semiconductor industry standard for emission control of exhaust streams from process operations where VOC is the primary contaminant is a zeolite-based rotor concentrator capture system coupled with a recuperative thermal oxidizer system (e.g., an RCTO). This provides better adsorption effectiveness for process-generated VOCs, the capacity to recuperate waste combustion heat in heat exchangers, and the operating temperature flexibility for the proposed processes. For process exhaust streams where the primary constituent to be controlled is VOC, Micron will utilize a zeolite-based adsorption system coupled with a recuperative thermal oxidation system.

VOC capture and control systems employing adsorbent material, such as carbon, without subsequent combustion, are a technically feasible option for VOC control. Per the EPA Air Pollution Control Cost Manual, carbon adsorption is suitable for relatively dilute exhaust streams, however, the Manual does not provide clarification on what is considered to be dilute. The Manual does indicate that "carbon adsorbers can achieve high VOC removal efficiencies of 95 to 99 percent at input VOC concentrations of between 500 and 2,000 ppm in air".[17] This aligns with LAER limits proposed above.

Cleaning operations are required throughout semiconductor fabs, including for process tools, workspaces, and other surfaces. Because some, but not all, of the operations in which cleaning is necessary are routed to emissions control devices, it is very difficult to estimate the capture efficiency for cleaning operations. As a result, it is assumed that the VOC emissions from cleaning will be emitted through all process stacks and general exhaust stacks, not specifically routed to a VOC control device. The resulting VOC concentration from cleaning will be less than 1 ppmv in stack discharges due to the high exhaust flow rates.

1.6.4.1 Achieving Compliance with LAER Limits

Given the significant variability in processes and emissions across the fab, Micron will use a combination of technologies and work practice standards to achieve specified destruction and removal efficiencies (DRE) and/or the concentration-based (10 ppmv as methane) emission limits. These limits will apply to all semiconductor process operations and fab general exhausts. Control technologies may include combustion-based oxidation devices, such as RCTOs. Work practices include the implementation of good combustion

[17] Ibid.

and maintenance practices for combustion-based control devices and management of VOC-generating operations to limit VOC emissions, and/or operation and maintenance practices. In certain cases, work practice standards to limit VOC emission generation may be used without VOC emission control equipment in place.

1.6.4.2 Compliance Demonstration for all Semiconductor Manufacturing Process Exhaust Stacks

Compliance will be demonstrated for each type of exhaust stream and associated air pollution control devices (i.e., Acid Scrubbers, Ammonia Scrubbers) by performance testing a representative number of exhaust stacks and control device(s). When planning a stack testing campaign, Micron will propose the representative number and location of control devices to be tested in a stack test protocol submitted to the NYSDEC. If more than one of the same type of control device is tested in a given testing campaign, the average result of the test results of similar exhaust stacks, or the applicable equation below (RCTO Calculation 1 or 2), will be calculated as the compliance measurement. Initial compliance demonstration will be completed within 180 days after the date of startup of the first phase of semiconductor process operations. Ongoing compliance demonstrations will be completed once every five years following the initial compliance demonstration.

1.6.4.2.1 Compliance Demonstration for Semiconductor Process Exhaust to RCTOs

Emissions from each RCTO will be vented through two (2) stacks, one (1) at the outlet of the thermal oxidizer (TO) that will contain the controlled emission stream and products of natural gas combustion, and one (1) for the rotor concentrators that will exhaust VOC emissions that were not collected by the zeolite. To demonstrate compliance with the LAER limits for RCTOs equipped with two stacks, Micron is proposing to use one or both of the following calculations to demonstrate compliance based on a mass and volumetric flow balance (calculation 1) and/or a mass balance (calculation 2).

RCTO Calculation 1: Concentration (ppmv) based compliance demonstration. The following calculation methodology will be used to demonstrate compliance using a flow averaging of VOC concentrations in the inlet duct and outlet stacks.

$$Combined\ ppmv\ = \frac{(TO\ ppmv\ \times\ TO\ scfm) + (Concentrator\ ppmv\ \times\ Concentrator\ scfm)}{(TO\ scfm + Concentrator\ scfm)}$$

Where:

- TO ppmv is the average concentration of total VOC in the TO exhaust stack measured over the course of the performance test by an appropriate EPA stack test method;
- TO scfm is the average volumetric flow rate of the TO exhaust stack measured over the course of the performance test as measured by EPA Methods 1 – 4;
- Concentrator ppmv is the average concentration of VOC in the stack that exhausts emissions from the rotor concentrator(s) measured over the course of the performance test by an appropriate EPA stack test method, and;

- Concentrator scfm is the average volumetric flow rate of the stack that exhausts emissions from the rotor concentrator(s) measured over the course of the performance test as measured by EPA Methods 1 – 4.

RCTO Calculation 2: Mass-based DRE compliance demonstration. The following calculating methodology will be used to demonstrate compliance by calculating a DRE on a mass basis using the two measured exhaust mass flow rates and the measured inlet mass flow rate.

$$\%\ DRE = \frac{(Duct\ Inlet\ Mass - (TO\ Outlet\ Mass + Concentrator\ Outlet\ Mass))}{Duct\ Inlet\ Mass} \times 100\%$$

Where:

- Duct inlet mass is the total mass of VOC determined to flow through the inlet duct to the control device during the performance test;
- TO outlet mass is the total mass of VOC determined to be emitted from the TO exhaust stack during the performance test; and
- Concentrator outlet mass is the total mass of VOC determined to be emitted from the stack that exhausts emissions from the rotor concentrator(s) during the performance test.

The total mass of VOC determinations made using Calculation 2 will be determined using EPA stack test methods that appropriate to measure the concentration VOC in the duct/stack, and the flow rate of the duct/stack as measured by EPA Methods 1 – 4.

For both Calculation 1 and Calculation 2 compliance demonstrations, Micron will submit test-specific EPA Methods to NYSDEC for approval prior to conducting compliance performance tests. Measurements are to be taken during a stack test that is no shorter than 60 minutes in duration.

1.7 Volatile Organic Liquid Storage

Micron is proposing to install fixed roof organic liquid storage tanks at the Proposed Air Permit Project. The bulk storage tanks will hold both raw materials that contain volatile organic liquids, such as IPA, tetramethyl ammonium hydroxide (TMAH), and propylene glycol methyl ether acetate (PGMEA), as well as waste organic liquids. VOC emissions from storage tanks primarily occur through evaporation and changes in temperature and pressure.

The following sections address the LAER analysis for the organic liquid storage tanks to be installed at the Proposed Air Permit Project.

1.7.1 Step 1. Identify All Control Technologies

The following control methods have been identified for reducing VOC emissions from the organic liquid storage tanks:

- Good operating and maintenance practices;
- Efficient equipment design to minimize VOC emissions;
- VOC capture and control systems; and
- Thermal oxidation systems.

1.7.2 Step 2. Eliminate Technically Infeasible Options

Some of the emissions control technologies identified are considered infeasible. These instances are discussed in the following section.

1.7.2.1 VOC Capture and Control Systems

The challenges in implementing certain VOC capture and control systems on VOL storage tanks are the same as those identified in Section 1.5.2.1. The summary of different types of capture systems along with a summary of their infeasibility is repeated below in Table 1-5.

Table 1-5. Examples of Adsorption Systems and Feasibility Determination

System Type	Feasibility	Infeasibility Discussion
Fixed-Bed Capture Systems (No Regeneration)	Infeasible	► Finite Adsorption Capacity ► Significant Waste Generation ► Frequent Maintenance
Capture Systems with Liquid Recovery via Condensation	Infeasible	► Low VOC Concentration in Vent Stream
Capture Systems Equipped with Adsorption and Recovery/Regeneration (RCTO)	Feasible	► N/A

1.7.3 Step 3. Rank Remaining Control Technologies by Control Effectiveness

The use of all remaining control technologies is considered feasible. As discussed in more detail in Step 4, Micron is proposing to use a combination of technically feasible control technologies to comply with the control efficiency limits identified as LAER. As a result, ranking the remaining control technologies is unnecessary.

1.7.4 Step 4. Select LAER

The BAAQMD LAER Guideline for fixed roof organic liquid storage tanks with capacities less than 20,000 gallons has indicated that vapor recovery systems with an overall system efficiency $\geq$ 95% control is LAER.[18] This represents the most stringent limitation identified as achieved in practice during this LAER evaluation

[18] BAAQMD Best Available Control Technology (BACT) Guideline, Section 4, Storage Tanks – Fixed Roof, Organic Liquids, <20,000 gal. Accessed March 2024, https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook

and as such, Micron is proposing to achieve ≥ 95% overall reduction of VOC emissions from storage tanks as LAER. The following control technologies have been determined to be feasible for organic liquid storage tanks:

- Good operating and maintenance practices;
- Efficient tank design to minimize VOC emissions;
- Adsorption-based VOC capture and control systems; and
- Thermal oxidation systems.

To achieve ≥95% overall reduction of VOC emissions, Micron is proposing to use good operating and maintenance practices and procure storage tanks that are efficiently designed to reduce the potential for VOC emissions. This includes VOL containing tanks that are:

- Equipped with a submerged fill system to reduce emissions that occur during filling activities; and
- Located indoors or painted a light color or white when located outside to reduce emissions that occur due to standing losses.

At the time of Permit Application 1, the detailed design for Fab 1 and Fab 2 were in the early stages of development and control decisions were not made at the time of its submittal. However, for this Permit Application 2, Micron proposes the following to control VOC emissions from the VOL tanks in the HPM and FAB buildings:

- Ammonia Scrubber to control TMAH emissions; and
- RCTOs for all the other tanks

Lastly, certain volatile organic liquid waste storage tanks are expected to contain hazardous waste. These tanks would be equipped with nitrogen blanketing, conservation vents, and adequately sized pressure relief valves, so there are expected to be no emissions except for during upset conditions. These practices would minimize emissions of hazardous wastes with organic concentrations of at least 10 percent from storage tanks and equipment. Therefore, Micron is proposing these practices to achieve the LAER.

1.8 Wastewater Treatment Plant

Micron is proposing to install a wastewater treatment plant as a part of the Proposed Air Permit Project to treat high fluoride wastewater, industrial wastewater, and hydrocarbon in wastewater generated from the semiconductor process tools. The primary constituents in the influent wastewater contributing to VOC emissions from the process will be IPA, 1,2,4-Triazole, and N-Methyl-2-Pyrrolidone and other organic compounds. The facility discharges a portion of the treated wastewater to the nearest waterbody using the outfalls located at the Proposed Air Permit Project and reuses some of the treated wastewater and stored in the reclaimed water tank.

The emissions profile for VOC emissions from wastewater treatment plants is specific to the influent wastewater constituents and varies greatly based on the industry. For this reason, non-semiconductor industries including petroleum refining (which includes benzene, phenols and oils) and organics

manufacturing like ethylene oxide and methanol were excluded from the RBLC search conducted for this LAER analysis.

In addition to the RBLC search, Micron reviewed the air permits for a representative selection of semiconductor fabs that manufacture 300-mm wafers within the United States as described in Section 5.4.4 of this Permit Application 2.

1.8.1 Step 1. Identify All Control Technologies

A review of the EPA's RBLC database did not identify any entries of facilities that utilize control technology to abate VOC emissions that are generated from wastewater treatment plants in the semiconductor industry.

Micron also reviewed relevant semiconductor air permits to evaluate if any control technologies are currently being utilized to abate VOC emissions from wastewater treatment plants. During the review of these permits, it was determined that no add-on control devices are currently installed to abate such VOC emissions.

Waste minimization and efficient design is the only method that has been identified for reducing VOC emissions from the wastewater treatment plant.

1.8.2 Step 2. Eliminate Technically Infeasible Options

The only control technology identified in Step 1 for wastewater treatment plants is technically feasible.

1.8.3 Step 3. Rank Remaining Control Technologies

Since the use of waste minimization and efficient design are the only identified control options, evaluating the most effective controls is unnecessary, and the next step is to select LAER.

1.8.4 Step 4. Select LAER

Given the diverse processes and complexity of semiconductor manufacturing, Micron is proposing to comply with a work practice standard to achieve LAER for VOC emitted from semiconductor process equipment in lieu of a formal limit. The proposed work practice standard includes the implementation of waste minimization and efficient design of the wastewater treatment plant, including the biodegradation of VOC in the wastewater stream through the use of a biological treatment unit.

Attachment 1
RACT/BACT/LAER Clearinghouse Search Results

Attachment 2
Bay Area Air Quality Management District Summary

Attachment 3
Semiconductor Permit Review Summary

Process IDs: 12.310, 13.310, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input ≤ 50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/09/2015	PACKAGE BOILER	13.31	GCP	0.006	LB/MMBTU
AL-0307	ALLOYS PLANT	AL	701-0007-X121-X126	10/09/2015	2 CALP LINE BOILERS	13.31	GCP	0.006	LB/MMBTU
AR-0159	BIG RIVER STEEL LLC	AR	2305-AOP-R4	04/05/2019	BOILER, PICKLE LINE	13.31	COMBUSTION OF NATURAL GAS AND GOOD COMBUSTION PRACTICE	0.0054	LB/MMBTU
AR-0159	BIG RIVER STEEL LLC	AR	2305-AOP-R4	04/05/2019	BOILER, ANNEALING PICKLE LINE	13.31	Combustion of Natural gas and Good Combustion Practice	0.0054	LB/MMBTU
AR-0159	BIG RIVER STEEL LLC	AR	2305-AOP-R4	04/05/2019	BOILERS SN-26 AND SN-27, GALVANIZING LINE	13.31	COMBUSTION OF NATURAL GAS AND GOOD COMBUSTION PRACTICE	0.0054	LB/MMBTU
AR-0171	NUCOR STEEL ARKANSAS	AR	1139-AOP-R24	02/14/2019	SN-233 Galvanizing Line Boilers	13.31	Good combustion practices	0.0055	LB/MMBTU
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-202, 203, 204 Pickle Line Boilers	13.31	Good Combustion Practice	0.0055	LB/MMBTU
AR-0172	NUCOR STEEL ARKANSAS	AR	1139-AOP-R26	09/01/2021	SN-202, 203, 204 Pickle Line Boilers	13.31	Good Combustion Practice	121	LB/MMBTU

Process IDs: 12.310, 13.310, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input ≤ 50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Pickle Line #2 Boiler #1 &#2 (EP 21-04 & EP 21-05)	13.31	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	5.5	LB/MMSCF
MD-0042	WILDCAT POINT GENERATION FACILITY	MD	CPCN CASE NO. 9327	04/08/2014	AUXILLARY BOILER	13.31	THE EXCLUSIVE USE OF PIPELINE QUALITY NATURAL GAS, LIMITED HOURS OF OPERATION, AND GOOD COMBUSTION PRACTICES	0.0033	LB/MMBTU
MD-0045	MATTAWOMAN ENERGY CENTER	MD	PSC CASE. NO. 9330	11/13/2015	AUXILIARY BOILER	13.31	EXCLUSIVE USE OF NATURAL GAS, AND GOOD COMBUSTION PRACTICES	0.003	LB/MMBTU
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Auxiliary Boiler (B001)	13.31	Good combustion controls	0.2	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Auxiliary Boiler (B001)	13.31	Good combustion controls	0.23	LB/H
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Auxiliary Boiler (B001)	13.31	Good combustion controls	0.23	LB/H

Process IDs: 12.310, 13.310, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input ≤ 50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Auxiliary Boiler (B001)	13.31	Good combustion controls	0.13	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Auxiliary Boiler (B001)	13.31	Good combustion practices	0.16	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	29.4 MMBtu/hr Natural Gas-Fired Boilers: B001 through B028	13.31	Good combustion practices and the use of natural gas	4.86	T/YR
OK-0164	MIDWEST CITY AIR DEPOT	OK	2009-394-C(M-2)PSD	01/08/2015	Heaters/Boilers	13.31	1. Use pipeline-quality natural gas. 2. Good Combustion Practices. 3. Tune-ups for applicable boilers/heaters per 40CFR63, Subpart DDDDD.	153716	TONS PER YEAR
OK-0164	MIDWEST CITY AIR DEPOT	OK	2009-394-C(M-2)PSD	01/08/2015	Heaters/Boilers	13.31	1. Use pipeline-quality natural gas. 2. Good Combustion Practices w/emission rate limit of 0.005 lb/MMBTU based on AP-42 (7/1998).	7.1	TONS PER YEAR
OK-0168	SEMINOLE GNRTNG STA	OK	2010-594-C(M-2)PSD	05/05/2015	NATURAL GAS-FIRED BOILER (100MMBTUH)	13.31	NO CONTROLS FEASIBLE;GOOD COMBUSTION PRACTICES	0.0075	LB/MMBTU

Process IDs: 12.310, 13.310, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input ≤ 50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OR-0050	TROUTDALE ENERGY CENTER, LLC	OR	26-0235	03/05/2014	Auxiliary boiler	13.31	Utilize Low-NOx burners and FGR.	0.005	LB/MMBTU
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	Auxiliary Boiler	13.31	Not Specified	0.005	LB/MMBTU
PA-0316	RENOVO ENERGY CENTER, LLC	PA	18-00033A	01/26/2018	Auxiliary Boiler	13.31	Not Specified	0.005	LB
SC-0192	CANFOR SOUTHERN PINE - CONWAY MILL	SC	1340-0029-CI	05/21/2019	Boiler No. 2	13.31	Work Practice Standards	0.0054	LB/MMBTU
SC-0193	MERCEDES BENZ VANS, LLC	SC	0560-0385-CA	04/15/2016	Energy Center Boilers	13.31	Annual tune ups per 40 CFR 63.7540(a)(10) are required.	5.5	LB/MMSCF
TX-0772	PORT OF BEAUMONT PETROLEUM TRANSLOAD TERMINAL (PBPTT)	TX	118901, GHGPSDTX108 AND PSDTX1	11/06/2015	Commercial/Institutional-Size Boilers/Furnaces	13.31	Good combustion practice to ensure complete combustion.	0.3	T/YR

Process IDs: 12.310, 13.310, 19.6
Other Search Criteria: Process Name Contains "Boilers"
Process Description: Natural Gas-fired Boilers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Process ID; Fuel type as "Natural Gas"; Heat Input ≤ 50 MMBtu/hr

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
TX-0813	ODESSA PETROCHEMICAL PLANT	TX	16963, PSDTX1478, GHGPSDTX148	11/22/2016	small Boiler	13.31	Best combustion practices	0.0005	MMBTU/HR
VA-0327	PERDUE GRAIN AND OILSEED, LLC	VA	60277	07/12/2017	(4) 27 MMBtu/hr boilers, Natural gas and No. 2 fuel oi	13.31	Not Specified	0.1	LB/HR
WI-0266	GREEN BAY PACKAGING, INC. - SHIPPING CONTAINER DIVISION	WI	18-DMM-077	09/06/2018	Natural gas-fired boiler (Boiler B01)	13.31	Good combustion practices, use only natural gas, equip boiler with Low NOx burners and flue gas recirculation	0.0055	LB/MMBTU
WI-0306	WPL- RIVERSIDE ENERGY CENTER	WI	19-POY-212	02/28/2020	Temporary Boiler (B98A)	13.31	Shall be operated for no more than 500 hours and combust only pipeline quality natural gas.	--	--
WY-0075	CHEYENNE PRAIRIE GENERATING STATION	WY	MD-16173	07/16/2014	Auxiliary Boiler	13.31	Good combustion practices	0.0017	LB/MMBTU
IN-0239	SUBARU OF INDIANA AUTOMOTIVE, INC.	IN	157-36379-00050	02/18/2016	BOILER	19.6	Not Specified	0.005	LB/MMBTU
SC-0183	NUCOR STEEL - BERKELEY	SC	0420-0060-DX	05/04/2018	Pickle Line Equipment (pickle line no. 3 boilers)	19.6	Good combustion practices	5.5	LB/MMSCF
TX-0885	METAL BEVERAGE CONTAINER OPERATIONS	TX	146824 AND N130M1	01/31/2020	Boiler 40 MMBtu/hr	19.6	GOOD COMBUSTION PRACTICES AND CLEAN FUEL	--	--

Process IDs: --
Other Search Criteria: Process Name Contains "Vaporizer"
Process Description: Natural Gas-fired Water Bath Vaporizers
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Fuel Type as "Natural Gas" or Equivalent

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 13-01 - Water Bath Vaporizer	19.9	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan	5.5	LB/MMSCF
KY-0115	NUCOR STEEL GALLATIN, LLC	KY	V-20-015	04/19/2021	Air Separation Unit Water Bath Vaporizer (2 indirect burners) (EP 23-01)	19.6	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan	5.5	LB/MMSCF
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	45.6 MMBtu/hr Natural Gas-Fired Nitrogen Vaporizers: B029 through B032	13.31	Good combustion practices and the use of natural gas	1.29	T/YR
WV-0034	WEST VIRGINIA STEEL MILL	WV	R14-0039	05/05/2022	Water Bath Vaporizer	81.29	Good Combustion Practices	0.06	LB/HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0082	POINT THOMSON PRODUCTION FACILITY	AK	AQ1201CPT03	01/23/2015	Emergency Camp Generators	17.11	Not Specified	0.0007	LB/HP-H
AR-0177	NUCOR STEEL ARKANSAS	AR	1139-AOP-R27	11/21/2022	SN-230 Galvanizing Line No, 2 Emergency Generator	17.11	Not Specified	0.8	G/KW-HR
FL-0347	ANADARKO PETROLEUM CORPORATION - EGOM	FL	OCS-EPA-R4015	09/16/2014	Emergency Diesel Engine	17.11	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	--	--
IL-0114	CRONUS CHEMICALS, LLC	IL	13060007	09/05/2014	Emergency Generator	17.11	Tier IV standards for non-road engines at 40 CFR 1039.102, Table 7.	0.4	G/KW-H
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Emergency Generator Engine	17.11	Not Specified	6.4	G/KW-HR
IN-0173	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	0.31	G/BHP-H
IN-0180	MIDWEST FERTILIZER CORPORATION	IN	129-33576-00059	06/04/2014	DIESEL FIRED EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES	0.31	G/B-HP-H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
IN-0263	MIDWEST FERTILIZER COMPANY LLC	IN	129-36943-00059	03/23/2017	EMERGENCY GENERATORS (EU014A AND EU-014B)	17.11	GOOD COMBUSTION PRACTICES	0.35	G/HP-H EACH
IN-0317	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Emergency generator EU-6006	17.11	Tier II diesel engine	6.4	G/KWH
IN-0324	MIDWEST FERTILIZER COMPANY LLC	IN	129-44510-00059	05/06/2022	emergency generator EU 014a	17.11	Not Specified	0.35	G/HP-HR
IN-0359	NUCOR STEEL	IN	107-45480-00038	03/30/2023	Emergency Generator (CC-GEN1)	17.11	Certified engine	0.32	G/HP-HR
KY-0109	FRITZ WINTER NORTH AMERICA, LP	KY	V-16-022 R1	10/24/2016	Emergency Generators #1, #2, & #3 (EU72, EU73 & EU74)	17.11	The permittee shall prepare and maintain for EU72, EU73, and EU74, within 90 days of startup, a good combustion and operation practices plan (GCOP) that defines, measures and verifies the use of operational and design practices determined as BACT for minimizing CO, VOC, PM, PM10, and PM2.5 emissions. Any revisions requested by the Division shall be made and the plan shall be maintained on site. The permittee shall operate according to the provisions of this plan at all times, including periods of startup, shutdown, and malfunction. The plan shall be incorporated into the plant standard operating procedures (SOP) and shall be made available for the Division's inspection. The plan shall include, but not be limited to: i. A list of combustion optimization practices and a means of verifying the practices have occurred. ii. A list of combustion and operation practices to be used to lower energy consumption and a means of verifying the practices have occurred. iii. A list of the design choices determined to be BACT and verification that designs were implemented in the final construction.	4.77	G/HP-HR (EU72 &EU73)

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-02 - North Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-03 - South Water System Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-07 - Air Separation Plant Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
KY-0110	NUCOR STEEL BRANDENBURG	KY	V-20-001	07/23/2020	EP 10-01 - Caster Emergency Generator	17.11	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	--	--
LA-0288	LAKE CHARLES CHEMICAL COMPLEX	LA	PSD-LA-778	05/23/2014	Emergency Diesel Generators (EQT 629, 639, 838, 966, & 1264)	17.11	Comply with 40 CFR 60 Subpart IIII; operate the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	0.85	LB/HR
LA-0292	HOLBROOK COMPRESSOR STATION	LA	PSD-LA-769(M-1)	01/22/2016	Emergency Generators No. 1 & No. 2	17.11	Good combustion practices consistent with the manufacturer's recommendations to maximize fuel efficiency and minimize emissions	0.83	LB/HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0296	LAKE CHARLES CHEMICAL COMPLEX LDPE UNIT	LA	PSD-LA-779	05/23/2014	Emergency Diesel Generators (EQTs 622, 671, 773, 850, 994, 995, 996, 1033, 1077, 1105, & 1202)	17.11	Compliance with 40 CFR 60 Subpart IIII; operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage.	0.85	LB/HR
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Emergency Generator Engines	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0312	ST. JAMES METHANOL PLANT	LA	PSD-LA-780(M-1)	06/30/2017	DEG1-13 - Diesel Fired Emergency Generator Engine (EQT0012)	17.11	Compliance with NSPS Subpart IIII	0.04	LB/HR
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Generator 1	17.11	Good combustion practices	27.34	LB/H
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 1	17.11	Compliance with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	3.86	LB/H
LA-0315	G2G PLANT	LA	PSD-LA-781	05/23/2014	Emergency Diesel Generator 2	17.11	Compliance with 40 CFR 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ	3.86	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	emergency generator engines (6 units)	17.11	Complying with 40 CFR 60 Subpart IIII	--	--
LA-0331	CALCASIEU PASS LNG PROJECT	LA	PDS-LA-805	09/21/2018	Large Emergency Engines (50kW)	17.11	Good combustion and operating practices.	0.79	G/KW-H
LA-0364	FG LA COMPLEX	LA	PSD-LA-812	01/06/2020	Emergency Generator Diesel Engines	17.11	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize combustion efficiency and minimize fuel usage.	--	--
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Generator Engine	17.11	Compliance with 40 CFR 60 Subpart IIII standards, good combustion practices, and the use of ultra-low sulfur diesel fuel.	4.8	G/HP-HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	06-22 - AO-5 Emergency Generator	17.11	Use of good combustion practices and compliance with NSPS Subpart IIII	0.11	LB/HR
LA-0394	GEISMAR PLANT	LA	PSD-LA-647(M-9)	12/12/2023	53-22 - PAO Emergency Generator	17.11	Use of good combustion practices, compliance with NSPS Subpart IIII	0.11	LB/HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	EGEN - Plant Emergency Generator	17.11	Compliance with 40 CFR 60 Subpart IIII	2.29	LB/HR
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	EMERGENCY GENERATOR	17.11	USE ONLY ULSD, GOOD COMBUSTION PRACTICES, AND DESIGNED TO ACHIEVE EMISSION LIMIT	4.8	G/HP-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUEMENGINE (Diesel fuel emergency engine)	17.11	Good combustion practices.	1.87	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (North Plant): Emergency Engine	17.11	Good combustion practices.	0.86	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUEMENGINE (South Plant): Emergency Engine	17.11	Good combustion practices	0.86	LB/H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUEMENGINE: Emergency engine	17.11	State of the art combustion design.	1.89	LB/H
MI-0442	THOMAS TOWNSHIP ENERGY, LLC	MI	210-18	08/21/2019	FGEMENGINE	17.11	Not Specified	0.86	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUEMENGINE (North Plant): Emergency engine	17.11	Good combustion practices	0.86	LB/H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUEMENGINE (South Plant): Emergency engine	17.11	Good combustion practices.	0.86	LB/H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Diesel Fired Emergency Generator	17.11	Use of ULSD a clean burning fuel, and limited hours of operation	1	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency generator (P003)	17.11	Not Specified	3.1	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency generator (P003)	17.11	State-of-the-art combustion design	3.84	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Generator (P009)	17.11	Good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	1.6	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency generator (P003)	17.11	State-of-the-art combustion design	2	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency generator (P003)	17.11	State-of-the-art combustion design	2	LB/H
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Generators (2 identical, P004 and P005)	17.11	Certified to the meet the emissions standards in 40 CFR 89.112 and 89.113 pursuant to 40 CFR 60.4205(b) and 60.4202(a)(2). Good combustion practices per the manufacturer's operating manual.	23.21	LB/H
OH-0375	LONG RIDGE ENERGY GENERATION LLC - HANNIBAL POWER	OH	P0122829	11/07/2017	Emergency Diesel Generator Engine (P001)	17.11	Good combustion design	24.71	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Diesel Generator (P003)	17.11	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	19.68	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Emergency Diesel-fired Generator Engine (P007)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer's operating manual	37.41	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	1,000 kW Emergency Generators (P008 - P010)	17.11	certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII, shall employ good combustion practices per the manufacturer's operating manual	14.96	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	5,051 bhp (3,768 kWm) Diesel-Fired Emergency Generators: P001 through P046	17.11	Certified to meet Tier 2 standards and good combustion practices	0.4	G/KW-H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
PA-0309	LACKAWANNA ENERGY CTR/JESSUP	PA	35-00069A	12/23/2015	2000 kW Emergency Generator	17.11	Not Specified	0.22	GM/HP-HR
PA-0311	MOXIE FREEDOM GENERATION PLANT	PA	40-00129A	09/01/2015	Emergency Generator	17.11	Not Specified	0.02	G/HP-HR
PA-0313	FIRST QUALITY TISSUE LOCK HAVEN PLT	PA	18-00030C	07/27/2017	Emergency Generator	17.11	Not Specified	3.5	G
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Generator	17.11	Not Specified	0.15	G/B-HP-H
TX-0728	PEONY CHEMICAL MANUFACTURING FACILITY	TX	118239, N200	04/01/2015	Emergency Diesel Generator	17.11	Minimized hours of operations Tier II engine	0.7	LB/H
TX-0872	CONDENSATE SPLITTER FACILITY	TX	118270 PSDTX1398M1 GHGPSDTX62	10/31/2019	Emergency Generators	17.11	Limiting duration and frequency of generator use to 100 hr/yr. Good combustion practices will be used to reduce VOC including maintaining proper air-to-fuel ratio.	0.12	G/KW HR
TX-0939	ORANGE COUNTY ADVANCED POWER STATION	TX	166032 PSDTX1598 GHGPSDTX210	03/13/2023	EMERGENCY GENERATOR	17.11	GOOD COMBUSTION PRACTICES, LIMITED TO 100 HR/YR	0.001	LB/HP HR

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED EMERGENCY GENERATOR 3000 kW (1)	17.11	Good Combustion Practices/Maintenance	6.4	G/KW
VA-0327	PERDUE GRAIN AND OILSEED, LLC	VA	60277	07/12/2017	Emergency Generator	17.11	Not Specified	0.49	LB/HR
WI-0284	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-017	04/24/2018	Diesel-Fired Emergency Generators	17.11	Good Combustion Practices	0.56	G/KWH
WI-0286	SIO INTERNATIONAL WISCONSIN, INC. - ENERGY PLANT	WI	18-JJW-022	04/24/2018	P42 -Diesel Fired Emergency Generator	17.11	Good Combustion Practices	0.56	G/KWH
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Generator (P07)	17.11	Operation limited to 500 hours/year and operate and maintain generator according to the manufacturer's recommendations	0.32	G/HP-H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Emergency Generator	17.11	Not Specified	1.24	LB/H

Process IDs: 17.110
Other Search Criteria: Process Name Contains "Engine"
Process Description: Diesel-Fired Engines
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered Process Types, Process Name for "Emergency Engine", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input > 500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
WV-0033	MAIDSVILLE	WV	R14-0038	01/05/2022	Emergency Generator	17.11	Good Combustion Practices w/ OxCat. Applicant did not justify why an oxcat is infeasible for an emergency engine	0.46	LB/HR
AR-0168	BIG RIVER STEEL LLC	AR	2305-AOP-R7	3/17/2021	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	1.55	G/KW-HR
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	1/31/2022	Emergency Engines	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	0.13	G/BHP-HR
LA-0292	HOLBROOK COMPRESSOR STATION	LA	PSD-LA-769(M-1)	1/22/2016	Emergency Generators No. 1 & No. 2	17.11	Good combustion practices consistent with the manufacturer's recommendations to maximize fuel efficiency and minimize emissions	0.83	LB/HR
TX-0962	POINT COMFORT PLANT	TX	PSDTX1610, PSDTX1588M1	09/22/2023	EMERGENCY ENGINES	16.21	601 hp and 100 hours of non-emergency operation per year. Good combustion practices.	--	--

Process IDs: 42.009, 49.999
Other Search Criteria: ---
Process Description: Organic Liquid Storage Tanks and Other Evaporative Loss Sources
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Does not include equipment that is not storage tank and tanks without listed capacity; capacity ≤20,000-gallon.

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0083	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT06	01/06/2015	Two (2) Methyl-diethanol Amine (MDEA) Storage Tanks	42.009	Submerged Fill Design	0.002	TONS/YEAR
AK-0086	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT07	03/26/2021	MDEA Storage Tanks	42.009	Submerged Fill Design	0.002	TPY (COMBINED)
AR-0124	EL DORADO SAWMILL	AR	2348-AOP-R0	08/03/2015	ELEVEN OIL STORAGE TANKS SN-14	42.009	ENCLOSED TANKS, TANKS ARE LIGHT COLOR	0.3	LB/H
AR-0124	EL DORADO SAWMILL	AR	2348-AOP-R0	08/03/2015	THREE DIESEL STORAGE TANKS SN-15	42.009	TANKS ARE LIGHT COLOR	0.4	LB/H
AR-0124	EL DORADO SAWMILL	AR	2348-AOP-R0	08/03/2015	ONE GASOLINE STORAGE TANK SN-16	42.009	TANKS ARE LIGHT COLOR	0.022	LB/MBF
IN-0241	CENTRAL INDIANA ETHANOL, LLC	IN	053-35637-00062	10/26/2015	FERMENTATION	42.009	WET SCRUBBERS	98	%OVERALL CTRL EFFIC

Process IDs: 42.009, 49.999
Other Search Criteria: ---
Process Description: Organic Liquid Storage Tanks and Other Evaporative Loss Sources
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Does not include equipment that is not storage tank and tanks without listed capacity; capacity ≤20,000-gallon.

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
IN-0312	LEHIGH CEMENT COMPANY LLC	IN	093-40198-00002	06/27/2019	Diesel tanks	42.009	Good design and operating practices	--	--
IN-0312	LEHIGH CEMENT COMPANY LLC	IN	093-40198-00002	06/27/2019	Gasoline tank	42.009	Submerged fill pipe and Stage I Vapor Control	--	--
IN-0318	RIVERVIEW ENERGY CORPORATION	IN	T147-39554-00065	06/11/2019	Amine Tanks	42.009	Tanks shall use a white shell. Tanks shall use submerged filling. Tanks shall use good maintenance practices as described in the permit.	0.48	TONS
KY-0103	LOGAN ALUMINUM, INC.	KY	V-20-004	12/27/2020	EP 156 - EP160 - Cold Mill 4 Area Storage Tanks	42.009	Each tank must be equipped with a submerged fill pipe.	--	--
LA-0276	BATON ROUGE JUNCTION FACILITY	LA	PSD-LA-741(M4)	12/15/2016	Sumps (2) and Oil/Water Separators (2)	42.009	Good housekeeping practices and closed top design	--	--
LA-0363	HOLDEN WOOD PRODUCTS MILL	LA	PSD-LA-834	10/02/2019	Diesel Storage Tank	42.009	Good Tank Design and Submerged Fill Page.	14,000	GAL
LA-0363	HOLDEN WOOD PRODUCTS MILL	LA	PSD-LA-834	10/02/2019	Gasoline Storage Tank	42.009	Good Tank Design and Submerged Fill Pipe	6,000	GAL

Process IDs: 42.009, 49.999
Other Search Criteria: ---
Process Description: Organic Liquid Storage Tanks and Other Evaporative Loss Sources
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Does not include equipment that is not storage tank and tanks without listed capacity; capacity ≤20,000-gallon.

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
MN-0095	BLUE LAKE	MN	13900010-105	08/07/2024	Diesel Tank #1 (EQUI 33)	42.009	Must be constructed and operated with good tank design, including: 1 Fixed roof, 2 PRV (conservation vent), 3 Submerged fill pipe, 4 Light tank color	--	--
TX-0656	GAS TO GASOLINE PLANT	TX	PSDTX1340 AND 107764	05/16/2014	METHANOL AND WATER STORAGE TANK	42.009	HORIZONTAL FIXED ROOF WITH SUBMERGED FILL, WHITE EXTERIOR	0.12	T/YR
TX-0846	MOTOR VEHICLE ASSEMBLY PLANT	TX	70661, PSDTX1036M1, GHGPSDTX18	09/23/2018	Gasoline Storage Tank 15,000 Gallons	42.009	White fixed roof storage tank equipped with a submerged fill pipe and vapor balance loading (Stage 1 Controls). The use of drain dry construction is required to minimize the emissions from tank entry and inspection.	--	--
TX-0846	MOTOR VEHICLE ASSEMBLY PLANT	TX	70661, PSDTX1036M1, GHGPSDTX18	09/23/2018	Storage Tanks " Very Low Vapor Pressure Non Gasoline Automotive Fluids" Gear Lube, Engine Oil, Diesel fuel, Urea, ATF Etc. ;20,000 gal each	42.009	White fixed roof storage tanks equipped with a submerged fill pipe. use of drain dry construction is required to minimize the emissions from tank entry and inspection.	--	--
IN-0359	NUCOR STEEL	IN	107-45480-00038	03/30/2023	Diesel Storage Tank (DST #6)	49.999	Submerged fill pipe and white painted tank shell and roof	--	--
PA-0313	FIRST QUALITY TISSUE LOCK HAVEN PLT	PA	18-00030C	07/27/2017	Storage Tanks	49.999	Not Specified	0.07	TPY

Process IDs: 99.011
Other Search Criteria: --
Process Description: Semiconductor Manufacturing
Date Range: 1/1/2014 - 11/7/2024
Date Conducted: 11/7/2024 - 1/6/2025
Notes & Filtering: Filtered for Process ID and Process Name

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0387	INTEL OHIO SITE	OH	P0132323	9/20/2022	Semiconductor Fabrication: P179 through P182	99.011	RCTO; annual burner tuning on the trimix systems; good combustion practices; the use of natural gas; store cleaning material in closed non-absorbent and non-leaking containers; minimize spills of cleaning materials and clean up spills immediately.	--	--

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
AK-0083	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT06	01/06/2015	Diesel Fired Well Pump	17.21	Limited Operation of 168 hr/yr.	0.36	LB/MMBTU
AK-0085	GAS TREATMENT PLANT	AK	AQ1524CPT01	08/13/2020	Three (3) Firewater Pump Engines and two (2) Emergency Diesel Generators	17.21	Good combustion practices, ULSD, and limit operation to 500 hours per year.	0.19	G/HP-HR
AK-0086	KENAI NITROGEN OPERATIONS	AK	AQ0083CPT07	03/26/2021	Diesel Fired Well Pump	17.21	Good Combustion Practices and Limited Use	0.36	LB/MMBTU
AR-0173	BIG RIVER STEEL LLC	AR	2445-AOP-R0	01/31/2022	Emergency Water Pumps	17.21	Good Operating Practices, limited hours of operation, Compliance with NSPS Subpart IIII	1.12	G/BHP-HR
IL-0134	CRONUS CHEMICALS	IL	19110020	12/21/2023	Firewater Pump Engine	17.21	Not Specified	4	G/KW-HR

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
KS-0030	MID-KANSAS ELECTRIC COMPANY, LLC - RUBART STATION	KS	C-13309	03/31/2016	Compression ignition RICE emergency fire pump	17.21	Not Specified	1.14	G/HP-HR
LA-0301	LAKE CHARLES CHEMICAL COMPLEX ETHYLENE 2 UNIT	LA	PSD-LA-779	05/23/2014	Firewater Pump Nos. 1-3 (EQTs 997, 998, & 999)	17.21	Compliance with 40 CFR 60 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures (consistent with safe operation) designed to maximize combustion efficiency and minimize fuel usage	0.1	LB/HR
LA-0309	BENTELER STEEL TUBE FACILITY	LA	PSD-LA-774(M1)	06/04/2015	Firewater Pump Engines	17.21	Complying with 40 CFR 60 Subpart IIII	---	---
LA-0313	ST. CHARLES POWER STATION	LA	PSD-LA-804	08/31/2016	SCPS Emergency Diesel Firewater Pump 1	17.21	Good combustion practices	1.87	LB/H
LA-0314	INDORAMA LAKE CHARLES FACILITY	LA	PSD-LA-813	08/03/2016	Diesel Firewater pump engines (6 units)	17.21	complying with 40 CFR 63 subpart ZZZZ	---	---
LA-0316	CAMERON LNG FACILITY	LA	PSD-LA-766(M3)	02/17/2017	firewater pump engines (8 units)	17.21	Complying with 40 CFR 60 Subpart IIII	---	---
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39A	17.21	Good combustion practices and NSPS Subpart IIII	4	G/KW-H
LA-0328	PLAQUEMINES PLANT 1	LA	PSD-LA-709(M-3)	05/02/2018	Emergency Diesel Engine Pump P-39B	17.21	Good combustion practices and NSPS Subpart IIII	4	G/KW-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
LA-0387	TAYLOR SAWMILL	LA	PSD-LA-842	04/12/2022	Firewater Pump Engine (FIR)	17.21	Compliance with 40 CFR 60 Subpart IIII	0.02	TPY
LA-0390	DERIDDER SAWMILL	LA	PSD-LA-843	05/10/2022	ENG1 - Emergency Fire Water Pump	17.21	Good combustion practices and maintenance and compliance with applicable 40 CFR 60 Subpart JJJJ limitation for VOC.	1.85	LB/HR
LA-0391	MAGNOLIA POWER GENERATING STATION UNIT 1	LA	PSD-LA-839	06/03/2022	Emergency Diesel Fired Water Pump Engine	17.21	Compliance with 40 CFR 60 Subpart IIII, good combustion practices, and the use of ultra-low sulfur diesel fuel.	3	G/HP-HR
LA-0397	WESTLAKE ETHYLENE PLANT	LA	PSD-LA-813(M3)	04/29/2022	Emergency Generators and Fire Water Pumps (EQT0027 - EQT0032, EQT0044, EQT0045)	17.21	Compliance with applicable requirements of 40 CFR 60 Subpart IIII	---	---
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-01 - Firewater Pump Engine No. 1	17.21	Compliance with 40 CFR 60 Subpart IIII	1.47	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-02 - Firewater Pump Engine No. 2	17.21	Compliance with 40 CFR 60 Subpart IIII	1.47	LB/HR
LA-0401	KOCH METHANOL (KME) FACILITY	LA	PSD-LA-851	12/20/2023	FWP-03 - Firewater Pump Engine No. 3	17.21	Compliance with the requirements of 40 CFR 60 Subpart IIII	0.61	LB/HR
LA-0402	DESTREHAN OIL PROCESSING FACILITY	LA	PSD-LA-855	12/13/2023	HLK39 - Emergency Diesel Fire Pump Engine (EQT0094)	17.21	Compliance with 40 CFR 60 Subpart IIII	0.14	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MD-0044	COVE POINT LNG TERMINAL	MD	PSC CASE NO. 9318	06/09/2014	5 EMERGENCY FIRE WATER PUMP ENGINES	17.21	USE ONLY ULSD, GOOD COMBUSTION PRACTICES, AND DESIGNED TO ACHIEVE EMISSION LIMIT	3	G/HP-H
MI-0423	INDECK NILES, LLC	MI	75-16	01/04/2017	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices	0.64	LB/H
MI-0424	HOLLAND BOARD OF PUBLIC WORKS - EAST 5TH STREET	MI	107-13C	12/05/2016	EUFPENGINE (Emergency engine-diesel fire pump)	17.21	Good combustion practices	0.47	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (South Plant): Fire pump engine	17.21	Good combustion practices.	0.75	LB/H
MI-0433	MEC NORTH, LLC AND MEC SOUTH LLC	MI	167-17 AND 168-17	06/29/2018	EUFPENGINE (North Plant): Fire pump engine	17.21	Good combustion practices	0.75	LB/H
MI-0435	BELLE RIVER COMBINED CYCLE POWER PLANT	MI	19-18	07/16/2018	EUFPENGINE: Fire pump engine	17.21	State of the art combustion design.	0.13	LB/H
MI-0451	MEC NORTH, LLC	MI	167-17B	06/23/2022	EUFPENGINE (North Plant): Fire Pump Engine	17.21	Good combustion practices.	0.75	LB/H
MI-0452	MEC SOUTH, LLC	MI	168-17B	06/23/2022	EUFPENGINE (South Plant): Fire pump engine	17.21	Good Combustion Practices	0.75	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
MS-0092	EMBERCLEAR GTL MS	MS	0040-00055	05/08/2014	firewater pumps, diesel	17.21	Not Specified	---	---
NJ-0081	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068 -(BOP120002)	03/07/2014	Emergency diesel fire pump	17.21	Not Specified	0.119	LB/H
NJ-0084	PSEG FOSSIL LLC SEWAREN GENERATING STATION	NJ	18068/BOP150001	03/10/2016	Emergency Diesel Fire Pump	17.21	use of ULSD a clean burning fuel, and limited hours of operation	0.1	LB/H
NJ-0085	MIDDLESEX ENERGY CENTER, LLC	NJ	19149/PCP150001	07/19/2016	EMERGENCY DIESEL FIRE PUMP	17.21	Use of Ultra Low Sulfur Diesel (ULSD) Oil a clean burning fuel and limited hours of operation	0.117	LB/H
OH-0366	CLEAN ENERGY FUTURE - LORDSTOWN, LLC	OH	P0117655	08/25/2015	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.11	LB/H
OH-0367	SOUTH FIELD ENERGY LLC	OH	P0119495	09/23/2016	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.25	LB/H
OH-0368	PALLAS NITROGEN LLC	OH	P0118959	04/19/2017	Emergency Fire Pump Diesel Engine (P008)	17.21	good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	0.14	LB/H
OH-0370	TRUMBULL ENERGY CENTER	OH	P0122331	09/07/2017	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.24	LB/H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
OH-0372	OREGON ENERGY CENTER	OH	P0121049	09/27/2017	Emergency fire pump engine (P004)	17.21	State-of-the-art combustion design	0.24	LB/H
OH-0374	GUERNSEY POWER STATION LLC	OH	P0122594	10/23/2017	Emergency Fire Pump (P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII. Good combustion practices per the manufacturer's operating manual.	2.7	LB/H
OH-0377	HARRISON POWER	OH	P0122266	04/19/2018	Emergency Fire Pump (P004)	17.21	Good combustion practices (ULSD) and compliance with 40 CFR Part 60, Subpart IIII	2.12	LB/H
OH-0378	PTTGCA PETROCHEMICAL COMPLEX	OH	P0124972	12/21/2018	Firewater Pumps (P005 and P006)	17.21	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII and employ good combustion practices per the manufacturer's operating manual	2.64	LB/H
OH-0387	INTEL OHIO SITE	OH	P0132323	09/20/2022	275 hp (205 kW) Diesel-Fired Emergency Fire Pump Engine	17.21	Certified to meet the standards in Table 4 of 40 CFR Part 60, Subpart IIII and good combustion practices	0.7	LB/H
OK-0164	MIDWEST CITY AIR DEPOT	OK	2009-394-C(M-2)PSD	01/08/2015	Diesel-Fueled Fire Pump Engines	17.21	1. Good Combustion Practices.	0.15	GRAMS PER HP-HR
PR-0009	ENERGY ANSWERS ARECIBO PUERTO RICO RENEWABLE ENERGY PROJECT	PR	R2-PSD 1	04/10/2014	Emergency Diesel Fire Pump	17.21	Not Specified	0.15	G/B-HP-H
VA-0325	GREENSVILLE POWER STATION	VA	52525	06/17/2016	DIESEL-FIRED WATER PUMP 376 bhp (1)	17.21	Good Combustion Practices/Maintenance	3	G/HP-H

Process IDs: 17.210
Other Search Criteria: Process Name Contains "Fire Pump"
Process Description: Diesel-Fired Fire Pump Engines
Date Range: 1/1/2014 - 2/14/2025
Date Conducted: 02/19/2025
Notes & Filtering: Filtered Process Types, Process Name for "Fire Pump", Fuel Type for "Diesel", "ULSD", "Fuel Oil No. 2", etc., Heat Input <500 HP

RBLC ID	Facility Name	State	Permit ID	Permit Issuance Date	Process Description	RBLC Process ID	Control Technology Definition	Emission Limit	
VA-0328	C4GT, LLC	VA	52588	04/26/2018	Emergency Fire Water Pump	17.21	good combustion practices and the use of ultra low sulfur diesel (S15 ULSD) fuel oil with a maximum sulfur content of 15 ppmw.	---	---
WI-0263	WISCONSIN POWER & LIGHT - NEENAH GENERATING STATION	WI	14-DMM-200	02/15/2016	Fire pump (process P05)	17.21	Good combustion practices, use diesel fuel, and operate <500 hr/yr	---	---
WI-0292	GREEN BAY PACKAGING INC. MILL DIVISION	WI	19-DMM-001	04/01/2019	P37 Diesel-Fired Emergency Fire Pump	17.21	Hours of Operation	200	HOURS
WI-0300	NEMADJI TRAIL ENERGY CENTER	WI	18-MMC-168	09/01/2020	Emergency Diesel Fire Pump (P06)	17.21	Operation limited to 500 hours/year and operate and maintain according to the manufacturer's recommendations.	1.1	G/HP-H
WI-0302	WPL- RIVERSIDE ENERGY CENTER	WI	19-DMM-153	02/28/2020	Diesel-Fired Fire Pump Engine (P04)	17.21	Good combustion practices	0.26	LB/H
WV-0025	MOUNDSVILLE COMBINED CYCLE POWER PLANT	WV	R14-0030	11/21/2014	Fire Pump Engine	17.21	Not Specified	0.17	LB/H

Summary of BAAQMD BACT

					BACT Determination		Typical Technology	
Source Type	**Classification**	**Primary Fuel**	**Reference** [a]	**Date of Reference**	**Feasible /Cost Effective**	**Achieved in Practice**	**Feasible/ Cost Effective**	**Achieved in Practice**
Boiler	5 - 33.5 MMBtu/hr Heat Input	Not Specified	BAAQMD	8/4/2010	No Determination	Not Specified	No Determination	Good Combustion Practice
Boiler	33.5 - 50 MMBtu/hr Heat Input	Not Specified	BAAQMD	8/4/2010	No Determination	Not Specified	No Determination	Good Combustion Practice
Boiler	> 50 MMBtu/hr Heat Input	Not Specified	BAAQMD	8/4/2010	No Determination	Not Specified	No Determination	Good Combustion Practice
Diesel-Fired Emergency Engine	> 50 BHP and < 1000 BHP Output	Diesel	BAAQMD	12/22/2020	Not Specified	CARB ATCM standard for POC at applicable horsepower rating (see attached Table 1).	Not Specified	Any engine certified or verified to achieve the applicable standard.
Organic Liquid Storage Tank	< 20,000 Gallons	Not Applicable	BAAQMD	3/3/1995	No Determination	Vapor recovery system w/ an overall system efficiency ≥95%	No Determination	Vapor Balance; or Carbon Adsorber; or Refrigerated Condenser; or Incinerator; or BAAQMD approved equivalent
Organic Liquid Storage Tank	≥ 20,000 Gallons	Not Applicable	BAAQMD	3/3/1995	No Determination	Vapor recovery system w/ an overall system efficiency >98%	No Determination	Thermal Incinerator; or Carbon Adsorber; or Refrigerated Condenser; or BAAQMD approved equivalent
Semiconductor Fabrication - Photoresist Operations	All	Not Specified	BAAQMD	6/16/1995	No Determination	Enclosure of photoresist track and spinner. Vent to control system w/ DRE ≥98.5% or VOC outlet ≤10 ppmv. For control device, the following are acceptable: ≤10 ppmv at outlet; or ≥98.5% DRE if inlet VOC ≥2000 ppmv; ≥97% DRE if inlet VOC ≥200 to <2000 ppmv; or ≥90% DRE if inlet VOC <200 ppmv.	No Determination	BAAQMD approved Collection System and Control Device

					BACT Determination		Typical Technology	
Source Type	**Classification**	**Primary Fuel**	**Reference** [a]	**Date of Reference**	**Feasible /Cost Effective**	**Achieved in Practice**	**Feasible/ Cost Effective**	**Achieved in Practice**
Semiconductor Fabrication - Siliconizing Reactors, Furnace Chambers, and Chemical Vapor Deposition Reactors	All	Not Specified	BAAQMD	1/10/1992	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Semiconductor Fabrication - Solvent Cleaning Stations	All	Not Specified	BAAQMD	10/25/1991	Enclosure of solvent station, and vent to control system w/ capture/destruction efficiency >90% or VOC outlet concentration ≤10 ppm	Compliance with BAAQMD Reg. 8, Rule 30, and all solvent station reservoirs, sinks, and containers shall be provided with a cover and have a freeboard ratio >1.0.	Collection System Vented to Incinerator or Carbon Adsorption System	BAAQMD Approved Design and Operation

Notes:

a. Data sources include:

BAAQMD - Bay Area Air Quality Management District (https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook);

Summary of Semiconductor Manufacturing Permits

Source Type	Permit Emission Unit Description	Permittee	State	Permit ID	Issue Date	Pollutant	Control Technology	Permit Limit
Wastewater Treatment	All TRMX systems (Catalytic Oxidizers)	Intel Corp	AZ	P0009315	1/11/2016	Odor, H_2S	Subject to Agency	0.03 ppmv H_2S emission limit (Averaging Period of 30 Minutes or More)
Wastewater Treatment	All TRMX systems (Catalytic Oxidizers)	Intel Corp	AZ	P0009315	1/11/2016	CO	Not Specified	---
Wastewater Treatment	All TRMX systems (Catalytic Oxidizers)	Intel Corp	AZ	P0009315	1/11/2016	NOx	Selective Catalytic Reduction (SCR) System	NO_x emission limit of 0.34 lb NO_X/hr.
Wastewater Treatment	Ammonia Wastewater Treatment System	Intel Corp	OR	34-2681-ST-01	1/22/2016	NO_X	Thermal Catalytic Oxidation/Reduction System	NO_X Limit of 0.34 lb/hr
Wastewater Treatment	Ammonia Wastewater Treatment System	Intel Corp	OR	34-2681-ST-01	1/22/2016	CO	Thermal Catalytic Oxidation/Reduction System	CO Limit of 0.030 lb/MMBtu
Wastewater Treatment	Wastewater Treatment Acid Scrubbers	TSMC Arizona Corporation	AZ	P0008497	11/4/2022	H_2S	--	0.03 ppm by Volume (30-min Minimum Averaging Period)

APPENDIX N. VOLATILE ORGANIC COMPOUNDS RACT ANALYSIS

This appendix presents the reasonably available control technology (RACT) determination for control of volatile organic compound (VOC) emissions from the proposed emission sources at the Proposed Air Permit Project.

RACT is defined in 6 CRR-NY 200.1 as "the lowest emission limit that a particular source is capable of meeting by application of control technology that is reasonably available considering technological and economic feasibility". The Proposed Air Permit Project would be a source of VOC emissions and operations at the facility would therefore be potentially subject to the VOC RACT requirements under the following regulations of Title 6 of the New York Codes, Rules, and Regulations (6 NYCRR):

- 6 NYCRR Part 226: Solvent Cleaning Processes and Industrial Cleaning Solvents;
- 6 NYCRR Part 229: Petroleum and Volatile Organic Liquid Storage and Transfer; and
- 6 NYCRR Part 212 – Process Operations, Subpart 212-3: Reasonably Available Control Technology for Major Facilities.

RACT requirements for the control of VOC emissions generally fall into one of two categories: (i) presumptive RACT limits, or (ii) case-by-case RACT determinations. Presumptive RACT limits are category wide requirements and are based on capabilities that are generally reasonably achievable for units in an emission source category. For some categories of emission sources, however, presumptive RACT limits may not be attainable at individual emission sources. In such circumstances, case-by-case RACT determinations consider the technological and economic circumstances of the individual emission source and may include factors such as site space constraints, burner design and existing fuel types, emission controls and ductwork geometry. In addition, there may be sources that are subject to VOC RACT, but are not in a category having a presumptive RACT limit. These sources are also subject to case-by-case determinations. Facilities including sources for which no presumptive RACT limit exists must submit proposals for RACT limits based on an analysis of the available control technologies.

Emission sources with potential to emit VOC in the Proposed Air Permit Project include:

- Natural gas-fired boilers;
- Natural gas-fired water bath vaporizers;
- Diesel-fired emergency generator engines;
- Diesel-fired emergency fire pump engine;
- Semiconductor process tools and other process and support operations that emit VOC;
- Volatile organic liquid storage tanks; and
- Wastewater Treatment Plant.

Each potentially applicable VOC RACT Regulation is discussed in the following sections.

1.1 6 NYCRR Part 226: Solvent Cleaning Processes and Industrial Cleaning Solvents

Subpart 226-1 states presumptive VOC RACT for facilities that operate cold cleaners, open-top vapor degreasers, and all types of conveyorized degreasers that carry out solvent cleaning processes of metal and non-metal objects using a solution containing VOCs. The Proposed Air Permit Project does not include any equipment that meets the definitions of cold cleaners, open-top vapor degreasers, or conveyorized degreasers and as such the requirements of Subpart 226-1 do not apply. If such equipment is included in the future, the requirements of Subpart 226-1 will be met.

Subpart 226-2 stipulates presumptive VOC RACT for facilities with actual emissions of three tons or more of VOCs from industrial cleaning solvents, on a 12-month rolling basis. Micron is proposing to use isopropanol (IPA) for wipe cleaning of tools, workspaces, and other surfaces within the semiconductor fab to reduce the presence of contaminants in those areas, which may be subject to Subpart 226-2. Methanol will also be used for a specific cleaning application as part of the photolithography process. IPA and methanol are both B-rated compounds per DAR-1, Guidelines for the Evaluation and Control of Ambient Air Contaminants Under 6 NYCRR Part 212. Per 6 NYCRR 226-2.1(c)(6), the use of cleaning solvents given an A rating by the department or that are already subject to RACT under Part 212 are exempt from the requirements of Subpart 226-2. The Proposed Air Permit Project is subject to VOC RACT requirements under Part 212 as detailed in Section 1.3 of this Appendix and as such, Micron will comply with RACT through Part 212 rather than Subpart 226-2.

1.2 6 NYCRR Part 229: Petroleum and Volatile Organic Liquid Storage and Transfer

Part 229 states presumptive VOC RACT for owners or operators of a gasoline bulk plant, gasoline loading terminal, petroleum liquid storage tank or volatile organic liquid storage tank which meets certain applicability criteria specified in the regulation. Micron is not proposing to install any gasoline or petroleum liquid storage tanks that would be potentially subject to Part 229 requirements. Micron is proposing to install multiple 25,000-gallon diesel storage tanks as a part of the Proposed Air Permit Project. Per 6 NYCRR 229.2(b)(17) and (22), diesel is not a petroleum liquid or a volatile organic liquid and as such, Part 229 does not apply to these tanks.

Micron is proposing to install several volatile organic liquid storage tanks with capacities ranging from 2,000 to 12,000 gallons. The Proposed Air Permit Project is in Onondaga County and is subject to applicable requirements identified in 6 NYCRR 229.1(d)(2). Per 6 NYCRR 229.1(f)(4), horizontal volatile organic liquid storage tanks are exempt from Part 229. For tanks that do not meet this exemption, Micron will comply with the presumptive VOC RACT requirements in 6 NYCRR 229.3(e)(2)(iv) or (v), depending on size.

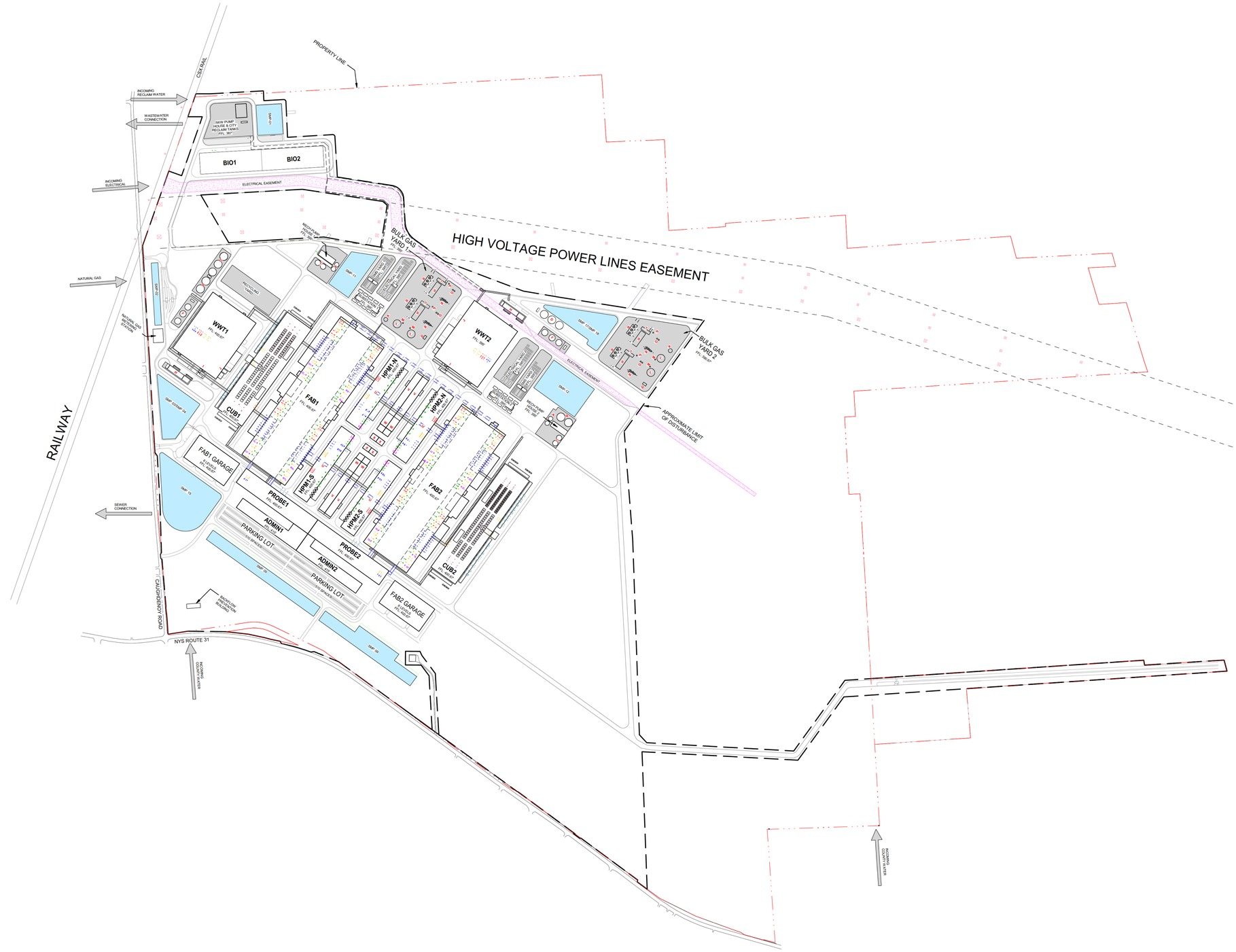
1.3 6 NYCRR Subpart 212-3.1: Process Operations

As per 6 NYCRR 212-3.1(f), each new emission point that has a potential to emit greater than 3 lb/hr and actual emissions in excess of 15 lb/day VOC will be subject to a case-by-case VOC RACT analysis. VOC emission sources at the Proposed Air Permit Project that are not already addressed under the presumptive

RACT (sections 1.1 and 1.2 of this Appendix) that would be subject to case-by-case RACT evaluation include wipe cleaning operations that would otherwise be subject to Subpart 226-2, natural gas-fired boilers, natural gas-fired water bath vaporizers, diesel-fired emergency generator engines, diesel-fired emergency fire pump engine, semiconductor process tools and other process and support operations that emit VOC, and the wastewater treatment plant.

Micron has completed a VOC Lowest Achievable Emission Rate (LAER) evaluation as required by the federal NNSR requirements. This evaluation is included in Appendix M of this air permit application. As described in Section 3.3.9 of the air permit application narrative, the Proposed Air Permit Project will be a new major source of VOC. Because this is a new major source, all emission sources at the facility that generate VOC are subject to LAER. Since LAER is inherently more stringent than RACT, Micron proposes to comply with VOC RACT by complying with the VOC LAER determinations made in Appendix M.

APPENDIX P. PLOT PLAN


PROPERTY LINE
CSX RAIL
INCOMING RECLAIM WATER
WASTEWATER CONNECTION
INCOMING ELECTRICAL
NATURAL GAS
SEWER CONNECTION
RAILWAY
CAUGHDENOY ROAD
NYS ROUTE 31
3WW PUMP HOUSE & CITY RECLAIM TANKS (TYP.), 35'
SWMP1
BIO1
BIO2
ELECTRICAL EASEMENT
MECHANICAL YARD 1
BULK GAS YARD 1
HIGH VOLTAGE POWER LINES EASEMENT
BULK GAS YARD 2
MECHANICAL YARD 2
APPROXIMATE LIMIT OF DISTURBANCE
NATURAL GAS METERING STATION
RECYCLING YARD
WWT1
FFEL 1640.0'
WWT2
FFEL 1641.0'
FAB1
FFEL 1642.0'
FAB2
FFEL 1642.0'
CUB1
FFEL 1642.0'
CUB2
FFEL 1642.0'
HPM1-N
HPM2-N
HPM1-S
HPM2-S
FAB1 GARAGE
FFEL 1642.0'
FAB2 GARAGE
FFEL 1642.0'
PROBE1
FFEL 1642.0'
PROBE2
FFEL 1642.0'
ADMIN1
FFEL 1642.0'
ADMIN2
FFEL 1642.0'
PARKING LOT
PARKING LOT
SWP 01
SWP 02
SWP 03
SWP 04
SWP 05
SWP 06
SWP 07
SWP 08
SWP 09
SWP 10
SWP 11
SWP 12
SWP 13
SWP 14
SWP 15
SWP 16
SWP 17
SWP 18
SWP 19
SWP 20
SWP

APPENDIX Q. EMISSION UNIT MATRIX

Source Description	Emission Unit	Process	Emission Source(s)/ Control(s)	ES Type	Emission Point(s)
Fab 1 acid scrubbers	1-FABOP	FA1	AS001 - AS040	K	1F001 - 1F040
Plasma etch processes exhausting to Fab 1 acid scrubbers	1-FABOP	FA1	PLE01	I	-
Plasma etch POU control devices exhausting to Fab 1 acid scrubbers	1-FABOP	FA1	POU01	K	-
Plasma etch RCS exhausting to Fab 1 acid scrubbers	1-FABOP	FA1	RCS01 - RCS10	K	-
Ion implant processes exhausting to Fab 1 acid scrubbers	1-FABOP	FA1	IMP01	I	-
Wet etch & wet clean processes exhausting to Fab 1 acid scrubbers	1-FABOP	FA1	WET01	I	-
Fab 1 CVD scrubbers	1-FABOP	FC1	CS001 - CS016	K	1F041 - 1F056
Thin films / diffusion processes exhausting to Fab 1 CVD scrubbers	1-FABOP	FC1	TFD01	I	-
Fab 1 ammonia (base) scrubbers	1-FABOP	FB1	BS001 - BS016	K	1F057 - 1F072
Photolithography processes exhausting to Fab 1 ammonia scrubbers	1-FABOP	FB1	PHO01	I	-
Wet etch & wet clean processes exhausting to Fab 1 ammonia scrubbers	1-FABOP	FB1	WET01	I	-
CMP processes exhausting to Fab 1 ammonia scrubbers	1-FABOP	FB1	CMP01	I	-
Fab 1 storage tanks for basic raw materials	1-FABOP	FB1	ST001 - ST006	I	-
Fab 1 RCTOs (solvent exhaust)	1-FABOP	FS1	TO001 - TO036	K	1F073 - 1F144
Photolithography processes exhausting to Fab 1 RCTOs	1-FABOP	FS1	PHO01	I	-
Wet etch & wet clean processes exhausting to Fab 1 RCTOs	1-FABOP	FS1	WET01	I	-
Fab 1 storage tanks for organic waste materials	1-FABOP	FS1	WS001 - WS030	I	-
Fab 1 general exhaust (IPA, HTF, MeOH, etc.)	1-FABOP	FG1	GN001 - GN040	I	1F145 - 1F184
Fab 2 acid scrubbers	2-FABOP	FA2	AS041 - AS080	K	2F001 - 2F040
Plasma etch processes exhausting to Fab 2 acid scrubbers	2-FABOP	FA2	PLE02	I	-
Plasma etch POU control devices exhausting to Fab 2 acid scrubbers	2-FABOP	FA2	POU02	K	-
Plasma etch RCS exhausting to Fab 2 acid scrubbers	2-FABOP	FA2	RCS11 - RCS20	K	-
Ion implant processes exhausting to Fab 2 acid scrubbers	2-FABOP	FA2	IMP02	I	-
Wet etch & wet clean processes exhausting to Fab 2 acid scrubbers	2-FABOP	FA2	WET02	I	-
Fab 2 CVD scrubbers	2-FABOP	FC2	CS017 - CS032	K	2F041 - 2F056
Thin films / diffusion processes exhausting to Fab 2 CVD scrubbers	2-FABOP	FC2	TFD02	I	-
Fab 2 ammonia (base) scrubbers	2-FABOP	FB2	BS017 - BS032	K	2F057 - 2F072
Photolithography processes exhausting to Fab 2 ammonia scrubbers	2-FABOP	FB2	PHO02	I	-
Wet etch & wet clean processes exhausting to Fab 2 ammonia scrubbers	2-FABOP	FB2	WET02	I	-
CMP processes exhausting to Fab 2 ammonia scrubbers	2-FABOP	FB2	CMP02	I	-
Fab 2 storage tanks storing basic raw materials	2-FABOP	FB2	ST007 - ST012	I	-
Fab 2 RCTOs (solvent exhaust)	2-FABOP	FS2	TO037 - TO072	K	2F073 - 2F144
Photolithography processes exhausting to Fab 2 RCTOs	2-FABOP	FS2	PHO02	I	-
Wet etch & wet clean processes exhausting to Fab 2 RCTOs	2-FABOP	FS2	WET02	I	-
Fab 2 storage tanks storing organic waste materials	2-FABOP	FS2	WS031-WS060	I	-
Fab 2 general exhaust (IPA, HTF, MeOH, etc.)	2-FABOP	FG2	GN041 - GN080	I	2F145 - 2F184
Natural gas-fired utility boilers	1-CMBOP	BLR	BLR01 - BLR03	C	1U001 - 1U003
Natural gas-fired water bath vaporizers	1-CMBOP	WBV	WBV01 - WBV04	C	1U004 - 1U007
Diesel-fired emergency generators	1-CMBOP	EMD	DG001 - DG060	C	1U008 - 1U067
Diesel-fired backup fire pump engine	1-CMBOP	DFP	FP001	C	1FP01
Natural gas-fired utility boilers	2-CMBOP	BLR	BLR04 - BLR06	C	2U001 - 2U003
Natural gas-fired water bath vaporizers	2-CMBOP	WBV	WBV05 - WBV08	C	2U004 - 2U007
Diesel-fired emergency generators	2-CMBOP	EMD	DG061 - DG118	C	2U008 - 2U065
HPM 1 acid scrubbers	1-HPMCU	HA1	AS081 - AS088	K	1H001 - 1H008
HPM 1 storage tanks storing acidic raw materials	1-HPMCU	HA1	ST013 - ST044	I	-
HPM 1 storage tanks storing acidic waste materials	1-HPMCU	HA1	WS061 - WS066	I	-
CUB 1 acid scrubbers	1-HPMCU	CA1	AS089 - AS092	K	1C001 - 1C004
CUB 1 storage tanks storing acidic raw materials	1-HPMCU	CA1	ST045	I	-
HPM 1 ammonia (base) scrubbers	1-HPMCU	HB1	BS033 - BS040	K	1H009 - 1H016
HPM 1 storage tanks storing ammonia and/or basic raw materials	1-HPMCU	HB1	ST046 - ST065	I	-
HPM 1 RCTOs (solvent exhaust)	1-HPMCU	HS1	TO073 - TO080	K	1H017 - 1H032
HPM 1 storage tanks storing organic raw materials	1-HPMCU	HS1	ST066 - ST077	I	-
SOD waste treatment station	1-HPMCU	HS1	SOD01	I	-
HPM 1 diesel tanks	1-HPMCU	DT1	DT001 - DT004	I	1D001 - 1D004
CUB 1 storage tanks with fugitive emissions	1-HPMCU	FU1	ST078 - ST081	I	-
CUB 1 cooling towers	1-HPMCU	CT1	CT001 - CT105	I	1C005 - 1C109
Gas yard 1 cooling towers	1-HPMCU	CT1	CT106 - CT111	I	1G001 - 1G006
HPM 2 acid scrubbers	2-HPMCU	HA2	AS093 - AS100	K	2H001 - 2H008
HPM 2 storage tanks storing acidic raw materials	2-HPMCU	HA2	ST082 - ST113	I	-
HPM 2 storage tanks storing acidic waste materials	2-HPMCU	HA2	WS067 - WS072	I	-
CUB 2 acid scrubbers	2-HPMCU	CA2	AS101 - AS104	K	2C001 - 2C004
CUB 2 storage tanks storing acidic raw materials	2-HPMCU	CA2	ST114	I	-
HPM 2 ammonia (base) scrubbers	2-HPMCU	HB2	BS041 - BS048	K	2H009 - 2H016
HPM 2 storage tanks storing ammonia and/or basic raw materials	2-HPMCU	HB2	ST115 - ST134	I	-
HPM 2 RCTOs (solvent exhaust)	2-HPMCU	HS2	TO081 - TO088	K	2H017 - 2H032
HPM 2 storage tanks storing organic raw materials	2-HPMCU	HS2	ST135 - ST146	I	-

SOD waste treatment stations	2-HPMCU	HS2	SOD02	I	-
HPM 2 diesel tanks	2-HPMCU	DT2	DT005 - DT008	I	2D001 - 2D004
CUB 2 storage tanks with fugitive emissions	2-HPMCU	FU2	ST147 - ST150	I	-
CUB 2 cooling towers	2-HPMCU	CT2	CT112 - CT216	I	2C005 - 2C109
Gas yard 2 cooling towers	2-HPMCU	CT2	CT217 - CT222	I	2G001 - 2G006
WWT 1 acid scrubbers	1-WWBIO	WA1	AS105 - AS108	K	1W001 - 1W004
WWT 1 main wastewater treatment processes	1-WWBIO	WA1	WWT01	I	-
WWT 1 storage tanks storing acidic raw materials	1-WWBIO	WA1	ST151 - ST168	I	-
WWT 1 storage tanks storing acid waste	1-WWBIO	WA1	WS073 - WS092	I	-
WWT 1 lab operations	1-WWBIO	WA1	WLB01	I	-
WWT 1 ammonia (base) scrubbers	1-WWBIO	WB1	BS049 - BS051	K	1W005 - 1W007
WWT 1 main wastewater treatment processes	1-WWBIO	WB1	WWT01	I	-
WWT 1 storage tanks storing ammonia and/or basic raw materials	1-WWBIO	WB1	ST169 - ST175	I	-
WWT 1 lab operations	1-WWBIO	WB1	WLB01	I	-
WWT 1 thermal oxidizers (solvent exhaust)	1-WWBIO	WS1	TO089 - TO091	K	1W008 - 1W010
WWT 1 main wastewater treatment processes	1-WWBIO	WS1	WWT01	I	-
WWT 1 lab operations	1-WWBIO	WS1	WLB01	I	-
WWT 1 silos storing solid raw materials	1-WWBIO	SL1	SIL01 - SIL02	I	1W011, 1W012
BIO 1 general exhaust / odor scrubber	1-WWBIO	BG1	OS001 - OS002	I	1B001 - 1B002
BIO 1 biological wastewater treatment processes	1-WWBIO	BG1	BIO01	I	-
BIO 1 storage tanks storing raw materials	1-WWBIO	BG1	ST176 - ST178	I	-
BIO 1 storage tanks with fugitive emissions	1-WWBIO	FU1	ST179 - ST183	I	-
WWT 2 acid scrubbers	2-WWBIO	WA2	AS109 - AS112	K	2W001 - 2W004
WWT 2 main wastewater treatment processes	2-WWBIO	WA2	WWT02	I	-
WWT 2 storage tanks storing acidic raw materials	2-WWBIO	WA2	ST184 - ST201	I	-
WWT 2 storage tanks storing acid waste	2-WWBIO	WA2	WS093 - WS112	I	-
WWT 2 lab operations	2-WWBIO	WA2	WLB02	I	-
WWT 2 ammonia (base) scrubbers	2-WWBIO	WB2	BS052 - BS054	K	2W005 - 2W007
WWT 2 main wastewater treatment processes	2-WWBIO	WB2	WWT02	I	-
WWT 2 storage tanks storing ammonia and/or basic raw materials	2-WWBIO	WB2	ST202 - ST208	I	-
WWT 2 lab operations	2-WWBIO	WB2	WLB02	I	-
WWT 2 thermal oxidizers (solvent exhaust)	2-WWBIO	WS2	TO092 - TO094	K	2W008 - 2W010
WWT 2 main wastewater treatment processes	2-WWBIO	WS2	WWT02	I	-
WWT 2 lab operations	2-WWBIO	WS2	WLB02	I	-
WWT 2 silos storing solid raw materials	2-WWBIO	SL2	SIL03 - SIL04	I	2W011, 2W012
BIO 2 general exhaust / odor scrubber	2-WWBIO	BG2	OS003 - OS004	I	2B001 - 2B002
BIO 2 biological wastewater treatment processes	2-WWBIO	BG2	BIO02	I	-
BIO 2 storage tanks storing raw materials	2-WWBIO	BG2	ST209 - ST211	I	-
BIO 2 storage tanks with fugitive emissions	2-WWBIO	FU2	ST212 - ST216	I	-
Admin/Probe 1 acid scrubbers	1-ADMPR	AA1	AS113 - AS114	K	1A001 - 1A002
Admin/Probe 1 lab operations	1-ADMPR	AA1	ALB01	I	-
Admin/Probe 1 thermal oxidizers (solvent exhaust)	1-ADMPR	AS1	TO095 - TO096	K	1A003 - 1A004
Admin/Probe 1 lab operations	1-ADMPR	AS1	ALB01	I	-
Admin/Probe 2 acid scrubbers	2-ADMPR	AA2	AS115 - AS116	K	2A001 - 2A002
Admin/Probe 2 lab operations	2-ADMPR	AA2	ALB02	I	-
Admin/Probe 2 thermal oxidizers (solvent exhaust)	2-ADMPR	AS2	TO097 - TO098	K	2A003 - 2A004
Admin/Probe 2 lab operations	2-ADMPR	AS2	ALB02	I	-

1. APPENDIX R. RESPONSE TO COMMENTS

During review of Permit Application 1, the New York State Department of Environmental Conservation (NYSDEC) sent Micron New York Semiconductor Manufacturing, LLC (Micron) and Trinity Consultants (Trinity) a Notice of Incomplete Application (NOIA) and Technical Review (TR) comment letter. The NOIA was received on June 3, 2024, and the TR comment letter was received on July 19, 2024. Micron and Trinity worked with NYSDEC to resolve most of NYSDEC's comments based on information available during those discussions. Micron will work with NYSDEC to resolve all outstanding comments and any additional comments after submission of Permit Application 2.

This appendix documents Micron and Trinity's responses to each comment and indicates how each comment has been addressed in Permit Application 2. The full text of each comment is included below for reference, with responses provided *in italic font*.

1.1 Responses to NOIA Comments

1.1.1 Uniform Procedures Act 6 NYCRR Part 621

NOIA Comment #1: 6 NYCRR Part 621.3(7)(i)(b) for projects subject to an environmental impact statement, a complete application includes a draft environmental impact statement (DEIS) that has been accepted by the lead agency for public review.

Response: *Comment noted.*

NOIA Comment #2: 6 NYCRR Part 621.3 (4) When a project requires multiple department permits, all applications must be submitted simultaneously, or the applicant must demonstrate to the department's satisfaction that there is good cause not to do so. This includes permit applications associated with infrastructure buildouts where Micron is not the applicant/owner/operator, such as the wastewater treatment SPDES permit application, which DEC requires for the construction and operation of the Micron facility.

Response: Section 621.3(a)(4) calls for all DEC permit applications for a project to be submitted "simultaneously," while Section 621.10(g) envisions issuance of final decisions on all applications to the agency "concurrently." The Department may deviate from this approach for "good cause."

Good cause exists for the NEPA/SEQRA Proposed Project. Given its size and scope, the Proposed Project triggers the need for many NYSDEC permits, both for construction activities and for operations. There are multiple drivers to demonstrate good cause. First, Micron's memory chip manufacturing facility falls under the ambit of the federal CHIPS Act and New York State's Green Chips Program, initiatives that seek to reduce U.S. reliance on foreign production of essential component parts in the semiconductor industry. This addresses a concrete national security concern by minimizing excessive exposure to global supply chain disruptions. Virtually every aspect of the CHIPS Act, whether encouraging development and expansion of

domestic semiconductor manufacturing capacity or streamlining and promoting industry innovation, reflects the need to achieve the statute's goals as soon as practicable.

Second, Micron understands that the magnitude of the NEPA/SEQRA Proposed Project imposes significant burdens on agency resources, and the Title V air permit, which will govern all major aspects of the facility's operations, is particularly complex and demanding. In this instance, it is logical and necessary to accept the Title V air permit application as soon as it is ready for submission and in advance of other important but less demanding applications that can be submitted later to ensure the CHIPS Act's timing objectives are met.

1.1.2 General Comments – Air Permit Application

NOIA Comment #3: Micron's application indicated that they intend to send an air dispersion modeling protocol under a separate cover by the end of May 2024. As of the date of this letter, a modeling protocol has not been received. The "Air Dispersion Modeling Protocol #1" document should be sent to DAR.Meteorology@dec.ny.gov mailbox as soon as possible. If the Protocol document is large, Micron may utilize our DEC File Transfer Service (https://fts.dec.state.ny.us/fts/).

Response: *An initial air dispersion modeling protocol was submitted on June 25, 2024. A revised modeling protocol will be submitted under a separate cover letter in conjunction with this application.*

NOIA Comment #4: The applicant did not provide adequate information regarding emission points. At a minimum, the following information is required: emission point ID, ground elevation, height, height above structure, inside diameter, exit temperature, cross section, exit velocity, exit flow, NYTM coordinates, building, and distance to property line (Appendix A, PDF page 131).

Response: *As described in Permit Application 1, Micron and NYSDEC agreed that Micron should prepare its application materials using a two-step approach, where the first application was based on information known at the time of the submittal, which did not allow submission of detailed emission point information. As part of Permit Application 2, project design has been further defined, and detailed emission point information is identified in Appendix A.*

NOIA Comment #5: The applicant did not provide adequate information regarding emission sources. At a minimum, the following information is required where applicable: emission source ID, emission source type, date of construction, date of operation, control type code, control type description, manufacturer's name/model number, design capacity, design capacity units, and design capacity description (Appendix A, PDF page 131).

Response: *Detailed emission source information is included in Appendix A.*

NOIA Comment #6: The applicant should provide a revised emission unit matrix. The existing matrix does not adequately address all emission sources, emission points, and processes. Nor does the existing matrix

provide a clear source, process, and emission unit associations. The emission unit matrix should be revised to clearly establish the number and size of equipment to be permitted, the proper emission unit and process associations, and any controls serving the equipment (Appendix Q, PDF page 874).

Response: *A revised and expanded emission unit matrix is provided in Appendix Q to this application.*

NOIA Comment #7: The applicant has provided process diagrams that do not adequately demonstrate operations on site. Revised process diagrams should make it exceedingly clear that there are 5+ exhaust types in each of 8 quadrants. It is anticipated additional detail will be required to address varying levels of control, and a significant number of emission points. Nomenclature should be revised to harmonize various process diagrams with the emission unit matrix and requested naming convention (Appendix E, PDF page 166).

Response: *New detailed process flow diagrams are provided in Appendix E to this application. Nomenclature has been reviewed and updated for consistency.*

NOIA Comment #8: The applicant has submitted an incomplete Methods to Determine Compliance form. Applications for Title V permits must provide descriptions of the methods used to determine the compliance status of the facility of each emission unit for each regulated pollutant and applicable requirement. The statement of methods must include a description of all required monitoring, records or tests as well as any other information which the applicant uses to determine whether its facility is complying with the applicable requirements. (Appendix A, PDF page 157)

Response: *Micron plans to develop permit condition language through discussions with the NYSDEC following the submittal of this application. A Methods to Determine Compliance form will be completed as part of that process.*

NOIA Comment #9: The applicant should provide a Confidentiality Justification as described in 6 NYCRR Part 616 for each specific process where confidentiality with restricted access to the public is requested. Confidential process information includes: the design capacity and design capacity units of each emission source; the total throughput quantity per hour and per year and the throughput quantity units; the operating schedule in hours per day and days per year; and the emissions estimation methods used.

Response: *A confidentiality justification was submitted on June 18, 2024.*

NOIA Comment #10: The applicant has not acknowledged the applicability of 6 NYCRR Part 257 to the site. The facility will need to demonstrate compliance with each Air Quality Standard established by this rule. The facility should make special note that the definition of fluorides in 6 NYCRR Part 257-4.1 includes all inorganic fluorides. Particularly this means that the facility needs to incorporate hydrogen fluoride (HF) as a fluoride when determining applicability to all New York State regulations (Appendix F, Table 1-1, PDF page 171).

Response: *The applicability of 6 NYCRR Part 257 is addressed in Section 3.3.10 of this application. The definition of fluorides in 6 NYCRR 257-1.4 does not explicitly include "all inorganic fluorides", but "material that tests as fluoride by methods acceptable to the commissioner". Micron proposes U.S. EPA test methods 13A and 13B, excluding HF as outlined in the North Carolina Department of Environment and Natural Resources (NCDENR) memo referenced in Section 3.3.9.4 of the application, as methods to quantify fluorides subject to §257-4.*

Further, according to the Regulatory Impact Statement published by the NYSDEC to accompany the revisions to Part 257 adopted in 2019, the standards were enacted to address "the deposition of fluoride compounds during the manufacturing of primary aluminum", not gaseous HF emissions.

NOIA Comment #11: The facility is claiming control efficiencies from the Process Equipment Exhaust Conditioners (PEEC) that are going to be installed on site. These units were not included as emission sources in the application.

Response: *As set forth in NYSDEC's TR Comment #1, PEECs are considered a part of the process tools, and therefore are not identified as control sources*.

NOIA Comment #12: The facility will be emitting Per- and polyfluoroalkyl substances (PFAS). Due to the ongoing variability in assessing and managing PFAS compounds, the applicant should openly acknowledge and discuss site operations containing PFAS. The facility is encouraged to create a stand alone permit section discussing PFAS use and control. (Appendix F, PDF page 224)

Response: *Please see Appendix S to this application.*

NOIA Comment #13: The applicant has proposed 789,670 HP worth of engine generation capacity. Although the applicant is seeking to classify these generators as emergency generation, the facility should consider implications this has on ambient air modeling as this many engines would be expected to pose a challenge to meeting emissions standards. The facility should discuss the operation scheme of these generators including how many and when these generators are expecting to operate. (Appendix F, PDF page 238)

Response: *The emergency generators are expected to operate only in the event of a partial or complete loss of power. In the event of a power failure, all emergency generators will switch on at once. The purpose of the generators is not to continue normal operation of the fab, but to operate emergency systems such as lighting, fire detection systems, and safety devices. Production will cease immediately, but power loads to certain tools and control devices will ramp down over time to prevent hazardous conditions. (Appendix H, J, K, L & M)*

In an effort to minimize ambient air impacts, Micron has reevaluated the demand for generators, and has reduced the number of generators planned for the Proposed Air Permit Project to 118. Each generator will be rated at 3350 HP, reducing the total generation capacity of the engines to 395,300 HP. In addition, Micron proposes a permit limit of 100 hours of operation per year for each unit and a permit limit requiring

ramp down of power supply in the hours following an outage event. Under this condition, 38 engines will be limited to no more than 4 consecutive hours of operation in a 24-hr period, 34 engines will be limited to no more than 8 hours of operation in a 24-hr period, while the remaining 46 engines will have no limit on consecutive operation. These proposed limits align with the projected demand over time for emergency power as each fab shuts down. (Appendix F)

NOIA Comment #14: Throughout the application, the various exhaust types are discussed. Although it is clear there are five general process exhaust types (Acid, CVD, Ammonia, Solvent/VOC, General exhaust) it should be made clear how each gas stream will be routed to controls and the atmosphere. When discussing air handling streams, combustion sources should also be discussed. The facility may find revisions to the emission unit matrix and process flow diagrams may solve some of this confusion (Appendix O, PDF page 747).

Response: *The emission unit matrix in Appendix Q and the process flow diagrams in Appendix E have been updated to include more detail on the exhaust configuration of each fab.*

NOIA Comment #15: It is unclear how the applicant intends to reconcile the facility's extremely variable emissions with the permit. The facility has asserted that various process tools and processes may duct through no controls or multiple controls. Further, the application discusses that each Fab will have four quadrants, and each quadrant will have each of the five exhaust types. Given that each quadrant is served by a header and will have dozens of individual stacks, the facility should consider how ducting and emission controls will affect stack testing. If the facility is ducting constantly variable emissions from variable processes to non-conforming stacks, the facility will be forced to conduct stack testing at many more stacks than would be otherwise be allowed based on similar source assumptions (PDF page 747).

Response: *Micron will operate Fab 1 and Fab 2 such that exhaust is routed to the appropriate control devices based on its composition. Moreover, the emission calculations presented in this application utilize conservative factors or assumptions to develop the potential emissions estimates from the facility. Information pertaining to the conservative assumptions implemented are presented in Section 2 of this application and Appendix G to this application. A detailed stack testing plan has been proposed in Appendix T. Revised process flow diagrams have been provided in Appendix E.*

NOIA Comment #16: 40 CFR 60 IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, 40 CFR 60 JJJJ - Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, and 40 CFR 63 ZZZZ - National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines were noted as applicable requirements. DEC has not accepted delegation of these regulations. If the facility would like permit conditions for these regulations, the facility will need to specify which conditions they would like added (Section 3.1, PDF page 48).

Response: *Micron is amenable to generic permit conditions requiring compliance with 40 CFR Part 60 Subpart IIII and 40 CFR Part 63 Subpart ZZZZ. 40 CFR Part 60 Subpart JJJJ will not apply, as all emergency generators and the emergency fire pump will be diesel-fired.*

NOIA Comment #17: 40 CFR 265 subparts AA – Air Emission Standards for Equipment Leaks, 40 CFR 265 BB – Air Emission Standards for Process Vents, and 40 CFR 265 CC – Air Emission Standards for Tanks, Surface Impoundments, and Containers are Federal Resource Conservation and Recovery Act regulations that are outside the purview of air permitting. These regulations will not appear in the facility's Air Title V permit (Section 3.3, PDF page 54).

Response: *References to 40 CFR Part 265, Subparts AA, BB, and CC have been removed from this application.*

NOIA Comment #18: The applicant has presented several assumptions based on "semiconductor process experience" or similar phrasing. Wherever the applicant seeks to apply an assumption that is not commonly accepted, supportive documentation should be provided. In some cases, it is expected that emissions testing reports would have been produced. For example, the emission chemicals for which emission factors were calculated were determined in part based on "semiconductor process experience" (Appendix G, PDF page 276).

Response: *Emission factors based on "semiconductor process experience" are based on iterative assessments and professional engineering judgment of reactions occurring in process tools, POUs, and/or PEECs and decades of experience testing various other facilities in the industry. Test data from other facilities not operated by Micron is confidential to those facilities and cannot be presented with this application. Test data from other Micron facilities in the United States may vary from the Proposed Air Permit Project due to scale and type of operation (e.g., research & development, as opposed to high volume manufacturing). Micron has proposed a detailed stack testing plan in Appendix T to this application, in part to demonstrate to the NYSDEC that emission factors are appropriate.*

NOIA Comment #19: The applicant has referenced a number of documents that are not routinely used by the Department. The facility should provide an appendix which includes applicable sections of any reference the Department or public would not be able to reasonably view online for free. For example, Semiconductor Industry Wafer Fab Exhaust Management cited as footnote 17 on PDF page (PDF page 31, footnote 17).

Response: *Documents cited in the application that are not routinely used by the NYSDEC are included in Appendix U.*

1.1.3 Emission Calculations

NOIA Comment #20: The applicant has regularly asserted that the nature of Micron's business requires a rapidly changing product mix, which may result in different materials or quantities used. This approach to operations would normal yield highly conservative projected material use. The applicant asserts that Fab 2,

however, is only expected to require 75% of the raw material usage as Fab1. This assumption should be further discussed and justified. (Section 2.1.1, PDF page 29).

Response: *Projected raw material usage has been revised in this application. It is now assumed that Fab 1 and Fab 2 will have equal raw material usage.*

NOIA Comment #21: The applicant has provided emissions estimates despite not providing the size and throughput of proposed process equipment. Equipment operating parameters are necessary to establish Potential to Emit (PTE), and Emission Rate Potentials (ERP). At this point, no emissions are verifiable as the applicant has not even provided similar process data for existing facilities elsewhere in the country.

Response: *As discussed with the NYSDEC since the submittal of Permit Application 1, the PTE and ERP are calculated based on total projected raw material usage for Fab 1 and Fab 2, not based on individual tool parameters, since the number, type, size, and function of tools will change frequently as part of leading-edge technology advancement. The PTE and ERP values in this application are estimated using conservative assumptions. Micron proposes to verify an appropriate subset of these conservative estimates through the stack testing plan outlined in Appendix T.*

NOIA Comment #22: The facility has applied a process emission factor to demonstrate how much of a contaminant will be emitted vs how much will be consumed by the process. This is significantly reducing emissions of the facility prior to control. The facility will need to provide justification for each contaminant demonstrating that the given fraction is truly indicative of chemical quantities emitted. (Section 2.1.4, PDF page 31).

Response: *Micron has proposed a detailed stack testing plan in Appendix T to this application, in part to demonstrate to the NYSDEC that the emission factors described above are appropriate and conservatively estimate emissions.*

NOIA Comment #23: It appears the applicant is providing pre-control process emissions on a pound per year basis after applying the PEEC fraction managed. The facility should provide pre-control emission values before being managed by the PEEC units. This would be indicative of the Emission Rate Potential (ERP) (Appendix F, Table 6-1, PDF page 186).

Response: *As set forth in NYSDEC's TR Comment #1, PEECs are considered a part of the process tools, and therefore ERP is set at the outlet of the PEECs*.

NOIA Comment #24: The applicant has proposed emission calculations utilizing emission chemicals that are chemically unique from the raw material chemicals. Although this methodology may be acceptable, the facility should provide supporting documentation in any cases where oxidation or reactions with other emission contaminants yield a new contaminant. Ideally the facility will provide stack testing data verifying these reactions are occurring. With regards to permitting, the facility should consider that each contaminant, either as a process chemical or emission chemical, will need to be assessed against the relevant regulatory

requirements independent of how it interacts with other contaminants in the gas stream. (Appendix G, Section 1.1.2.2, PDF page 275).

Response: *Micron has proposed a detailed stack testing plan in Appendix T to this application, in part to demonstrate to the NYSDEC that the emission factors described above are appropriate and conservative. In addition, the emission contaminants proposed by the NYSDEC in TR Comment #12 have been incorporated into this application.*

NOIA Comment #25: Micron has provided a number of assumed control efficiencies for the various control equipment on site. The applicant should provide documentation to support these assumptions. For example, the applicant states: "For the purposes of calculating emissions and analyzing Part 212 requirements, Micron has elected to assume 98% control efficiency of the RCTOs is achieved" (Section 3.4.4.15.4, PDF page 78)

Response: *A detailed set of internal equipment specifications for each proposed type of control device is included in Appendix V to this application.*

1.1.4 New Source Review (NSR) and Prevention of Significant Deterioration (PSD)

NOIA Comment #26: The applicant is currently determining the scope of properties associated with proposed air permit. In the submitted documentation, the facility has excluded the childcare center and rail spur sites from its evaluation. Although the Department will continue to engage with the site on what properties should be included, the inherent inclusion of these properties implies they should be considered a part of the project as both sites are being built exclusively to serve the facility (Section 1.2.1, PDF page 17).

Response: *The intent of Section 1.2.1 of Permit Application 1 was to provide Micron's justification for excluding the childcare center from evaluation, especially given that it will be included in other environmental reviews, such as the environmental impact statement (EIS). After considering this reason for its inclusion for that limited purpose, the NYSDEC has agreed that the childcare center should not be included in the scope of the Proposed Air Permit Project. At the time of Permit Application 1, the details surrounding the rail spur and associated conveyance system were still being developed. On October 23, 2024, Micron and Trinity submitted a memo detailing the position that the rail spur conveyance equipment and other construction equipment should be excluded from the scope of the Proposed Air Permit Project and permitted by its third-party operator, as necessary. To further demonstrate that Micron will not own nor operate the equipment in question, requests for proposal that have been used by Micron to solicit potential vendors to carry out rail spur operation are included in Appendix V to this application. Requests for proposal that are being used by Micron to solicit potential vendors to carry out fab construction will be provided once available under a separate cover letter.*

NOIA Comment #27: The applicant has stated that Fab 1 and Fab 2 will be major for PSD and NNSR and therefore there is no reason or intent to circumvent PSD/NNSR permitting when Fab 3 and Fab 4 undergo permitting. Although this may be the case, the applicant needs to revise how Fab 3 and 4 are addressed in

the application. It should be exceedingly clear that Fabs 1 and 2 are subject to PSD/NNSR and that Fabs 3 and 4 will also be subject to PSD/NNSR when the applicant chooses to undertake permitting of the final two Fabs (Section 1.2.1.2.2, PDF page 19).

Response: *Fab 1 and Fab 2 are subject to PSD/NNSR. Micron acknowledges that Fab 3 and Fab 4 will also likely be subject to PSD/NNSR when permitted in the future. However, Fab 3 and Fab 4 are not "substantially related" to Fab 1 and Fab 2 and are therefore excluded from this Proposed Air Permit Project. Section 1.2.1.2.2 of this application has been revised to increase the clarity pertaining to Fab 3 and Fab 4 not being "substantially related" to Fab 1 and Fab 2.*

NOIA Comment #28: The applicant has provided initial Emission Reduction Credit (ERC) quantities expected to be utilized, however, the applicant will need to provide additional information to facilitate the forfeiture of credits. The applicant will be required to submit emission source IDs and proposed project descriptions in addition to CAS numbers for the contaminant for which ERCs are being used, project emission potential (PEP), statement of compliance, and source of emission reduction credits (Appendix A, PDF page 146).

Response: *Appendix F to this application provides updated estimates of the quantity of ERCs to be retired. Micron plans to formally retire ERCs prior to the public comment period for the Title V permit.*

NOIA Comment #29: The facility has been required to consider BACT for multiple contaminants. In situations where LAER is not already applied, the BACT analysis should consider the cost feasibility of compiling exhaust streams to a centralized control device.

Response: *The exhaust configuration planned for Fab 1 and Fab 2 already includes centralized control devices that will operate in parallel to control exhaust that is vented from many individual tools to a common header. In discussing this comment further, the NYSDEC clarified that the intent of the comment was to ask Micron to consider one set of larger centralized control devices instead of multiple sets of centralized control devices per fab. Each fab will have two "halves" with separate exhaust systems to allow for gradual construction and startup. The centralized control devices are appropriately sized for their applications. Replacing several smaller units with fewer larger units would undermine the purposeful redundancy built into the exhaust configurations and exceed physical size constraints. For these reasons, it is not technically feasible to reduce the number of centralized control devices by increasing their size, nor would that necessarily have a positive impact on emissions of pollutants subject to BACT analyses.*

NOIA Comment #30: The applicant has completed BACT analyses for several sources on site. Some of the sources included in the BACT assessment are categorized as control equipment. The facility should be advised that a BACT assessment is not required for controls and may be removed from the application.

Response: *The BACT and LAER analyses presented in this application have been updated to remove control equipment from consideration as sources subject to BACT and LAER.*

NOIA Comment #31: The facility has indicated a waiver for the requirement to submit air quality monitoring data pursuant 6 NYCRR Part 231-12.3(c) will be submitted under a separate cover. This documentation should be submitted as soon as possible to facilitate Department (Section 4.1.2, PDF page 88).

Response: *A waiver for the requirements to submit air quality monitoring data is provided as an appendix to the air dispersion modeling protocol submitted under a separate cover letter in conjunction with this application.*

1.1.5 RACT/BACT/LAER Analyses

NOIA Comment #32: The applicant has proposed good combustion practices for emission controls of carbon monoxide from natural gas combustion devices and semiconductor process tools and oxidation systems. The application also notes that items such as insulation, oxygen trim controls are not considered a separate control and are considered good combustion practices and therefore will not be evaluated. Since these were indicated as the chosen BACT, these controls should be explicitly noted and discuss since this control will need to be incorporated to the SIP (Appendix J, PDF page 359).

Response: *The BACT and LAER analyses presented Appendix H, J, K, L & M to this application include additional details on the specific "good combustion practices" that will be implemented to satisfy BACT and/or LAER.*

NOIA Comment #33: The applicant does not appear to have considered all possible control technologies to manage Nitrogen Oxides. The facility should conduct an analysis on Oxy-fuel combustion.

Response: *Oxy-fuel combustion is considered in the NOx BACT/LAER analysis in Appendix H to this application.*

NOIA Comment #34: GHG BACT

a. The applicant has eliminated Carbon Capture and Storage (CCS) from the GHG BACT evaluation in part due to a lack of projects in New York to assess the suitability of geology for permanent carbon storage. This is despite two industrial projects demonstrating feasibility. The intent of the BACT analysis is to assess technological and economic feasibility, therefore, the applicant should continue to assess this technology as a control technology (Appendix L, Section 1.1.8, PDF page 578).
b. The applicant has eliminated Carbon Capture and Storage (CCS) from the GHG BACT evaluation because it was already considered on a facility level. BACT evaluations are to be applied on a source level, therefore, each source should be considered for CCS since the technology may be feasible for individual sources (Appendix L, Section 1.1.8, PDF page 578).
c. The applicant appears to have missed one portion of the facility for the GHG BACT analysis. Since many of the circuit breakers in switchyards use SF6 the applicant should either state that they are using a different medium in the proposed circuit breakers or complete a BACT analysis for alternatives.

Response: *A more detailed assessment of CCS on a source-by-source basis is included in the GHG BACT analysis in Appendix L to this application. An estimate of fugitive emissions of SF_6 from use for electrical insulation and an analysis of potential controls or alternatives has been incorporated throughout this application, including in the emission calculations in Appendix F, the GHG BACT analysis in Appendix L, and the CLCPA analysis that will be submitted under a separate cover letter in conjunction with this application..*

1.1.6 CLCPA

NOTE: As agreed upon between Micron, NYSDEC, and Trinity during a February 5, 2025 meeting, the CLCPA analysis originally submitted as Appendix O to Permit Application 1 has been updated to include a broader scope in addition to stationary air quality impacts. The updated CLCPA analysis will be submitted under a separate cover letter under the Draft Environmental Impact Statement.

NOIA Comment #35: There are several references to draft DEP-23-1 throughout the analysis. These should be corrected to reflect DEP-24-1 now that it has been finalized.

Response: *References to draft DEP-23-1 have been updated to reference DEP-24-1.*

NOIA Comment #36: Table 3.1 of the CLCPA analysis includes various global warming potentials (GWPs) used in the analysis, some of which are presented on a 100-year basis. Chapter 7 of IPCC's 2021 Sixth Assessment Report (AR6) provides additional 20-year GWPs for various compounds. These values should be used where 20- year GWPs are not available in earlier reports. Another potential source for 20-year GWPs is the World Meteorological Organization. Please determine if additional 20-year GWPs are available and update the associated calculations accordingly (PDF page 717).

Response: *The CLCPA analysis will be updated to incorporate 20-year GWP values from AR6 where appropriate.*

NOIA Comment #37: Section 1.2.2.1 indicates that Micron plans to utilize 100% renewable energy for purchased electricity during the operational phase of the project. This section further indicates that some or all of this energy could be generated outside of New York State. As discussed in DAR-21, Micron should include any imported electricity in its CLCPA Section 7(2) analysis (PDF page 708).

Response: *At the time of this application, Micron expects to purchase 100% of the electricity used at the site of the Proposed Air Permit Project directly from the local grid. As such, Micron will not have line of sight to the source of generation of its electricity, and cannot estimate how much, if any, of its electricity will be imported. Micron plans to achieve its carbon-free energy goals by offsetting the amount of non-renewable electricity used at the Proposed Air Permit Project with virtual power purchase agreements (VPPAs) and other measures. Micron's VPPAs will be associated with carbon-free power generation in other locations, which will be used by third parties. This carbon-ree power will not be imported into New York State.*

NOIA Comment #38: Section 1.2.2.1 indicates that Micron will evaluate the feasibility of onsite renewable energy systems and revisit such evaluations periodically. However, this application is for the construction of a new facility. Please discuss why onsite renewable energy systems such as solar panels or other technologies have not been incorporated into the design given the stated commitment to renewable energy and the overall power demands of the project (PDF page 708).

Response: *At this time, Micron can commit to installing solar panels on top of numerous non-production buildings. The proposed solar panels are projected to generate at least 4 Megawatts (MW) of electricity. Micron will continue to evaluate other onsite renewable energy systems as the design progresses.*

NOIA Comment #39: Section 2.3.2 indicates "…all carbon-based compounds that enter a tool-level thermal oxidation system or RCTO are assumed to oxidize fully to CO2 as a conservative assumption in addition to forming other potential carbon-containing byproducts." Please elaborate on why this is a conservative assumption (PDF page 715).

Response: *Permit Application 2 assumes that all carbon-based compounds will fully oxidize to CO_2, and in addition, applies appropriate emission factors for other carbon-based compounds, including those published by the Intergovernmental Panel on Climate Change (IPCC) that are used to estimate emissions of hydrofluorocarbon (HFC) and perfluorocarbon (PFC) gases. The carbon atoms in HFC and PFC gases that are assumed to be emitted are double counted; they are calculated as being emitted as CO_2 in addition to as the HFC or PFC. This approach is outlined in more detail in Section 2.2 of this application.*

NOIA Comment #40: The second to last paragraph of Section 3.3.1.1.2 indicates that Micron intends to purchase burners that are certified to reduce tetrafluoromethane (CF4) emissions from the process equipment exhaust conditioners (PEECs). However, the following paragraph indicates that Micron will *evaluate* (emphasis added) obtaining PEECs equipped with burners designed to minimize CF4 formation. Please clarify whether the PEECs will be equipped with burners designed to minimize CF4 emissions (PDF page 720).

Response: *Micron cannot ensure that suppliers will, in all applications, be able to certify PEECs to minimize CF_4 formation while meeting the performance obligations required to maintain safe operation of the fab. Micron will consider certification to minimize CF4 formation when selecting PEEC vendors and proposes to comply with a permit condition requiring documentation of this selection process. Micron will propose specific condition language as part of a future submittal.*

NOIA Comment #41: Section 3.3.3 indicates that electrically heated equipment was considered as a potential alternative to fossil fuel fired equipment. However, this section does not appear to discuss the feasibility of other potential alternatives such as equipment that combusts hydrogen or hydrogen blends, methane/natural gas fuel cells, and on-site renewable energy paired with battery storage systems. Please discuss the feasibility of these potential alternatives and any other potential technologies that would reduce the use of fossil fuels (PDF page 723).

Response: *Additional alternatives to fossil fuel fired equipment, such as green hydrogen, green ammonia, and biomethane, are discussed in the CLCPA analysis.*

NOIA Comment #42: Section 3.3.3.1.3 suggests that centralized regenerative catalytic systems (RCS) are a potential alternative that would reduce reliance on natural gas and reduce GHG emissions from natural gas combustion while effectively mitigating fluorinated greenhouse gas (F-GHG) emissions. The text further indicates that RCS have not been proven in the United States (emphasis added) but does not discuss whether such systems have been proven elsewhere. Please clarify whether RCS systems have been used elsewhere, and if so, whether they will be installed at the proposed facility (PDF page 724).

Response: *Micron plans to install RCS units as part of the Proposed Air Permit Project. The CLCPA analysis will be updated to reflect this change.*

NOIA Comment #43: Section 3.3.3.5 indicates that Micron plans to install several stationary internal combustion engines to provide emergency power. However, the application does not discuss the feasibility of alternatives such as equipment fired using hydrogen or hydrogen blends, methane/natural gas fuel cells, or renewable energy paired with battery storage systems for this purpose. Please include discussion of these potential alternatives in the revised analysis (PDF page 726).

Response: *The discussion of alternatives to diesel-fired emergency generators will be expanded in the CLCPA analysis.*

NOIA Comment #44: Several portions of Section 3.4 describe measures identified as GHG BACT as mitigation. Both DAR-21 and CP-49 require mitigation measures to go beyond what an applicant is already required to do by existing laws and regulations. Accordingly, it is not appropriate to classify measures established as GHG BACT as mitigation even though they may reduce or minimize GHG emissions from the project consistent with the requirements of New Source Review. Some potential mitigation measures which could be evaluated include, but are not limited to:

a. The installation of high-efficiency lighting and/or other building and process systems (e.g. vacuum pumps, variable frequency drive motors, etc.)
b. The installation of on-site solar photovoltaic systems and/or other renewable energy systems
c. Shared POU abatement systems to reduce fossil fuel consumption
d. Improved process control software to modulate natural gas flow to control devices based on the flow rate and composition of the process gas being controlled
e. Projects within the local community such as electric vehicle charging stations, funding for electric school or transit buses, forestry and afforestation projects, etc.

Response: *Additional mitigation measures are proposed in the CLCPA analysis.*

NOIA Comment #45: Section 3.4.3.1 indicates that it was assumed the "high-fire" mode of the proposed thermal oxidation systems was always active to conservatively estimate GHG emissions. It is further indicated that Micron will mitigate GHG emissions by ensuring that "high-fire" mode is only used as needed.

Please describe what specific additional steps will be taken by Micron beyond the normal process automation built into the thermal oxidation systems themselves such that this would be appropriately considered as a potential mitigation measure (PDF page 729).

Response: *Micron acknowledges that the steps it will take to minimize use of "high-fire" mode are consistent with typical best practices for operating thermal oxidation systems, and has not considered these practices to be a formal mitigation measure in the updated CLCPA analysis.*

NOIA Comment #46: Section 3.4.3.4 indicates that the proposed boilers will only be needed during the construction and start-up phases of the project. Please provide an estimate of when the boilers would be removed and include the resulting change in GHG emissions in the projected actual GHG emissions from the facility in Section 3.5, if appropriate (PDF page 729).

Response: *Micron has determined that the boilers may be required to supplement planned fab heat recovery systems once construction and startup are completed. A limit of 6,000 hours of operation per year is proposed for each boiler.*

NOIA Comment #47: Section 3.4.3.5 states that Micron will mitigate emissions from the proposed emergency engines by limiting their hours of operation. However, this section does not propose an operational limit. Please propose a limit and quantify the resulting GHG reduction (PDF page 730).

Response: *Micron proposes a limit of 100 hours of operation per year for each emergency engine. Further, Micron proposes limits on the number of emergency engines that may operate for an extended period of time. No more than 80 of the 118 planned emergency engines may operate for more than 8 hours in a given 24-hour period, and no more than 36 engines may operate for more than 4 consecutive hours.*

NOIA Comment #48: Section 3.4.4 indicates that proposed process chillers will be equipped with level alarms that will alert operators to heat transfer fluid leaks. The text also states that frequent leaks will be evaluated and repaired expeditiously. While this may have the effect of reducing GHG emissions from the facility, DEC regulations require that all emission sources be operated consistent with the manufacturer's specifications and good engineering practice. Accordingly, this practice is not acceptable as a mitigation measure as Micron is already required to promptly repair leaks (PDF page 730).

Response: *Micron has implemented a global tracking system that notifies equipment maintenance teams of any high fluorinated heat transfer fluid consumption. This is performed through tracking heat exchanger top off volumes in a global dashboard. When triggered for an out of spec condition, equipment teams will leak check the system with handheld point of use detectors and remedy leaks as needed. The HTF loops are typically customized to fab design and each loop may be different. Therefore, there are no standardized manufacturer recommendations for this type of maintenance.*

While there are recommendations from manufacturers on fittings and hoses for HTF loops, following these recommendations do not prevent all leaks. Also, manufacturer recommendations do not cover the loops outside of their equipment. Micron's global program was devised and implemented to further mitigate and

respond quickly to potential leaks. For these reasons, Micron believes that its global HTF leak reduction program should be considered mitigation.

NOIA Comment #49: The projected GHG emissions shown in Section 3.5 indicate that Micron is unable to foresee a difference in the design maximum emissions between 2030 and 2050. However, the analysis also indicates that Fab 1 will become operational in approximately 2030 with Fab 2 being constructed sometime thereafter. Accordingly, the projected emissions for 2030 should reflect the design maximum for Fab 1 only, whereas the projection for 2050 would include the operation of both Fab 1 and Fab 2 (PDF page 732).

Response: *The estimates of 2030 and 2050 emissions will be updated in the CLCPA analysis to reflect the assumption that Fab 2 will not be fully operational by 2030.*

NOIA Comment #50: Portions of Section 5 focus on the proposed project location and other site- specific concerns (e.g. building configuration) as potential justification for the project. While these details are important to the overall environmental review, they appear to justify the proposed location rather than the potential GHG impacts from the project. Accordingly, please revise this section to provide potential justification for the various process design considerations, emissions controls, and other related factors. The section should discuss the specific actions that will be taken to minimize any GHG impacts and otherwise indicate why the project should be approved despite any remaining impacts (PDF page 735).

Response: *The justification section of the CLCPA analysis will be revised and expanded to increase the focus on GHG mitigation efforts and importance of the Proposed Air Permit Project.*

NOIA Comment #51: The Upstream CO2e emission factor utilized in Appendix F Table 17-2 is for natural gas but the factor for diesel should be used instead (PDF page 238).

Response: *The Upstream CO_2e factor has been revised in Appendix F to this application.*

NOIA Comment #52: The Upstream CO2e emission factor utilized in Appendix F Table 18-2 is in units of lb/MMBtu even though the column header indicates kg/MMBtu. Please correct the PTE calculation accordingly (PDF page 240).

Response: *Table 18-2 has been removed from Appendix F to this application, as there are no longer plans to install natural gas-fired emergency generators.*

1.1.7 Air Toxics

NOIA Comment #53: Mass-Based Thresholds: The last sentence of the second bullet should be edited as follows with the addition of the underlined text: "Per DAR-1, this applies to compounds that are listed in DAR-1, but which are not Table 2 HTACs, and other compounds that are not listed on DAR-1,

but which are determined as not having the potential to be classified as high toxicity" (Section 3.4.4.3, PDF page 61).

a. The same wording that is used for the HTAC MEL in the first bullet of "require no further evaluation under Part 212" could be used for those non-High Toxicity Air Contaminants with actual annual emissions less than 100 lbs/yr. Alternatively, the wording used in the DAR-1 guidance document of "meeting the provisions of 212-1.5(g)" could be used.

Response: *The section referenced above, now Section 3.3.4.3, has been updated as suggested.*

NOIA Comment #54: Mass-Based Thresholds, third bullet: This sentence should be edited as follows with the addition of the underlined text: "The NYSDEC DAR Air Toxics Section has provided guidance that Part 212 applicability determinations require modeling if chemical compounds that are not listed on DAR-1, but which are determined as having the potential to be classified as high toxicity, but as not being dioxins, furans, or dioxin-like compounds, exceed the second lowest MEL established for a Table 2 HTAC of 0.1 lb/yr" (Section 3.4.4.3, PDF page 61).

Response: *The bullet referenced above has been removed from Section 3.3.4.3 as it is no longer relevant.*

NOIA Comment #55: The Department will continue to determine the appropriate annual MELs, as well as the Guideline Concentrations (AGCs and/or SGCs) and toxicity classifications, to be used for the unlisted air contaminants that are part of the Micron facility's emissions profile (Section 3.4.4.3, PDF page 61).

Response: *Micron understands that the NYSDEC's work to determine appropriate MELs, AGCs, SGCs, and toxicity classifications for unlisted air contaminants is ongoing. The status of this work as of this application submittal is documented in Table 34-1 of Appendix F to this application.*

NOIA Comment #56: There is a subset of the unlisted air contaminants indicated to be among the Micron facility's emissions profile that actually have been "previously assessed by the NYSDEC". However, these are getting reassessed as part of this project. Therefore, the first sentence of this section should be edited with the addition of the underlined text as follows: "As part of the process described in Section 3.4.4.4, Micron is proposing to characterize the Environmental Rating/toxicity classification and establish interim AGCs/SGCs (annual and short-term guideline concentrations) for compounds that have not yet been officially listed in the DAR-1 AGC/SGC Tables by the NYSDEC" (Section 3.4.4.5, PDF page 62).

Response: *Micron is not reevaluating all Environmental Ratings and interim AGCs/SGCs provided by NYSDEC, so the language in Section 3.3.4.4 appropriately describes the process.*

NOIA Comment #57: Micron should be speciating out the PM being emitted from the facility's cooling towers into the individual chemical constituents to the fullest extent possible (Section 3.4.4.8, last paragraph, PDF page 69).

Response: *Micron and the NYSDEC agreed that PM from cooling towers does not need to be speciated, as Micron will be using municipal water for cooling and will not have clear line of sight to the potential PM constituents present in that water. Chemicals added by Micron to cooling water have been speciated in emissions estimates.*

NOIA Comment #58: Methane, ethane, and propane do not need to be included in the Part 212 Air Toxics regulation's Toxic Impact Analysis (TIA) and associated air dispersion modeling.

Response: *Methane, ethane, and propane are no longer addressed with respect to Part 212 compliance in Section 3.3.4 of this application.*

NOIA Comment #59: The work described in Section 3.4.4.5 of "Table 3-3 below lists the analog groups that have been proposed to the NYSDEC. Additional detail is presented in Table 1-3 of Appendix F. If the NYSDEC does not approve a proposed analog group, Environmental Rating, or interim AGC/SGC, updates will be made to this evaluation as a part of Permit Application 2." continues to be ongoing (Section 3.4.4.5 (PDF page 63).

Response: *Micron understands that the NYSDEC's work to determine appropriate analog groups, AGCs, SGCs, and toxicity classifications for unlisted air contaminants is ongoing. The analog groups approved by the NYSDEC to this point are shown in Table 1-4 of Appendix F to this application.*

NOIA Comment #60: In section 3.4.4.15.3 (PDF page 78) the Department believes that "tungsten trioxide" was intended to be indicated, rather than "tungsten dioxide" in the two following sentences:

- "If it is determined to be B- or C-rated, the emissions of tungsten dioxide will be subject to air dispersion modeling to demonstrate compliance with Part 212."
- "Notwithstanding this approach, emissions of tungsten dioxide will be included in air dispersion modeling."

Response: *Micron agrees that "tungsten trioxide" was erroneously referred to as "tungsten dioxide". Section 3.3.4 has been revised such that this level of detail is no longer provided in the narrative. Please refer to Table 1-3 of Appendix F.*

NOIA Comment #61 (*Mislabeled as #58 in the NOIA*): Table 1-2 (PDF pages 770-772):

- Tetrafluoromethane (CAS# 75-73-0) has an AGC of 330 µg m^{-3}, not 300 µg m^{-3} as indicated.
- To our knowledge, CAS #s [redacted] and 7681-52-9 were never provided to the ATS. Both of these air contaminants have had previous assessments of them performed by the ATS and the results of those chemical reviews are below:

CAS#	AGC ug/m³	SGC ug/m³	Toxicity Classification	Derivation Method
[redacted]			HIGH	Analogy to CAS# [redacted]
7681-52-9	2.0E-01	116	MODERATE	Analogy to CAS# 7782-50-5

Based on the above results, the ERs of CAS #s [redacted] and 7681-52-9 should be "INT-A" and "INT-B", respectively.

Response: *The AGC of tetrafluoromethane has been updated. The previous NYSDEC reviews for the compounds with CAS [redacted] and 7681-52-9 have been incorporated into this application where appropriate.*

1.2 Responses to TR Comments

1.2.1 General Comments

TR Comment #1: As a point of clarification from the NOIA dated June 3, 2024, the Process Equipment Exhaust Conditioners (PEECs) will be considered incorporated as a part of the process tools, and therefore will not be independently named control sources. Emission Rate Potential (ERP) shall be established as emissions that are emitted from process tools after being processed by the PEEC units.

Response: *In this application, PEECs have not been named as individual control sources, and ERP has been established at the outlet of the PEECs.*

TR Comment #2: The facility was previously advised to assess compliance with 6 NYCRR Part 257 with special concern for gaseous fluorides, however, the facility may also be required to comply with the Total Fluorides standards of this rule. Due to ongoing refinements in facility emission calculations, the facility would benefit from preemptively assessing total fluorides which may be present in and on forage for consumption by grazing ruminants.

Response: *Per verbal guidance from the NYSDEC, air dispersion modeling for gaseous fluorides regulated by Part 257 will satisfy the applicable requirements of Part 257. The applicability of Part 257 is addressed in Section 3.3.10 of this application.*

TR Comment #3: Construction of the facility is anticipated to be ongoing for several years and will consume significant amounts of construction material processed by emission sources such as concrete batch plants, crushers, and screeners. The facility will need to incorporate any construction related equipment and associated emissions in the upcoming revisions to the permit application for each source that will not be considered temporary and/or portable as addressed by 6 NYCRR 201-2.1(b)(29) and 6 NYCRR Part 201-2.1(b)(24).

Response: *Micron and Trinity submitted a memo to the NYSDEC on October 23, 2024, explaining that a third party will own and operate this equipment and should be responsible for its own permitting, as necessary, including the construction-related equipment and conveyance system planned in conjunction with the proposed rail spur. Micron will neither own nor operate this equipment and asserts that "common control" will not exist between the Proposed Air Permit Project and the construction and rail spur equipment. Therefore, the construction and rail spur equipment are not included in this application. The rail spur request for proposal is included in Appendix V demonstrating Micron's plans for vendors to own and operate the construction-related equipment and conveyance system. Construction requests for proposals will be provided under a separate cover letter.*

TR Comment #4: The facility is currently proposing to produce significant amounts of Ozone for use in the thin films process. Although much of this Ozone will be managed by the PEEC units, the facility should provide a discussion to the Department of how any remaining ozone will interact with other process emissions being ducted to the centralized acid scrubbers and CVD scrubbers and whether all expected reaction products are accounted for in the facility emission summary. (PDF page 72, Section 3.4.4.12)

Response: *The vast majority of ozone generated will be destroyed in ozone destruct units before it may enter a tool. When ozone is needed, it will be routed to the tool instead of to the ozone destruct unit. This selective usage is conservatively ignored in the emissions calculations. In addition, an estimated 99.9% of ozone exiting the tools will be destroyed in a PEEC. The small amount of oxygen remaining in the exhaust is not expected to affect the emission chemicals otherwise estimated. Each primary chemical used in thin films/diffusion deposition tools is expected to fully oxidize in the tool and PEEC in most circumstances, already accounting for potential oxidation due to the presence of ozone.*

TR Comment #5: The facility has asserted that the exhaust from process tools will be routed to a common header then distributed from the header to multiple similar control devices along the length of the header. Each exhaust type will therefore have dozens of individual stacks at each Fab 1 and Fab 2. The facility should provide a discussion on control equipment operation which clarifies how units in parallel will be sized and operated to ensure there will not be excess emissions from the site. This discussion should provide answers to the following concerns:

a. How many control units in parallel will be able to be offline at one time;
b. How are control units sized to account for variability in process emission concentration and parallel unit downtime;
c. Why control devices in series were not the preferred design;
d. The facility will have to propose a robust emissions testing program to test stacks that will inevitably have concentration and flow variability based on which process tools and controls are operating.

Response: *For all fab exhaust headers, redundant units in parallel will be able to be offline without affecting the performance of the system. Units are sized appropriately such that when the redundant units in parallel are not running, the maximum potential pollutant load can be handled by the remaining units. Every exhaust header includes redundant units that are not expected to operate unless necessary. Due to the extremely large amounts of airflow necessary for proper operation of the fab, units in parallel are preferrable so that many smaller units can be purchased as opposed to fewer larger units. Many smaller units are preferable as they are able to perform to the level needed and fit within space constraints. It*

should be noted that the centralized control units Micron will purchase are larger than most units seen in use in the semiconductor industry. In a future submittal, Micron will propose permit language specifying the minimum number of control units per exhaust type.

TR Comment #6: According to Table 3-1 on PDF page 53: ammonia exhaust is indicated that "No NESHAP Subpart BBBBB process units are directly vented to the ammonia exhaust. However, there is the potential for trace inorganic HAP due to potential intermingling with fab acid and CVD exhausts". The site has long asserted that separate exhaust headers are being used for each exhaust type, if this continues to be the case, then how would contaminants intermingle? (PDF page 53, Section 3.2.3)

Response: *Fab 1 and Fab 2 will be designed and operated such that exhaust is segregated to the extent practicable, i.e., process tools exhausting primarily acidic materials will be routed to the acid exhaust and process tools exhausting primarily caustic materials will be routed to the ammonia exhaust. However, there is a potential that trace exhaust may not be fully segregated to the corresponding header, especially from tools that have the potential to route exhaust to multiple headers. To demonstrate that the amount of inorganic HAP incidentally intermingling with the ammonia exhaust is negligible, Micron proposes to test a representative sample of ammonia scrubber stacks for inorganic HAP. A detailed stack testing plan has been proposed in Appendix T.*

TR Comment #7: The applicant has proposed to build a wastewater treatment plant to manage facility wastewater, though discussions with other Department divisions has yielded that the site may also be considering improvements to an offsite wastewater treatment plant. The applicant will need to determine which construction scheme will be utilized prior to submission of changes to the facility application. (PDF page 748, Section 2.3.4)

Response: *This application assumes that Micron will construct and operate its own wastewater treatment plant, including a biological treatment facility. Negotiations with other parties on the potential for improved offsite treatment are ongoing.*

1.2.2 Emission Calculations, Factors, and Derivations

TR Comment #8: In review of the emissions calculations spreadsheet provided by the applicant, the Department has developed comments that the applicant should correct or clarify as applicable.

a. In the Emissions Calcs Excel Sheet, Tab 9, Row 28, the fourth footnote indicates that "Leak rates based on historical loss rates of heat transfer fluids at similar facilities" The facility should provide a discussion which would support these assumptions. This discussion should include considerations such as differences in equipment type and quantity used at each site, whether the Heat Transfer Fluid is utilized in the same application, and how Heat Transfer Fluid leaks are quantified at the similar facility?
b. In the Emissions Calcs Excel Sheet, Tab 10, how was the total usage for isopropanol quantified? Was the information derived from a similar facility?

Response:

a. *In Table 9-1 of the emission calculations in Appendix F to this application, heat transfer fluid (HTF) annual usage, assumed to correspond with annual leak rates, has been updated based on recent data from comparable Micron facilities in other locations outside of the United States. These other Micron facilities use the same or similar HTFs that are currently projected for use in Fab 1 and Fab 2 for the same application, i.e., use in-process chillers to regulate the temperature of tools.*
b. *In Table 10-1 of the emission calculations in Appendix F to this application, total isopropanol usage was estimated using the same set of Micron internal procurement projections that was used to estimate usage of other chemicals used in fab processes.*

TR Comment #9: During the Department review, a discrepancy between the quantity of sources and stacks listed in the Total Emissions Calc Excel Sheet and the Modeling Protocol was discovered. For example, on Tab 20 on the excel sheet, the amount of cooling towers listed is 471 and 13 for a total of 484 while the modeling protocol under Table 5-1 lists 605 and 12 for a total of 617. Another example is the quantity of water bath vaporizers listed in Tab 15 which shows 5 active and 5 redundant for a total of 10 while the modeling protocol under Table 5-1 lists 8. Please clarify and update what the final count is for all sources and stacks so that both the Modeling Protocol and the Excel Sheet are consistent.

Response: *The discrepancies between Permit Application 1 and the initial air dispersion modeling protocol noted above have been resolved in Permit Application 2 and the revised air dispersion modeling protocol.*

TR Comment #10: The facility should clarify in emission calculations documentation which solvents are being used for which processes (ISP vs methanol) to minimize confusion of which emissions are solvent fugitives vs process emissions.

Response: *The two solvents that will be used for general cleaning resulting in fugitive emissions are isopropanol and methanol. The portion of isopropanol used for general fab cleaning is addressed on Table 10-1 of the emission calculations in Appendix F to this application. Isopropanol used in fab processes is addressed on Table 6-1. Methanol is used for cleaning a very specific type of equipment that is used in photolithography tools. Emissions of methanol used in this manner are differentiated by the fact that they will vent through the general exhaust. All other solvent will be used in fab processes.*

TR Comment #11: Whenever relevant, the facility should indicate when a process is taking place with ozone or oxygen in the process chamber. At a minimum, the Department requests a column be added to the facility emission calculation spreadsheet acknowledging these different environments.

Response: *The emission factor derivations in Appendix G to this application have been clarified to indicate whether or not a source of oxygen is expected to be present in the process chamber alongside each chemical.*

TR Comment #12: The applicant has proposed the use of emission chemicals that are separate from the primary chemicals being input to process equipment on site. This is primarily due to the understanding that the primary chemicals undergo significant chemical changes while in the process. The applicant has

attempted to characterize this chemical change via stoichiometric equations. The Department does not outrightly disagree with this methodology, however, due to the assumptions being made, the Department is not able to verify a scale of accuracy of this methodology, therefore the Department would like to offer the following additions to the methodology moving forward.

a. The facility will be subject to emissions testing after completing construction. The applicant should assume stack testing will occur for all primary chemicals utilized in addition to all emission contaminants derived at each source type.
b. To assist in determining accuracy of stoichiometric reactions, the applicant should add a column in Table 6-1 indicating oxygen rich environment (or environment favoring oxidation).
c. The facility will be required to quantify, and incorporate in their application, several contaminants the Department has determined are reasonable potential byproducts of the process. The reference primary chemical and proposed emissions are noted in Table 1

Table 1: Primary Chemicals and Stoichiometric Potential Emissions

Application Reference/Primary Chemical	Process	Applicant Proposed Emissions	NYS DEC Proposed Emissions
[redacted]	ALD	[redacted] Methanol CO2 NO2	[redacted] Dimethylamine Methanol CO2 NO2
[redacted]	ALD	Ammonia (NH3) Methane(CH4) CO2 NO2	Dimethylamine Ammonia (NH3) Methane(CH4) CO2 NO2
[redacted]	ALD	Ammonia (NH3) Ethane(C2H6) CO2 NO2	Diethylamine Ammonia (NH3) Ethane(C2H6) CO2 NO2
1.1.2.4.16/Tetraethylorthosilicate (TEOS)	CVD	Ethanol CO2	Ethanol Ethane(C2H6) CO2
1.1.2.4.20/Trimethylaluminum (TMAl)	ALD	Methanol CO2	Formaldehyde Methanol Ethane CO2
[redacted]	ALD	[redacted] Methanol CO2 NO2	[redacted] Dimethylamine Methanol CO2 NO2

Response:

a. *Micron has proposed a detailed stack testing plan in Appendix T to this application, in part to demonstrate to the NYSDEC that the emission factors described above are appropriate and conservative.*
b. *The emission factor derivations in Appendix G to this application have been clarified to indicate whether or not a source of oxygen is expected to be present in the process chamber alongside each chemical.*
c. *The emission chemicals proposed by the NYSDEC in Table 1 above have been incorporated into this application, with the exception of ethane. As the NYSDEC indicated in NOIA Comment #58, ethane is not subject to analysis under 6 NYCRR Part 212 since its emissions are trivial per 6 NYCRR 201-3.3(c)(94). Additionally, ethane, unlike methane, is not subject to analysis under any other state or federal rules or policies. Therefore, including ethane as an emission chemical is not warranted.*

1.2.3 Process Emissions and Part 212

TR Comment #13: If combustion is used to control emissions from a process operation, such as a flare operating at a wastewater treatment plant (WWTP), then the emissions would be subject to Part 212. The emissions from the WWTP need to be provided to fully evaluate Part 212 applicability and potential modeling. Compliance with VOC RACT does not provide an exclusion from Part 212 applicability for individual HAP emissions (PDF page 65, Section 3.4.4.7)

Response: *As part of Permit Application 2, additional detail regarding the proposed wastewater treatment operations, their emissions, and the applicability of state and federal regulations, including 6 NYCRR Part 212, is included throughout this application. Micron does not plan to operate a flare to control emissions from wastewater treatment operations.*

TR Comment #14: To assist the Department in completing an assessment of process sources applicability to Part 212, the application should provide a more detailed process flow diagram including a description (location and function) for each of the processes and these components:

a. Process equipment exhaust conditioners
b. Process tools and equipment
c. Compound-specific vent header
d. General exhaust system
e. Common exhaust header
f. Dozens of individual stacks collecting the different types of exhaust gas
g. Point-of-use control devices - Used at or near plasma etch process tools. Thermal oxidation used as control device.
h. Fab exhaust and centralized control devices

Response: *Revised process flow diagrams are included as Appendix E to this application. These diagrams provide a greater degree of detail than the diagrams included with Permit Application 1 and illustrate the relationship between each type of process tool, thin films PEECs, wet process PEECs, POU control devices, exhaust headers, and centralized control devices.*

TR Comment #15: The applicant has provided a significant amount of information for assessing applicability with Part 212, although a significant amount of this information is segmented and provided on a process category basis. To assist in the Department's evaluation, the facility should compile this applicability information into a single table in recognition that Part 212 is based on a facility wide basis. This table should include the following information at a minimum:

a. Chemical identifier, including CAS # for every contaminant emitted from a process source regardless of environmental rating.
b. Chemical emissions including facility wide Potential to Emit (PTE), Emission Rate Potential (ERP), and anticipated actual emissions.
c. The proposed environmental ratings for each contaminant.
d. The AGC and SGC values for each contaminant.
e. Identifier of whether the chemical is a Hazardous Air Pollutant (HAP) or High Toxicity Air Contaminant (HTAC)
f. Notation indicating contaminants which may be emitted from both 40 CFR 63 BBBBB and Part 212 applicable sources.
g. All particulate matter, regardless of environmental rating must be combined to assess compliance with Part 212-2.4 for total particulate. Further, the individual constituents need to be evaluated separately for Part 212 applicability.

Response: *The Part 212 analysis in Section 3.3.4 of the application has been streamlined, and Tables 1-3 and 1-4 of Appendix F has been expanded to indicate the applicable Part 212 requirement(s) for each pollutant and analog group. Tables 1-3 and 1-4 as revised are intended to provide the information requested in items (a) through (f) above. Table 1-5 has been added to assess 212-2.4 compliance as requested in item (g) above.*

TR Comment #16: As a matter of clarification, the following are not exempt from 6 NYCRR Part 212:

a. RCTO (rotor-concentrator thermal oxidizer) is listed in the application as exempt per 201.3.2(c)(1) (PDF page 56). In other locations of the application, it is stated that these control devices are not subject to Part 212 (PDF page 60), even though used as a control device for organic HAPs (PDF page 78). Emissions of NOx and SOx from the combustion of fuel may be exempt from Part 212, but emissions of other pollutants generated as a result of controlling emissions from process operations would not be exempt.
b. Emissions of CO and VOC from combustion per 6 NYCRR 212-1.4(m) are exempt under pyrolysis conditions. This does not apply for many of the process operations at Micron which are conducted under oxidative conditions.

Response:

a. The referenced section was intended to note that the emissions of certain pollutants generated from natural gas combustion (such as from RCTOs) are not subject to Part 212. Micron agrees that the emissions from process operations that exhaust through RCTOs are subject to Part 212 and has clarified the language in Section 3.3.4.2 of this application accordingly.

*b. As discussed previously with the NYSDEC, Micron would like to clarify that emissions of CO and VOC from combustion are exempt **except** under pyrolysis, or oxygen deficient, conditions per 6 NYCRR 212-1.4(m). Therefore, emissions of CO and VOC resulting from combustion under oxidative*

conditions are considered to be excluded from Part 212 applicability. Emissions of CO and VOC resulting from process operations are considered subject to Part 212 and addressed accordingly in Section 3.3.4.2.3 of this application.

TR Comment #17: In the absence of a comprehensive process description, the Department cannot confirm the exclusion of conveyance systems such as piping used to deliver stored process materials from storage tanks to fabs or waste from the fabs to storage and waste handling operations from 6 NYCRR Part 212. (PDF page 60, Section 3.4.4.2.3).

Response: *On September 3rd, 2024, the NYSDEC verbally agreed that this comment was written in error and that conveyance systems without vents are not considered process operations per the definition in 6 NYCRR 212-1.2(b)(18).*

TR Comment #18: EPA's NESHAP for Source Category: Manufacture of Semiconductors – Background Information for Proposed Standards notes that "A subsequent SIA study showed that the following 10 chemicals comprised approximately 93.8 percent of all controlled HAPs emitted, with methanol being the most predominant: ethylbenzene, methanol, ethylene glycol, methylene chloride, glycol ethers, perchloroethylene, hydrochloric acid, trichloroethylene, hydrofluoric acid, xylene". The facility's current application omits several of these contaminants. The Department recognizes that the semiconductor industry has undergone significant process improvements since the publication of this EPA documentation, however, the facility should review the following HAPs and confirm facility operations will not result in emissions of these contaminants:

- Ethylbenzene (100-41-4)
- Methylene Chloride (75-09-2)
- Glycol Ethers
- Xylene (1330-20-7)
- Perchloroethylene (127-18-4)
- Trichloroethylene (79-01-6)

Similarly, this EPA documentation indicates several other constituents which the facility should also assert is not being emitted:

- Acetaldehyde (75-07-0)
- Acrylonitrile (107-13-1)
- Antimony
- Ethylene Oxide (75-21-8)
- Formaldehyde (50-00-0)
- Hydrazine (302-01-2)
- Benzene (71-43-2)
- Hydroquinone (123-31-9)
- Beryllium compounds
- 1,3 Butadiene (106-99-0)
- Cadmium compounds
- Methyl Ethyl Ketone (78-93-3)
- Carbon Tetrachloride (56-23-5)

- Naphthalene (91-20-3)
- Catechol (120-80-9)
- Nickel Compounds
- Phenol (108-95-2)
- Chloroform (67-66-3)
- Chromium Compounds
- Silane (7803-62-5)
- Cresol (1319-77-3)
- Cyanide (57-12-5)
- Toluene (108-88-3)
- Diethanolamine (111-42-2)
- 1,2,4 trichlorobenzene (120-82-1)

Response: *The semiconductor industry is constantly evolving to meet the fast-paced changes in demand in the technology markets it supplies. Therefore, the SIA study referenced as part of the EPA document "National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Category: Manufacture of Semiconductors - Background Information for Proposed Standards", which was conducted nearly 30 years ago in 1996, is outdated relative to the operations of Fab 1 and Fab 2, which will incorporate leading-edge processes. The primary chemicals and emission chemicals characterized in this application is a comprehensive list based on Micron's recent internal procurement estimates and semiconductor process experience.*

1.2.4 Air Dispersion Modeling

TR Comment #19: The facility has asserted that the exhaust from process tools will be routed to a common header then distributed from the header to multiple similar control devices along the length of the header. Each exhaust type will therefore have dozens of individual stacks at each Fab 1 and Fab 2. The facility should provide a discussion on control equipment operation which clarifies how units in parallel will be modeled to ensure a worst case operations scenario is represented.

Response: *Each exhaust header will have a subset of stacks that are redundant and not expected to operate unless one of the typically operational control devices is down. Instead of dividing total facility emissions across all the stacks at the site, Micron is dividing total facility emissions across operational stacks, resulting in a higher emission rate per stack and modeling redundant stacks with no emission rate. Redundant stacks were selected to provide the most conservative modeled impact based on proximity to the western fenceline, as that is where Micron expects the maximum off-site concentrations to be located.*

TR Comment #20: In Section 2.1 Table 2-1: On May 6, 2024, EPA lowered the PM2.5 annual SIL to 0.13 µg/m3. New York State intends to adopt this new SIL in its next revision of 6 NYCRR Part 231. Based upon Micron's projected construction timetable, the PM2.5 annual SIL of 0.13 µg/m3 should be used in Micron's modeling evaluation.

Response: *The revised $PM_{2.5}$ annual SIL is used in the revised modeling protocol.*

TR Comment #21: Section 2.2.1 needs additional justification regarding the use of these specific NO2, PM2.5 and PM10 monitors. This may include a discussion of regional air quality trends, climatology, and a comparison of the prevailing wind directions at the monitors and the proposed facility location.

Response: *The revised modeling protocol, submitted under a separate cover letter in conjunction with this application, has been updated to consider the prevailing wind directions and the type of emission sources near the monitors chosen to better compare them to the expected conditions surrounding the Micron Campus.*

TR Comment #22: Section 2.2.2 indicates that emission rates are not finalized, and the Significant Impact Area (SIA) and regional modeling inventory may need future alterations. The facility's emission rates of all air contaminants will need to be evaluated and approved by a DEC engineer prior to their use in any air quality dispersion modeling analyses.

Response: *Micron understands that the emission calculations in Appendix F to this application require verification by the NYSDEC before the forthcoming air dispersion modeling report can be approved.*

TR Comment #23: Section 2.4: Additional information is needed regarding the use of MERPs. What is the proposed size and the geographical location of the hypothetical representative MERPs source?

Response: *Livingston County, NY is the closest hypothetical source, and the proposed size reflects the source-wide emissions in the air permit application. The revised modeling protocol discusses the appropriate MERPs selection for the modeling analysis in more detail.*

TR Comment #24: Section 2.7 Table 2-2 lists 42 air contaminants and the only NAAQS pollutant listed in this table is SO2. Are all other NAAQS pollutants emitted by combustion sources? Will particulate matter (PM) be modeled to demonstrate compliance with Part 212?

Response: *SO_2 is the only NAAQS pollutant requiring modeling solely under 6 NYCRR Part 212. NO_X, CO, PM_{10}, and $PM_{2.5}$ all require modeling under 6 NYCRR Part 231, regardless of applicability of Part 212. Section 2.7, Table 2-2 of the initial modeling protocol summarized only those pollutants, including SO_2, being modeled to demonstrate compliance with Part 212.*

TR Comment #25: Section 4.2: DEC will be re-running EPA's AERMET and AERSURFACE programs to incorporate the latest 2021 National Land Cover Database (NLCD) data for the area near the Syracuse Hancock Airport. DEC can send the updated 2019-2023 Syracuse meteorological data to the Micron consultant when this analysis is complete.

Response: *The revised modeling protocol incorporates the most recent meteorological data for the area near the Syracuse Hancock Airport.*

TR Comment #26: Section 4.5 indicates that the 70-meter spaced receptor grid will extend out 1.5 km from the Micron Campus center. However, the 70-meter spaced grid should begin at Micron's fenceline and extend outward to at least 1 km. Guidance on receptor grid placement can be found in Section 2.4 of DAR-10.

Response: *The revised modeling protocol has been updated to indicate that the 70-meter spaced receptor grid will begin at Micron's fenceline and extend outward for a minimum of 1 km from there.*

TR Comment #27: Sensitive receptors should be included in the modeling analysis with details and specific locations listed on a map and in a table. These sensitive receptors would include places such as hospitals, day care centers, schools, environmental justice areas and Disadvantaged Community (DAC) areas near the facility. Additional information on the New York State DAC areas can be found here: https://climate.ny.gov/resources/disadvantaged-communities-criteria/

Response: *Micron asserts that the receptor grid described in the revised modeling protocol is sufficiently dense to accurately estimate impacts to sensitive receptors such as those described above. However, Micron has identified nearby sensitive locations and there are no hospitals, schools, or day care centers that are within 3 km of the Micron Campus center.*

TR Comment #28: Section 4.5 states that Micron is in the process of purchasing land from nearby individual property owners and the Onondaga County Industrial Development Agency. The exact delineations of the ambient air boundary for the Micron facility will need to be finalized prior to running any air dispersion modeling to demonstrate compliance with the NAAQS or NY's Guideline concentrations at all off-site, publicly accessible areas.

Response: *The revised modeling protocol has been updated to reflect the current ambient air boundary for the Micron facility, based on Micron's confidence that all land within that boundary will be under its control by the time operations commence.*

TR Comment #29: Does Figure 4-4 show Micron's current ambient air boundary or the 'future' ambient air boundary after all nearby land has been purchased from other private and governmental entities?

Response: *The revised modeling protocol is updated to reflect the expected ambient air boundary at the time of permit issuance.*

TR Comment #30: Section 4.7 stated that Micron is not certain whether OLM or PVMRM will be used for the NO2 modeling analysis. Once Micron makes this determination, please allow DEC sufficient time to process the hourly ozone data for both the East Syracuse site (#36-067-1015) as the primary monitor and the Fulton site (#36-075-0003) as the secondary monitor.

Response: *The revised modeling protocol has been updated to clarify the proposed methodology for the NO_2 modeling analysis. Micron will be utilizing the Tier 2 Ambient Ratio Method 2.*

TR Comment #31: Section 4.7.2: In-stack ratios listed in Table 4-1 will need to be evaluated and approved by a DEC engineer prior to use in the NO2 chemistry modeling evaluation.

Response: *As Micron is not planning to use Tier 3 methods for NO_2 modeling, in-stack ratios have been removed from the modeling protocol.*

TR Comment #32: Section 5.1.1: The second paragraph implies that DAR-10 Section 4.1.7 suggests the exclusion of emergency engines from the modeling analysis for Micron. However, that Section of DAR-10 also states that facilities must consult with the Department to determine if these engines can be excluded from the 1- hour NO2 modeling analysis. DEC will need to review detailed information for each of the proposed emergency engines in order to make this determination. This would include the exact number and size of intermittent emission units, frequency and duration of operation, allowable fuels and their sulfur and nitrogen content, short-term peak emission rates, operating hours concurrent with other intermittent equipment and the location of the intermittent source(s) with respect to the ambient air boundary of the facility.

Response: *Micron proposes to model emergency generators in the 1-hour NO_2 modeling analysis, but will account for the proposed 100 hour per year operational limit by modeling an average annual emission rate. This approach is outlined in the revised modeling protocol, which will be submitted under a separate cover letter in conjunction with this application.*

TR Comment #33: Section 5.1.1: Detailed information about each of the space heaters will be required to determine whether they need to be included in the 1-hour NO2 modeling analysis. For example, a facility that has two or three space heaters may have insignificant 1-hr NO2 emissions, however, a large number of space heaters running simultaneously may contribute significantly to the 1-hour NO2 emissions profile at the facility.

Response: *Micron will not operate space heaters as part of the Proposed Air Permit Project. Heat generated in the fab will be recovered and distributed to maintain an appropriate internal temperature, as supplemented by the proposed natural gas-fired boilers only when necessary.*

TR Comment #34: Table 5-1 appears to summarize 1445 individual emission sources and condense their stack parameter information into 26 source 'types'. This Table does not provide specific emission source details necessary to determine if the air contaminant impacts from this large facility will be in compliance with the NAAQS, NYAAQS, or the NY Guideline concentrations. For example, Table 5-1 states that there will be 605 cooling tower emission points. Will all the cooling towers have identical stack heights of 28.65 meters (94 feet)?

Response: *Both the revised modeling protocol and Appendix A to this application have been amended to include detailed stack parameter information.*

TR Comment #35: Table 5-1: For clarity, the stack temperatures for the cooling towers should be listed in the table as "Ambient", not as the AERMOD model placeholder of 0 K.

Response: *Stack temperatures in the revised modeling protocol have been amended where appropriate to indicate "Ambient".*

TR Comment #36: Section 5.1.2.1 (NOx and PM10) and Section 5.1.2.2 (PM2.5): Please provide additional justification for the regional source representativeness of the chosen monitors. This may include an evaluation of the types of emission sources in the Rochester vicinity and an evaluation of the prevailing wind directions.

Response: *The revised modeling protocol has been updated to consider the prevailing wind directions and the type of emission sources near the monitors chosen to better compare them to the expected conditions surrounding the Micron Campus.*

TR Comment #37: Section 5.1.2.3 indicates that only three of the nearby sources in the inventory will be included in the modeling analysis. How was this determined? Are each of these three sources significant contributors of NOx, PM10 and PM2.5 or just some of them?

Response: *The nearby sources were determined based on the prevailing wind conditions and the proximity of sources to the Micron Campus. Further details are provided in the revised modeling protocol.*

TR Comment #38: Section 5.2 states that the emission rates are found in Appendix B of this modeling Protocol. They do not seem to have been added to the PDF received by the Impact Assessment and Meteorology (IAM) section. Please forward the Appendix B information to our shared mailbox at DAR.Meteorology@dec.ny.gov.

Response: *The appropriate emission rates were provided to the NYSDEC. Updated emission rates are provided as Appendix B to the revised modeling protocol.*

TR Comment #39: Table 5-3, Footnote 'a': Were the maximum annual NOx emissions calculated using a scaled maximum emission rate, for example, 500 hours divided by 8760 hours in a year? The footnote seems to indicate that an average rate was used instead of an appropriately-scaled, maximum emission rate. 21. Table 5-4, Footnote 'b': How were the maximum 24-hour PM10 emissions scaled to 500 hours per year?

Response: *Annual NO_x emissions account for proposed operational limits, if applicable, which scale maximum emissions based on the operating hours in a year, and annual potential throughputs. PM_{10} 24-hr emissions are scaled to proposed daily operating hour limits, if applicable, or modeled at the maximum emission rate.*

TR Comment #40: Table 5-5, Footnote 'a': How were the maximum annual PM2.5 emissions scaled to 500 hours per year?

Response: *Annual $PM_{2.5}$ emissions account for proposed operational limits, if applicable, and annual potential throughputs. Note that the proposed operational limit for emergency engines has been updated to 100 hours per year per engine.*

TR Comment #41: Table 5-5 does not have a 'b' footnote as indicated at the top of the Table.

Response: *This typographical error has been resolved.*

TR Comment #42: Section 5.3: The description of the Part 212 screening evaluation will need to be clarified so that non-modelers can understand the proposed screening methodology. Will the consultant be using the Lakes Environmental Multi-Chem tool or a similar program? As Section 5.3 currently reads, it does not adequately characterize the full discussion on November 7, 2023, as indicated in footnote #14.

Response: *Micron will use an initial unit emission rate modeling methodology that processes results via a Microsoft Excel spreadsheet. This spreadsheet can be shared with the DEC prior to submittal of the air dispersion modeling report.*

TR Comment #43: Section 5.3, third paragraph: Incorrectly states that any air contaminant with a screening impact below its Guideline concentration will not be modeled further using AERMOD. After running the screening model, the first step will be to provide DEC with the modeling files and a detailed summary of the air quality impacts for each of the emitted air contaminants. After a thorough review of this table, DEC's IAM and the Air Toxics section will provide Micron with the final determination of which air contaminants need to undergo further refined air dispersion modeling.

Response: *Micron will provide the modeling files and post-processing analysis used to determine modeled impacts for each contaminant to DEC upon request.*

TR Comment #44: Section 6: In addition to the input and output files, please also include the building, terrain, and any other associated dispersion modeling files. These files should also be accompanied by a directory and may be submitted to our DAR.Meteorology@dec.ny.gov email box. If the files are large, please send them to DEC using our File Transfer Service, https://fts.dec.state.ny.us/fts/.

Response: *The requested files will all be provided to the NYSDEC with the forthcoming air dispersion modeling report.*

TR Comment #45: Section 7: Please submit a formal letter to DEC Region 7 and the IAM Section indicating Micron's request for a pre-construction monitoring waiver. In addition to the information

contained in Section 7, the letter should provide additional justification for the use of the specific monitors, including an analysis of the wind directions and regional air quality trends.

Response: *A waiver for the requirements to submit air quality monitoring data is provided as an appendix to the air dispersion modeling protocol that will be submitted under a separate cover letter in conjunction with this application.*

TR Comment #46: Appendix A, Figure A-1 'Modeled Building Inventory': The simplified drawing does not provide sufficient details necessary to determine and develop the appropriate modeling methodology for the emission points at the facility. DEC will need a highly detailed facility schematic/plan(s) which shows the exact location of every emission source, building locations, side views of building tiers, and the detailed parameters for each building and emission source.

Response: *Appendix A to the revised modeling protocol has been updated to provide additional detail on the location and parameters for each building comprising the Proposed Air Permit Project.*

TR Comment #47: As part of the non-attainment NSR, will Micron be evaluating the secondary formation of ozone resulting from Micron's emissions of precursor pollutants (NOx and VOCs)?

Response: *Micron will not be evaluating the secondary formation of ozone from NO_X and VOCs.*

TR Comment #48: Prior to running any air dispersion modeling analyses, all emission rates, emission source parameters, and building dimensions will need to be reviewed and approved by a DEC engineer.

Response: *Micron understands that emission rates, source parameters, and building parameters require verification by the NYSDEC before the forthcoming air dispersion modeling report can be approved.*

APPENDIX S. PFAS ANALYSIS

This appendix addresses potential air emissions of per- and polyfluoroalkyl substances (PFAS) from the Proposed Air Permit Project. In Comment #12 of its Notice of Incomplete Application (NOIA) issued on June 3, 2024, the NYSDEC requested that PFAS emissions be addressed as part of Permit Application 2. This appendix discusses the use of PFAS and potential PFAS emissions from the Proposed Air Permit Project, describes Micron's proposed efforts to reduce possible emissions of PFAS from its operations, and identifies the applicable regulatory requirements for air emissions of PFAS.

1.1 Use of PFAS and Potential Emissions

PFAS are a group of manufactured fluorinated organic chemicals.[1] PFAS are widely used due to their unique characteristics, such as water-, heat-, oil-, and chemical-resistant qualities. There are thousands of different types of PFAS used in a wide range of industries. There is growing international attention on PFAS due to their potential health effects and persistence in the environment. PFAS are used in the manufacture of semiconductors, including: (1) fab infrastructure, tools, and parts; (2) fabrication process chemistries and indirect fabrication support needs; and (3) substances used to create packaging materials for products that incorporate semiconductors. Fabrication process chemistries that contain PFAS and may come into contact with the wafer during the fabrication process include photolithography, plasma etch, and wet chemicals. Chemicals that support the fabrication process, but that do not come into contact with the wafer, include heat transfer fluids (HTFs), lubricants, greases, pump fluids, and refrigerants. PFAS also may be present in chemical delivery systems and shipping packaging delivered to the facility. There are no known alternatives for many of these uses. The Proposed Air Permit Project would incorporate a range of measures to manage PFAS use and potential emissions.

1.2 Reducing Presence of PFAS

Micron is engaged in a broad range of activities to reduce the presence of PFAS in semiconductor manufacturing. Micron is a leading member of these efforts working with groups such as the World Semiconductor Council (WSC), the Semiconductor Industry Association (SIA) PFAS Consortium, SEMI, and the Semiconductor Research Corporation Research Center for Environmentally Benign Materials. As part of these efforts, Micron is collaborating with industry peers to gather industry data on PFAS usage, facilitate information-sharing on usage, engage in efforts to develop non-PFAS alternatives, and explore effective management of PFAS environmental releases. While novel projects such as these often take many years and generally occur after industry receives guidelines from regulatory agencies, Micron is making it a priority to accelerate these evaluations in advance of regulation.

[1]PFAS are defined differently by different organizations. For completeness of review, this application uses the definition published by the Organisation for Economic Cooperation and Development (OECD), which is understood to provide the broadest (most inclusive) definition of PFAS. The OECD defines PFAS as "fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS." Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances (July 2021), available at https://www.oecd.org/en/publications/reconciling-terminology-of-the-universe-of-per-and-polyfluoroalkyl-substances_e458e796-en.html.

For its semiconductor operations, Micron is implementing measures to mitigate and eliminate PFAS-related risks. Fugitive emissions of fluorinated heat transfer fluid from process chillers are being reduced by increasing use efficiency and transitioning to alternative substances. Fluorinated gases used in plasma etch processes will be abated using regenerative catalytic systems (RCS) as part of the Proposed Air Permit Project.

Micron also controls and mitigates chemical and process hazards in the workplace by employing the principles of the NIOSH Hierarchy of Controls (i.e., elimination, substitution, engineering, administrative, and personal protective equipment (PPE)), as well as EPA's waste management hierarchy for source reduction, reuse, recycling, treatment and disposal. Micron incorporates these approaches in its evaluation and approval of chemical usage. Through its chemical use approval process, Micron identifies sources of PFAS in its fabrication process chemistries and makes efforts to identify possible non-PFAS containing alternative chemistries, where available and feasible. For instance, Micron eliminated both perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) from the fabrication process chemistries at all its facilities around the world ahead of industry-wide goals set by the World Semiconductor Council. Micron also employs industry standards set by SEMI, including those relating to facility and equipment design (e.g., enclosed and automated chemical delivery systems), risk management and work practice standards, and PPE usage.

1.3 Regulatory Requirements for PFAS

At the time of this application, there are no federal regulations that specifically address air emissions of PFAS, except to the extent they are required to be reported under EPA's Mandatory Greenhouse Gas Reporting Rule (40 C.F.R. Part 98). In accordance with these requirements, Micron will estimate and report emissions of fluorinated chemicals that are greenhouse gases from its Proposed Air Permit Project.

NYSDEC has not promulgated regulations specific to air emissions of PFAS, but regulates air emissions of all contaminants, including PFAS, as part of its air toxics program. Like other emissions of air contaminants from process emission sources, emissions of compounds that could potentially be classified as PFAS are subject to Title 6 of the New York Codes, Rules, and Regulations (6 NYCRR) Part 212. Micron has analyzed the applicable requirements of air emissions from process emission sources under Part 212 in Section 3 and will perform air dispersion modeling and/or implement emissions controls as required to ensure that public health and safety is protected.

Given the vast number of different PFAS compounds, their ubiquity, and the different environmental media in which they may appear, the development and validation of detection methods has been challenging. Methods of PFAS detection and analysis are still evolving and there is currently no final EPA-approved method for the detection of PFAS concentrations in stationary source air emissions. For example, EPA is seeking feedback from the scientific community on Other Test Method (OTM)-45: *Measurement of Selected PFAS from Stationary Emission Sources* and OTM-50: *Sampling and Analysis of Volatile Fluorinated Compounds from Stationary Sources Using Passivated Stainless-Steel Canisters*.[2] As methods for analysis

[2]USEPA, PFAS Analytical Methods Development and Sampling Research (last updated on Dec. 11, 2024), available at https://www.epa.gov/water-research/pfas-analytical-methods-development-and-sampling-research.

develop, methods of pollution control for emissions of PFAS from stationary sources are also evolving. Should regulations specific to PFAS air emissions be promulgated, Micron will ensure that the Proposed Air Permit Project meets applicable requirements.

APPENDIX T. STACK TEST PLAN

This appendix describes a proposed stack test plan to resolve several comments written by NYSDEC to Micron and Trinity in both the Notice of Incomplete Application (NOIA) and Technical Review (TR) letter received following Permit Application 1. The proposed testing plan would be incorporated in the final Title V permit to demonstrate the accuracy of emission calculations.

1.1 Comments from NYSDEC Relating to Stack Testing

The following portions of comments from NYSDEC included in the NOIA, dated June 3, 2024, and TR comment letter, dated July 19, 2024, relate to stack testing *(emphasized text has been italicized).* These comments have been carefully considered in the development of this stack testing plan. Full responses to all comments are provided as Appendix R to this permit application.

TR Comment #6 quotes a portion of Permit Application 1 that references 40 CFR Part 63, Subpart BBBBB, the National Emission Standard for Hazardous Air Pollutants (NESHAP) regulating emissions of hazardous air pollutants (HAP) from semiconductor manufacturing (NESHAP Subpart BBBBB).

NOIA Comment #18: The applicant has presented several assumptions based on "semiconductor process experience" or similar phrasing. Wherever the applicant seeks to apply an assumption that is not commonly accepted, supportive documentation should be provided. *In some cases, it is expected that emissions testing reports would have been produced.* For example, the emission chemicals for which emission factors were calculated were determined in part based on "semiconductor process experience" (Appendix G, PDF page 276).

NOIA Comment #24: The applicant has proposed emission calculations utilizing emission chemicals that are chemically unique from the raw material chemicals. Although this methodology may be acceptable, the facility should provide supporting documentation in any cases where oxidation or reactions with other emission contaminants yield a new contaminant. *Ideally the facility will provide stack testing data verifying these reactions are occurring…*

TR Comment #5: The facility has asserted that the exhaust from process tools will be routed to a common header then distributed from the header to multiple similar control devices along the length of the header. Each exhaust type will therefore have dozens of individual stacks at each Fab 1 and Fab 2. The facility should provide a discussion on control equipment operation which clarifies how units in parallel will be sized and operated to ensure there will not be excess emissions from the site. The discussion should provide answers to the following concerns…

D. The facility will have to propose a robust emissions testing program to test stacks that will inevitably have concentration and flow variability based on which process tools and controls are operating.

TR Comment #6: According to Table 3-1 on PDF page 53 [of Permit Application 1]: ammonia exhaust is indicated that "No NESHAP Subpart BBBBB process units are directly vented to the ammonia exhaust. However, there is the potential for trace inorganic HAP due to potential intermingling with the fab acid and CVD exhausts". *The site has long asserted that separate exhaust headers are being used for each exhaust*

type, if this continues to be the case, then how would contaminants intermingle? (PDF page 53, Section 3.2.3)

TR Comment #12: The applicant has proposed the use of emission chemicals that are separate from the primary chemicals being input to process equipment on site. This is primarily due to the understanding that the primary chemicals undergo significant chemical changes while in the process. The applicant has attempted to characterize this chemical change via stoichiometric equations. The Department does not outrightly disagree with this methodology, however, due to the assumptions being made, the Department is not able to verify a scale of accuracy of this methodology, therefore the Department would like to offer the following additions to this methodology moving forward.

A. *The facility will be subject to emissions testing after completing construction. The applicant should assume stack testing will occur for all primary chemicals utilized in addition to all emission contaminants derived at each source type…*

1.2 Proposed Stack Testing Plan

As described in Permit Application 1, the proposed air permit project will include five (5) exhaust systems in each of the main fab buildings, three (3) exhaust systems in each of the hazardous process material (HPM) buildings, and three (3) exhaust systems in each of the wastewater treatment (WWT) buildings. The fab building exhausts will contain emissions generated from the operation of semiconductor process tools, while the HPM and WWT building exhausts will contain emissions from raw material and waste treatment and storage. The stack testing plan refers to these exhaust types as part of identifying the scope of each proposed test.

- Fab Acid Exhaust
- Fab Chemical Vapor Deposition (CVD) Exhaust
- Fab Ammonia Exhaust
- Fab Solvent Exhaust
- Fab General Exhaust
- HPM Acid Exhaust
- HPM Ammonia Exhaust
- HPM Solvent Exhaust
- WWT Acid Exhaust
- WWT Ammonia Exhaust
- WWT Solvent Exhaust

To satisfy regulatory requirements and NYSDEC's comments in an efficient manner, the plan includes tests that will meet each of these goals:

- Demonstrating compliance with NESHAP Subpart BBBBB;
- Demonstrating compliance with Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) permit limits, where applicable, and;
- Confirming engineering emissions estimates based on semiconductor process knowledge made by Micron and Trinity.

All tests will limit testing to pollutants that can realistically be sampled using sound testing methods. Each proposed test is summarized in Table T-1 and described in more detail below.

Exhaust System	Emission Units	Processes	Pollutant(s) to be Tested Every 5 Years	Pollutant(s) to be Tested Once
Fab Acid Exhaust	1-FABOP 2-FABOP	FA1 FA2	NO_X, CO, VOC, PM	Inorganic HAP, other TBD
Fab CVD Exhaust	1-FABOP 2-FABOP	FC1 FC2	NO_X, CO, VOC, PM	Inorganic HAP, other TBD
Fab Ammonia Exhaust	1-FABOP 2-FABOP	FB1 FB2	-	Inorganic HAP, ammonia, other TBD
Fab Solvent Exhaust	1-FABOP 2-FABOP	FS1 FS2	NO_X, CO, VOC, PM	Organic HAP, other TBD
Fab General Exhaust	1-FABOP 2-FABOP	FG1 FG2	-	Organic HAP
HPM Acid Exhaust	1-HPMCU 2-HPMCU	HA1 HA2	-	Inorganic HAP
HPM Ammonia Exhaust	1-HPMCU 2-HPMCU	HB1 HB2	-	Inorganic HAP
HPM Solvent Exhaust	1-HPMCU 2-HPMCU	HS1 HS2	-	Inorganic HAP
WWT Acid Exhaust	1-WWBIO 2-WWBIO	WA1 WA2	-	Inorganic HAP
WWT Ammonia Exhaust	1-WWBIO 2-WWBIO	WB1 WB2	-	Inorganic HAP
WWT Solvent Exhaust	1-WWBIO 2-WWBIO	WS1 WS2	-	Inorganic HAP

1.2.1 Stack Testing to Comply with NESHAP Subpart BBBBB

The proposed air permit project will be subject to NESHAP Subpart BBBBB as a semiconductor manufacturing facility that is major source of HAP. Per 40 CFR 63.7187, initial performance testing is required for both inorganic HAP and organic HAP emitted from "semiconductor manufacturing process units" to demonstrate compliance with applicable standards for removal efficiency or outlet concentration. According to 40 CFR 63.7186, the required performance tests must be completed within 180 days of startup. Micron proposes to consider "startup" of each subject exhaust header to be the date on which the processes routing to the exhaust header begins full operation.

Table 3-1 of Permit Application 1 (PDF page 52), replicated as Table 1 below, identifies the applicable requirement for each exhaust type under NESHAP Subpart BBBBB. An initial performance test will be completed for each exhaust using the process or storage tank vent stream test methods specified in Table 1 to NESHAP Subpart BBBBB. The fab ammonia exhaust, HPM ammonia exhaust, HPM solvent exhaust, WWT ammonia exhaust, and WWT solvent exhaust, as stated below, will be designed to not contain any inorganic HAP, but could contain trace inorganic HAP due to inadvertent intermingling with acid exhausts. To address TR Comment #6, Micron proposes to test these exhausts to demonstrate that they do not contain detectable quantities of inorganic HAP.

Table 1: Method(s) of Compliance with NESHAP BBBBB by Process and Exhaust Type

Area	Exhaust Type	HAP Emitting Process Unit(s)	Type of Process Vent	Allowable Method(s) of Compliance
Fab	Acid Exhaust	Thin films / diffusion, diffusion non-deposition, plasma etch, wet etch / wet clean, and ion implant process tools and associated equipment	Inorganic HAP	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
Fab	CVD Exhaust	Thin films / diffusion process tools and associated equipment	Inorganic HAP	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
Fab	Ammonia Exhaust	No NESHAP Subpart BBBBB process units are directly vented to the ammonia exhaust. However, there is the potential for trace inorganic HAP due to potential intermingling with fab acid and CVD exhausts	Inorganic HAP	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
Fab	Solvent Exhaust	Photolithography process tools and associated equipment	Organic HAP	Organic HAP emissions ≤20 ppmv or reduced by 98%
Fab	General Exhaust	Methanol or other organic HAP used for cleaning	Organic HAP	Organic HAP emissions ≤20 ppmv or reduced by 98%
HPM	Acid Exhaust	Tanks storing acidic raw materials that are HAP	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
HPM	Ammonia Exhaust	Trace inorganic HAP due to potential intermingling with CUB/HPM acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
HPM	Solvent Exhaust	Trace inorganic HAP due to potential intermingling with HPM acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
WWT	Acid Exhaust	Tanks storing acidic waste materials that are HAP	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
WWT	Ammonia Exhaust	Trace inorganic HAP due to potential intermingling with WWT acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%
WWT	Solvent Exhaust	Trace inorganic HAP due to potential intermingling with WWT acid exhaust	Storage Tank	Inorganic HAP emissions ≤0.42 ppmv or reduced by 95%

1.2.2 Stack Testing to Demonstrate Compliance with BACT/LAER Limits

As outlined in Permit Application 1, the proposed air permit project will be subject to BACT for particulate matter (PM), carbon monoxide (CO), and greenhouse gases (GHGs), and subject to LAER for oxides of nitrogen (NO_X) and volatile organic compounds (VOC). As such, Micron will propose limits in Permit Application 2 on both emission rates and potential annual emissions for each of these pollutants.

To demonstrate that the estimated emission rates and potential to emit (PTE) are conservative in cases where engineering judgement and semiconductor process knowledge were used in the absence of published emission factors, Micron proposes stack testing for pollutants subject to BACT or LAER. At this time, no tests

are proposed for GHGs, as emissions of GHGs from fab process operations are calculated using emission factors published by the Intergovernmental Panel on Climate Change (IPCC). As described below, emissions of other pollutants from fab process operations are estimated using methods that are more difficult to verify.

For each test for pollutants subject to BACT or LAER, Micron proposes a testing frequency of once every five (5) years. To address the fact that each exhaust includes several stacks in parallel pulling from one common header, resulting in potential variations in exhaust composition between stacks on the same header as identified in NOIA Comment #15 and TR Comment #5, Micron proposes to test individual stacks located in positions on the header that would be expected to see the highest concentrations of pollutants. A representative subset of stacks to test will be determined as part of each stack test protocol submitted to the NYSDEC.

1.2.2.1 Proposed NO_X Testing

Emissions of NO_X from combustion sources were estimated using published emission factors in the United States Environmental Protection Agency (USEPA)'s AP-42 guidance. NO_X will also be emitted as a result of semiconductor process operations through the oxidation of nitrogen-bearing compounds such as nitrous oxide (N_2O) and ammonia (NH_3). These compounds will be used primarily in processes exhausting to the fab CVD exhaust, as well as some processes exhausting to the fab acid exhaust. Based on semiconductor process knowledge, emissions were estimated using conservative assumptions regarding the stoichiometric conversion of these compounds to NO_X.

Micron proposes testing for NO_X from the fab acid, CVD, and solvent exhausts. This test would be completed at the inlet to the fab acid scrubbers, CVD scrubbers, and RCTOs. The emission rate measured would be compared to the expected emission rate estimated using the PTE calculations.

1.2.2.2 Proposed PM Testing

Emissions of PM from combustion sources and cooling towers were estimated using published emission factors, including those from AP-42. PM will also be emitted as a result of semiconductor process operations through the oxidation of process raw materials into solid compounds, predominantly silicon dioxide (SiO_2). SiO_2 and other particulate will be emitted through the fab CVD and solvent exhausts. Based on semiconductor process knowledge, emissions were estimated using conservative assumptions regarding the stoichiometric conversion of process raw materials to their oxides.

Micron proposes testing for total PM from the fab acid, CVD, and solvent exhausts. This test would be completed at the inlet to the fab acid scrubbers, CVD scrubbers, and RCTOs. The emission rate measured would be compared to the expected emission rate estimated using the PTE calculations.

1.2.2.3 Proposed VOC Testing

Emissions of VOC from combustion sources and storage tanks were estimated using published emission factors, including those from AP-42. Micron will use VOC solvents in the photolithography and wet etch/wet clean processes, which will exhaust to the fab solvent exhaust. VOC solvents will also be used to clean tools, workstations, floors, etc. Emissions of these cleaning solvents will be exhausted through all of the exhaust systems as part of the fab operations. Based on semiconductor process knowledge, emissions were

estimated using conservative assumptions regarding the extent to which these solvents will evaporate during use.

VOC will also be used and/or generated in other processes that exhaust to the fab acid, ammonia, and CVD exhausts, but the majority of total VOC emissions from the fab building will exhaust to the fab solvent exhaust.

Micron proposes testing for total VOC from the fab acid, CVD, and solvent exhausts. This test would be completed at the inlet to the fab acid scrubbers, CVD scrubbers, and RCTOs. The emission rate measured would be compared to the expected emission rate estimated using the PTE calculations.

1.2.2.4 Proposed CO Testing

Emissions of CO from combustion sources were estimated using published emission factors from AP-42. CO will also be generated as a result of semiconductor process operations through the partial oxidation of organic compounds primarily in thermal oxidation systems and rotor-concentrator thermal oxidizers (RCTOs). Additional CO emissions from these sources have been estimated by multiplying the emissions predicted by AP-42 by a factor of 5, to reflect the fact that natural gas combustion alone accounts for just a portion of CO generated. Thermal oxidation systems all exhaust to the fab acid exhaust and fab CVD exhaust, and RCTOs all exhaust to the fab solvent exhaust.

Therefore, Micron proposes testing for CO from the fab acid CVD, and solvent exhausts. This test would be completed at the inlet to the fab acid scrubbers, CVD scrubbers, and RCTOs. The emission rate measured would be compared to the expected emission rate estimated using the PTE calculations.

1.2.3 Stack Testing to Confirm Engineering Estimates

The PTE calculations for semiconductor processes were largely based on semiconductor process knowledge and incorporated conservative engineering estimates. Micron recognizes that NYSDEC has an interest in confirming the accuracy of these calculations, as described in NOIA Comment #18, NOIA Comment #24, and TR Comment #12. Therefore, Micron is proposing stack testing for a subset of toxic air contaminants that represents each of several categories of emission factors used in the PTE calculations.

Stack testing for a subset of contaminants is proposed above in lieu of testing for each and every individual compound since it will accomplish the goal of confirming Micron's engineering estimates in a much more efficient manner. It is not feasible to detect every air contaminant potentially emitted from semiconductor process due to small usage quantities of many raw materials and the high levels of dilution achieved by the fab exhausts. Therefore, many compounds will be below detection using sound testing methodologies. In addition, Micron has no regulatory requirement to test any pollutants other than HAP regulated by NESHAP Subpart BBBBB. Other semiconductor fabs in New York have testing requirements that are limited to criteria pollutants and HAP.

For each pollutant to be tested to confirm engineering estimates, Micron proposes two (2) initial performance tests, one at the time each half of Fab 1 becomes fully operational. For pollutants where performance test results show emission rates less than those calculated in Permit Application 2, Micron proposes no additional testing. To address the fact that each exhaust includes several stacks in parallel pulling from one common header, resulting in potential variations in exhaust composition between stacks on the same header as identified in NOIA Comment #15 and TR Comment #5, Micron proposes to test

individual stacks that are located in positions on the header that would be expected to see the highest concentrations of pollutants. A conservative subset of stacks to test will be determined as part of each stack test protocol submitted to the NYSDEC.

1.2.3.1 Proposed Testing to Confirm Absence of CVD Reactants

CVD processes utilize several reactants whose purpose is to decompose and deposit an atom or group of atoms onto a wafer. After this reaction occurs in a process chamber, these reactants will flow through process equipment exhaust conditioner (PEEC) burners, which are expected to oxidize the unreacted portion into a number of byproducts. The composition of the exhaust from these processes was estimated through stoichiometric equations in Appendix G to Permit Application 1.

To confirm the absence of reactants that are predicted to fully decompose into byproducts in the exhaust, Micron proposes to test the outlet of PEECs routed to the CVD exhaust for one (1) CVD reactant, to be determined at the time of the stack test protocol submittal, to the extent that an established, reliable test method exists to identify that chemical.

1.2.3.2 Proposed Testing to Confirm Presence of CVD Byproducts

As described above and as mentioned by NYSDEC in NOIA Comment #24 and TR Comment #12, CVD processes generate chemical byproducts that are unique from raw materials used. These byproducts are generated through both chemical reactions in process chambers and oxidation of process exhaust in PEEC burners. The composition of the exhaust from these processes was estimated through stoichiometric equations in Appendix G to Permit Application 1.

To confirm the presence and predicted emission rates of byproducts from CVD processes, Micron proposes to test the test the outlet of PEECs routed to the CVD exhaust for each byproduct predicted as a result of using the CVD reactant chosen for the test described above, so long as established test methods exist to identify those chemicals.

1.2.3.3 Proposed Testing to Confirm Emission Factor of 0.50

Emissions of aqueous ammonia are estimated using a process emission factor of 0.50 pounds emitted per pound used. Aqueous ammonia used will be exhausted through the ammonia exhaust. Micron proposes to validate this emission factor by testing the inlet for the ammonia scrubbers.

1.2.3.4 Proposed Testing to Confirm Emission Factor of 0.20

Emissions of many volatile solvents were estimated using a process emission factor of 0.20 pounds emitted per pound used. Micron proposes to validate this estimated emission factor by selecting one (1) compound with emissions estimated using this factor and testing for it in the appropriate exhaust(s). The compound will be determined at the time of the stack test protocol submittal.

1.2.3.5 Proposed Testing to Confirm Emission Factor of 0.05

Emissions of many aqueous acidic and basic solutions and solvents with relatively low volatility were estimated using a process emission factor of 0.05 pounds emitted per pound used. Micron proposes to validate this estimated emission factor by selecting one (1) compound with emissions estimated using this

factor and testing for it in the appropriate exhaust(s). The compound will be determined at the time of the stack test protocol submittal.

1.2.3.6 Compounds With an Estimated Emission Factor of 0.001

Emissions of many compounds that expected to exist in the process exhaust only in trace amounts were estimated using a process emission factor of 0.001 pounds emitted per pound used. Micron asserts that the emission factor of 0.001 is conservative for these compounds, and that stack testing is not necessary. These compounds are not expected to be detected in the exhaust ductwork or at the stack.

APPENDIX U. REFERENCE MATERIALS

This appendix has been added for Permit Application 2 to address NOIA Comment #19 received from the NYSDEC. Excerpts from cited sources that may not be commonly used by the NYSDEC and/or may be more difficult to locate or access are included following a cover page with the name of each document. The following documents are included in this appendix:

- *Semiconductor Industry: Wafer Fab Exhaust Management*
- 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6
- *The Relationship Between SP and HGBIK Drift Measurement Results*, CTI Paper TP98-16
- *Calculating Realistic PM 10 Emissions from Cooling Towers*, AWMA, Proceedings Florida Conference 2001, Session No. AM-1b
- *Nationwide Emission Benefits of a Low Sulfur Diesel Fuel*, Air Improvement Resource, Inc.
- IPCC Assessment Report 5 Chapter 8 Supplementary Material
- IPCC Assessment Report 6 Chapter 7 Supplementary Material

Semiconductor Industry: Wafer Fab Exhaust Management

7.3 EXAMPLE NO. 7-2

An existing newer silicon wafer fab had sporadic visible emissions from the stacks of the centralized acid scrubber and periodic odor reports on-site near the centralized acid scrubbers. The fab had three exhaust systems: centralized acid, centralized VOC, and centralized general-heat. Centralized equipment for VOC control and six 30,000 ft^3/min centralized acid scrubbers (vertical countercurrent packed-bed) existed at the site. The six centralized acid scrubbers were found to have low removal efficiencies for hydrogen fluoride and hydrogen chloride. This facility had centralized VOC control equipment that was found to have higher emissions of carbon monoxide and oxides of nitrogen emissions than previously permitted.

A team was established to develop an action plan for determining and implementing the best solutions for the issues listed. Understanding the technical information of each

issue was critical in developing the best solutions, and then an action plan could be developed for each issue. The action plan developed was:

1. There was a need to understand the technical information surrounding the issues.
2. The facility did have a written strategy for exhaust systems, POU device, and centralized abatement equipment. The current strategy allowed for the exhausting of ammonia into the centralized acid exhaust system.
3. The source(s) of sporadic visible emissions and odors was to be determined.
4. The reason for higher-than-expected emissions of carbon monoxide and oxides of nitrogen from centralized VOC control equipment had to be determined.

The next sections will describe what was developed and implemented for each action.

7.3.1 Fab Personnel Need to Understand Technical Information Surrounding Issues

This technical information was developed by working with knowledgeable personnel on fab exhaust management (including POU devices) and centralized abatement equipment. The following technical information was developed.

1. Ammonia and acid compounds form ammonium compounds which deposit in ducts and can be visible out of centralized acid scrubber stacks at around 1 ppmv and higher. The removal efficiency of ammonium compounds in existing centralized acid scrubbers was near zero.
2. Odors attributed to fab evacuations were similar to those of fluorine.
3. Good design and operation information for large vertical countercurrent scrubbers was found.
4. Possible reasons for higher than expected carbon monoxide emissions from centralized VOC control equipment were burner inefficiency, the supplier of VOC control equipment not including carbon monoxide from partial oxidation of organic compounds, and supplier not supplying correct carbon monoxide emissions information. Possible reasons for higher-than-expected emissions of oxides of nitrogen were oxidation of nitrogen-containing organic compounds (which were not provided initially to the VOC control equipment supplier) and VOC control equipment supplier not supplying correct information for emissions of oxides of nitrogen.

Project plans needed to be developed to find solutions and implement them. The following sections describe what was done.

7.3.4 Project Plan and Solutions for Higher-Than-Expected Emissions of Carbon Monoxide and Oxides of Nitrogen from Centralized Equipment to Control Volatile Organic Compounds

Fab personnel held a meeting with the supplier of the VOC control equipment to determine why the emissions of carbon monoxide and oxides of nitrogen were higher than listed by the supplier when the VOC control equipment was purchased. The

following information was determined at the meeting and additional work was performed.

7.3.4.1 Carbon Monoxide Emissions

The emissions measured for carbon monoxide were approximately five times higher than data for carbon monoxide emissions provided initially by the supplier of the VOC control equipment. The supplier stated that fab personnel were provided with carbon monoxide emissions data for the oxidation of natural gas only, not for oxidation of organic compounds. Fab personnel asked the supplier to check burner efficiency to ensure carbon monoxide emissions were minimized from the burner operation; this work was conducted and carbon monoxide emissions dropped by only 20%. The higher carbon monoxide emissions will need to be permitted with local air regulatory personnel.

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6

CHAPTER 6

ELECTRONICS INDUSTRY EMISSIONS

Authors

Laurie Beu (USA) and Sebastien Raoux (France/USA)

Yun Chung (Jack) Chang (USA), Michael Roger Czerniak (UK), Francesca Illuzzi (Italy), Tetsuya Kitagawa (Japan), Deborah Ottinger (USA) and Natalya Parasyuk (Ukraine)

Contributing Authors

Stephanie N. Bogle (USA), Shoumian Chen (China), Joseph Van Gompel (USA), Melissa Ann Gresham (USA), David Harman (USA), Kyungah Kim (Republic of Korea), Joey (Ching-Hui) Lu (Taiwan, Province of China), Youngsook Lyu (Republic of Korea), Brian K. Raley (USA) and Jennifer Politsch (USA)

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6 ELECTRONICS INDUSTRY EMISSIONS

Users are expected to go to the Mapping Tables in Annex 5, before reading this chapter. This is required to correctly understand both the refinements made and how the elements in this chapter relate to the corresponding chapter in the 2006 IPCC Guidelines.

This Chapter 6 Volume 3 of the *2019 Refinement* is a complete update of Chapter 6 Volume 3 of the *2006 IPCC Guidelines* and should be used instead of Chapter 6 Volume 3 of the *2006 IPCC Guidelines*.

The *2019 Refinement* of Volume 3 Chapter 6 was designed to maintain the scientific validity of GHG emissions estimates from the electronics industry. Compared to the *2006 IPCC Guidelines*, the *2019 Refinement* takes into account the changes in manufacturing processes and equipment that have occurred in the electronics industry during the thirteen-year interim period and reflect the much larger set of experimental data available (as of 2018 compared to 2006) to calculate default emissions factors for the sector. Also, several methodological refinements are introduced in an attempt to increase accuracy and flexibility, depending on how reporting facilities track gas usage and implement emissions control technologies. The *2019 Refinement* includes six revised methods (Tier 1, 2a, 2b, 2c, 3a, and 3b), compared to four for the *2006 IPCC Guidelines*. Section 6.1.2 and the mapping Tables in Annex 5 summarize the substantial refinements of this Chapter. Annex 5 provides a list of the sections, equations, tables, figures, and boxes that have been refined in this chapter, describing the type of refinement and a comparison between the *2006 IPCC Guidelines* and the *2019 Refinement*.

6.1 INTRODUCTION

6.1.1 Overview of emissions and their sources

As part of its manufacturing processes, the electronics industry uses and emits greenhouse gases (GHGs) from the family of fluorinated compounds (FCs) and nitrous oxide (N_2O). The specific electronic industry sub-sectors discussed in this chapter include the manufacturing of semiconductor devices, microelectromechanical systems (MEMS), photovoltaic (PV) devices, and displays, which in turn consist of thin-film-transistors (TFTs) for displays and organic light emitting diodes (OLEDs). FC emissions from waterproofing of electronic circuits are discussed in Chapter 8 of this Volume.

6.1.1.1 COMPOUNDS USED AND EMITTED

The electronics industry currently emits both FCs that are gases at room temperature (FC gases) and fluorinated compounds that are liquids at room temperature (fluorinated liquids) and that enter the atmosphere through evaporation. FC gases are used in two important steps of electronics manufacturing: (i) plasma etching and wafer cleaning (EWC) of silicon-containing materials and (ii) cleaning of the chamber walls of thin-film deposition (TFD) and diffusion tools after processing substrates. Electronic manufacturers also use fluorinated liquids as heat transfer fluids (HTFs) for temperature control during certain processes, as well as during testing of packaged semiconductor devices and during vapour phase reflow soldering of electronic components to circuit boards. In addition, fluorinated liquids are sometimes used to clean substrate surfaces, e.g., for MEMS. (Before 2010, fluorinated liquids were occasionally used to clean TFT-display panels during manufacture, but this is no longer believed to be the case.) Finally, electronics manufacturers use N_2O as an input gas during TFD processes and for other N_2O-using manufacturing processes such as diffusion and dry removal of photoresist.

For the purpose of this Chapter, FC gases are defined to include perfluoromethane (CF_4), perfluoroethane C_2F_6, perfluoropropane (C_3F_8), 1,3-hexafluorobutadiene (C_4F_6), perfluorocyclobutane (c-C_4F_8), octafluorotetrahydrofuran (C_4F_8O), octafluorocyclopentene (c-C_5F_8), trifluoromethane (CHF_3), difluoromethane (CH_2F_2), fluoromethane (CH_3F), pentafluoroethane (C_2HF_5), nitrogen trifluoride (NF_3), and sulphur hexafluoride (SF_6). Although not considered to be greenhouse gases, carbonyl fluoride (COF_2), and fluorine (F_2) should be tracked as input gases because they are known to create FC gas by-products which should be included in the inventory. Fluorinated liquid emissions consist primarily of hydrofluoroethers, perfluoropolyethers (including PFPMIE), and other fully fluorinated liquids (perfluorinated amines and perfluoroalkylmorpholines). More than 40 different fluorinated liquids are marketed to the electronics industry, often as mixtures of fully fluorinated compounds. Although this list of FC gases and classes of fluorinated liquids is believed to include all relevant compounds used in appreciable quantities for the production of electronic devices as of this writing, FC gases and

fluorinated liquids that should be considered for inventory purposes under this Chapter could also include other fluorinated compounds currently used in small quantities for production or for research and development (R&D) purposes, and FC gases and fluorinated liquids that may be used in the future for manufacturing electronic devices. In general, fluorinated compounds that are greenhouse gases or whose use during the manufacturing of electronic devices could result in emissions of greenhouse gases should be considered.

6.1.1.2 PROCESSES LEADING TO EMISSIONS

Both plasma etching and wafer and thin film deposition chamber cleaning processes use plasma or thermal energy to break down fluorinated compounds into fluorine atoms and other reactive species to perform these process steps. TFD and other N_2O-using processes also use plasma or thermal energy to break down N_2O molecules and generate oxygen or nitrogen atoms or molecules and other excited species to perform the process. The majority of FC gases and N_2O emissions result from the failure to completely break down the FC gases or N_2O molecules that are fed into the process, causing the utilisation efficiency of the input gases to be limited. In this chapter, input gases are generally designated with the subscript "i." In addition, a fraction of FC input gases used in the production process can be converted into FC gas by-products such as CF_4, C_2F_6, C_4F_6, C_4F_8, C_3F_8, CHF_3, CH_2F_2, and CH_3F. Several of these by-products can also be formed even if no carbon-containing FCs are fed into the process. In particular, processes using molecular fluorine (F_2), nitrogen trifluoride (NF_3), sulphur hexafluoride (SF_6), or chlorine trifluoride (ClF_3) input gases can generate CF_4, C_2F_6, CHF_3, CH_2F_2, CH_3F (and potentially other FC gases) as by-products of etching carbon-containing materials or cleaning chambers previously used to deposit carbon-containing thin films.[1] Moreover, under certain circumstances, CF_4 may be formed in combustion-based emissions control systems using hydrocarbon fuels by reaction between the fuel and fluorinated species (e.g. F_2) emitted during F_2 and remote NF_3 chamber cleans; thus, an appropriate CF_4 by-product emission factor ($AB_{CF4, F2}$) should be used to account for this phenomenon. In this chapter, by-product gases are generally designated with the subscript "k" (or "k,i" where a particular input gas "i" reacts to form the by-product "k"). Finally, with respect to fluorinated liquids, emissions occur through evaporative losses. Table 6.1 summarizes the sources and types of GHGs emitted during electronics manufacturing and identifies the section of this Refinement where they are discussed.

[1] When using cleaning or etching gases that do not contain carbon (e.g. F_2, NF_3, SF_6, or ClF_3), CF_4 and other FCs with high GWPs can be formed during the etching or cleaning of carbon-containing thin films, thus resulting in global warming emissions from the process. In particular, it should be noted that emissions of CF_4 and other FC by-products with high GWPs should be taken into account, even when the cleaning or etching precursor itself has no or low global warming potential (such as F_2, COF_2, or ClF_3). Please see section 6.2.2.1 for more detail.

TABLE 6.1 (NEW)
SOURCES AND TYPES OF GHGS EMITTED DURING ELECTRONICS MANUFACTURING

Source	GHG(s) Emitted	Relevant Sections of Volume 3 of *2019 Refinement*
Incompletely utilized FC gases fed into plasma etching, wafer cleaning, and chamber cleaning processes	Multiple FC gases	6.2.1.1, 6.2.2.1
By-products formed from carbon-containing FC gases fed into plasma etching, wafer cleaning, and chamber cleaning processes	Multiple FC gases	6.2.1.1 (See especially Box 6.2), 6.2.2.1
By-products formed from fluorine-containing gases (e.g., NF_3, F_2, COF_2) fed into plasma etching, wafer, cleaning, and chamber cleaning processes that involve carbon-containing films	Multiple FC gases	6.2.1.1 (See especially Box 6.2 and discussion following Equation 6.6), 6.2.2.1
By-product formed in some combustion-based FC emissions control systems	CF_4	6.2.1.1 (Equation 6.7 for Tiers 2a and 2b, Equation 6.15 for Tiers 2c and 3a)
Incompletely utilized N_2O fed into thin film deposition and other (e.g., diffusion) processes	N_2O	6.2.1.1 (throughout)
Fluorinated liquids used for temperature control, device testing, cleaning substrate surfaces and other parts, and soldering	Multiple FC liquids	6.2.1.2, 6.2.2.2, (See especially Table 6.5)
FCs emitted during waterproofing of electronic circuits	Multiple FC gases	Chapter 8, section 8.3 (See discussion near Equation 8.22A)

6.1.2 Summary of refinements

The Tier 1 method of the *2019 Refinement* uses the same approach as in the *2006 IPCC Guidelines*, where emissions are estimated based on the surface area of substrate produced for each sub-sector, but the Tier 1 default emissions factors (EFs) for semiconductor and display manufacturing have been updated to account for technological advancements and for the use of a broader basket of FC gases and fluorinated liquids. In addition, default EFs for MEMS have been introduced.

The Tier 2 and 3 methods of the *2019 Refinement*, like their predecessors in the *2006 IPCC Guidelines*, are based on gas consumption. The 2006 Tier 2a method is updated as a new refined 2019 Tier 2a method for the semiconductor sub-sector with revised emission factors, also accounting for additional precursors and by-products. For the display sub-sector, the *2019 Refinement* no longer provides a Tier 2a method because it is typically not needed. For the PV sub-sector, the 2006 Tier 2a method default factors cannot be applied to the 2019 Tier 2a method.

The 2006 Tier 2b method, which formerly distinguished emission factors by process type (etch versus chemical vapour deposition (CVD) [2] chamber clean) is now replaced with a new refined 2019 Tier 2b method using emission factors applicable to different wafer sizes for the semiconductor sub-sector (≤200 mm or 300 mm). Note that the revised 2019 Tier 2b method no longer distinguishes EFs by process type (this is now done under the new 2019 Tier 2c method), and that the 2019 Tier 2b method is applicable only to the semiconductor sub-sector.

The new 2019 Tier 2c method for the semiconductor sub-sector distinguishes emissions factors by both wafer size (≤200 mm or 300 mm), and by refined process type. For the display and PV sub-sectors, the Tier 2c method does not distinguish by substrate size but provides differentiated emission factors by process type.

Using the Tier 2 and Tier 3a methods requires some degree of apportioning of gas consumption. That is, the consumption of input gases should be differentiated by process type (e.g. etching vs. chamber cleaning). Compared to the *2006 IPCC Guidelines*, the *2019 Refinement* provides additional guidance to apportion gas consumption to different process types.

[2] This chapter uses the term "thin-film deposition," which encompasses chemical vapour deposition as well as other thin film deposition techniques.

The 2006 Tier 3 method, which was based on process-specific parameters, has evolved into a new 2019 Tier 3a method, which provides increased guidance for estimating emissions using measured, site-specific emissions factors (as opposed to the default emission factors used for the Tier 2 methods). In principle, the Tier 3a method is applicable to all sub-sectors (semiconductor, display, MEMS, PV).

The *2019 Refinement* includes a new 'stack' Tier 3b method to develop site-specific emission factors based on measurements at the stack level. Like the Tier 3a method, the 3b method is applicable to all sub-sectors.

Finally, it should be noted that, in addition to emissions arising from the direct manufacture of semiconductor, display, MEMS, and PV devices themselves, account has also been taken in the *2019 Refinement* for GHG emissions (including a variety of FC gases) from the application of thin, conformal waterproofing films to assembled circuit boards as used in electronic devices that are likely to be exposed to the weather; a good example being mobile ("cellular" or "smart") phones. This is discussed separately in Chapter 8 of the *2019 Refinement*.

Table 6.2 summarizes the refinements and applicability of each Tier by electronics industry sub-sector.

TABLE 6.2 (NEW)
REFINEMENTS AND APPLICABILITY OF GUIDANCE BY ELECTRONICS INDUSTRY SUBSECTOR

Electronics Industry Subsector	Gaseous Fluorinated Compounds and N_2O						Fluorinated Liquids	
	Tier 1	Tier 2a	Tier 2b	Tier 2c	Tier 3a	Tier 3b	Tier 1	Tier 2
Semiconductors	U	U	U	NG	U	NG	U	NR
Display (formerly "FPD" or "LCD")	U	*NA*	*NA*	U[1]	U	NG	U	NR
Photovoltaic	NR	*NA*	*NA*	U[2]	U	NG	U	NR
MEMS	NG	*NA*[3]	*NA*[3]	*NA*[3]	U	NG	U	NR

U – Update, NG – New Guidance, NR – No Refinement, *NA* – Not Applicable

[1]For display, the Tier 2c method now includes a default emission factor for N_2O TFD but is otherwise similar to the former 2b method. The Tier 2c method does not distinguish by substrate size for display.

[2]While the Tier 2 methods for all electronics sub-sectors were updated (e.g., to include additional guidance on gas apportioning and abatement), the default Tier 2c emission factors for photovoltaic manufacturing were not updated and are the same as for the *2006 IPCC Guidelines* Tier 2b method.

[3]Data were not available to calculate separate Tier 2 default EFs for MEMS manufacturing, but the corresponding Tier 2 EFs for semiconductors may be applied to MEMS manufacturing that uses semiconductor manufacturing tools.

6.2 METHODOLOGICAL ISSUES

6.2.1 Choice of method

6.2.1.1 GASEOUS FLUORINATED COMPOUNDS AND NITROUS OXIDE

Emissions of gaseous fluorinated compounds (FCs) and nitrous oxide from electronics manufacturing vary according to the quantities of the gases used (which vary roughly with the quantity of substrate processed), the identities of the gases used, the processes used, the wafer size (for semiconductors~~)~~, and the type and implementation of emissions control technologies. The choice of methods will depend on data availability and whether the electronics source category is *key*. See Figure 6.1 (Decision tree for estimation of GHG emissions from electronics manufacturing) and Tables 6.3 and 6.4 (Information for sources necessary for completing the tiered emissions estimating methods for electronics manufacturing) for more information.

Continuous (in-situ) emissions monitoring is not currently considered an economically viable means to estimate emissions from the electronics industry; however, greenhouse gas emissions are periodically measured at the process tool exhaust during the development of new processes and tools, generally for centreline process conditions.[3] Such measurements, performed on a large set of processes and averaged at varying levels of

[3] Centreline conditions refer to specific process conditions of gas flows, chamber pressure, processing time, plasma power, etc., for which an electronic device manufacturer may have measured emissions, or specific process conditions that may have

aggregation, form the basis of the Tier 1 and Tier 2 default emission factors presented in this guidance. They can also be performed by individual facilities and/or their tool suppliers to develop emission factors for specific process recipes or families of recipes when using the Tier 3a method. Finally, some facilities may periodically (for short periods of time) install equipment to measure emissions from their stacks for purposes of developing facility-specific emission factors to estimate emissions over the long term, as required by the Tier 3b method.

As discussed further below, the precision of the emissions estimate generally improves as one moves from lower to higher Tiers, accounting for more and more site-specific factors. For any single facility, the accuracy of the methods depends, among other things, on the differences between the emission factors of the processes actually used in production and the emission factors of a particular method, and on potential errors in calculating the overall efficiency and uptime of emissions control equipment. These differences and errors are likely to decrease (though not to disappear) as the Tier is increased. Errors in gas consumption measurements and apportioning can also occur and can limit the improvement in precision achieved by characterizing processes at a highly detailed level (e.g., in the Tier 3a method). However, apportioning errors depend on the measurements or model used and, if the guidance provided below is followed, are not expected to become important at the Tier 2 level (e.g., in moving from Tier 2a to Tier 2c). Thus, the use of higher tiered methods is strongly encouraged, especially in the case where default emission factors do not exist.

Where no gas consumption data is available and the electronics category is not *key*, emissions can be estimated using the Tier 1 method based on production figures (surface area of substrate used during the production of electronic devices). However, this approach is the least accurate and should be used only in cases where company-specific gas consumption data is not available. The uncertainty of the Tier 1 method is very high because it does not account for the quantities of the gases consumed (which are only loosely correlated with production), the identities of the gases consumed, the process type, the wafer size (for semiconductors), or the use of emissions control technology.

The Tier 2 methods are expected to be more accurate than the Tier 1 method because they rely on the actual consumption of individual gases and account for the use of emissions control technology. To varying extents, they also distinguish among process types and, for semiconductor manufacturing, wafer sizes. Note that insufficient data was available to calculate Tier 2 factors specifically for MEMS manufacturing; however, the corresponding semiconductor Tier 2 emission factors may be applied unless the MEMS are manufactured using MEMS-specific processes and manufacturing tools. If MEMS-specific manufacturing tools are used, the only higher-Tiered methods available are the Tier 3a and 3b methods.

The Tier 2a method does not distinguish among process types for most GHGs. The exceptions are NF_3 and C_3F_8, for which the Tier 2a method distinguishes between two process types (remote plasma clean vs. all other processes), and N_2O, for which the Tier 2a method distinguishes between two process types for semiconductor manufacturing (TFD and "other"). In addition, the 2a method does not distinguish between wafer sizes for semiconductor or MEMS manufacturing. Because emission factors for semiconductor manufacturing vary significantly based on wafer size, the Tier 2a method should only be used in the case of semiconductor facilities processing multiple substrate sizes where it is not possible to distinguish (apportion) gas consumption between the different substrate sizes. The *2019 Refinement* does not provide a Tier 2a method for the display sub-sector because display manufacturers typically use separate gas supplies for different process types, thus enabling the direct use of the more accurate Tier 2c method without having to apportion gas usage.[4] For the PV sub-sector, it should be noted that the 2006 Tier 2a default factors cannot be applied to the 2019 Tier 2a method because no data was available to calculate default $\gamma_{i,p}$ and $\gamma_{k,i,p}$ values for PV manufacturing. Thus, for PV manufacturing, only the 2019 Tier 2c or the 2019 Tier 3 methods are available.

The 2b method applies only to semiconductor manufacturing and to MEMS manufacturing that uses tools and processes which are similar to those used to manufacture semiconductors. The Tier 2b method is identical to the 2a method except that it provides emission factors that depend on the size of the wafers used for manufacturing (≤200 mm or 300 mm). The Tier 2b method is therefore more accurate than the Tier 2a method for semiconductor and MEMS manufacturing, and it should be used instead of the Tier 2a method when a facility only has one wafer size.

The Tier 2c method is expected to provide more accurate emission estimates than either of the other Tier 2 methods because it distinguishes among all process types for all GHGs, and it also distinguishes between wafer sizes in the semiconductor sub-sector. In addition, the method provides more accurate estimates of the quantities of FCs

been provided by a tool manufacturer who standardized its equipment for sale. Note that it is common for electronic devices manufacturers to modify centreline process conditions (developed in-house or by tool manufacturers) to optimise for particular needs or for a particular product.

[4] In the case display manufacturers use the same gas supply containers for multiple process types, a gas consumption apportioning model should be used.

exhausted[5] from tools which are connected to emission control systems (see discussion on the $\gamma_{i,p}$ and $\gamma_{k,i,p}$ factors and on the calculation of a_i and $a_{k,i}$ in the next paragraph as well as in the Tier 2a method section, particularly Box 6.3). The Tier 2c method is the only Tier 2 method available for the display and PV sub-sectors. Note that the definitions of process types are specific to each sub-sector: there are 6 distinct process types for the semiconductor sub-sector, 4 process types for the display sub-sector, and 2 process types for the PV sub-sector (see Tier 3a method description for details).

Apportioning is required to track gas consumption to process types. The Tier 2a and 2b methods require only limited apportioning. They are therefore simpler to use than the Tier 2c method, which requires apportioning of all gases to all process types that use those gases. However, the limited apportioning of the Tier 2a and Tier 2b methods significantly increases the uncertainty of their results. Instead of using facility-specific values as the Tier 2c and Tier 3a methods do, the Tier 2a and Tier 2b methods rely on industry average values for (1) the allocation of consumption of each gas to each process type, and (2) in the case of emissions control calculations, the per-tool pre-control emissions of each gas from each process type. These averages are respectively embodied in (1) weighted average emission factors for the process gases and (2) default weighting factors ($\gamma_{i,p}$ and $\gamma_{k,i,p}$) to account for average per-tool emissions from EWC vs. TFD tools for purposes of calculating the impacts of emissions control systems (D_i and $D_{k,i}$). (All of these quantities are discussed further below.) To the extent that the gas consumption patterns at individual facilities depart from these averages, the Tier 2a and Tier 2b methods will be inaccurate for those facilities. There is potential for large errors because emission factors can vary widely among process types, and the shares of each gas flowing to different process types (as well as per-tool emissions for different process types) vary widely among facilities. For these reasons, the Tier 2a and 2b methods should only be used when it is not possible to distinguish (apportion) gas consumption among the larger number of process types identified in the Tier 2c method.

The methods believed to provide the most accurate and least uncertain estimates of greenhouse gas emissions for electronic devices manufacturing are the Tier 3a and Tier 3b methods.

The Tier 3a method uses the same equations as the Tier 2c method. However, instead of using default emission factors for relatively broad process types, the Tier 3a method uses, at least in part, measured facility-specific emission factors. This enables the Tier 3a method to capture the variability in emission factors that can occur across processes within the same process type, using the same FC gas, and (for semiconductors) occurring on the same wafer size.[6] In theory, the Tier 3a method could be used to assign an emission factor to each centreline process, recipe, or families of similar recipes (see footnotes 2 and 5 and Tier 3a method discussion), or to assign a specific destruction removal efficiency (DRE) to a particular gas or by-product and emissions control system. It should be noted however that the new Tier 3a method provides more flexibility than the 2006 Tier 3 method in that using it does not require a complete set of measured values (see discussion on the use of 'hybrid' methods in the section on Adapting Tier 2 Methods to Account for Technological Changes). In the case of the Tier 3b method, reporting companies estimate their emissions based on fab[7]-specific emission factors. These emission factors are developed through periodic measurements of stack emissions correlated to 1) the consumption of input gases by the production tools connected to the stack system, and 2) the efficacy of the emissions control technologies used with those tools.

Because the new Tier 3b method is based on the measurement of emissions at the end-of-pipe (stack) level, it can be characterized as a 'top-down' method and contrasted to the Tier 2 and Tier 3a methods, which provide a 'bottom-up' approach by estimating emissions based on consumption at the inlet of the process tools. Thus, comparing the results of the various Tier 2 or Tier 3a bottom-up methods to the new top-down Tier 3b method could provide a measure of the accuracy (or inaccuracy) of the methods.

With respect to accounting for emissions control technologies, it should be noted that the *2019 Refinement* includes significant updates to the guidance on how to account for the use of emission control systems. One significant

[5] In this chapter, the fraction of gas or quantity of gas "exhausted" from process tools refers to the fraction or quantity of that gas that emerges from the tools before abatement is accounted for (i.e., the pre-control emissions). For example, if half of the tools that run etch processes with CHF_3 are equipped with suitable emissions control technologies, then the fraction of CHF_3 exhausted from etch process tools that are equipped with suitable emissions control technologies is 50 percent.

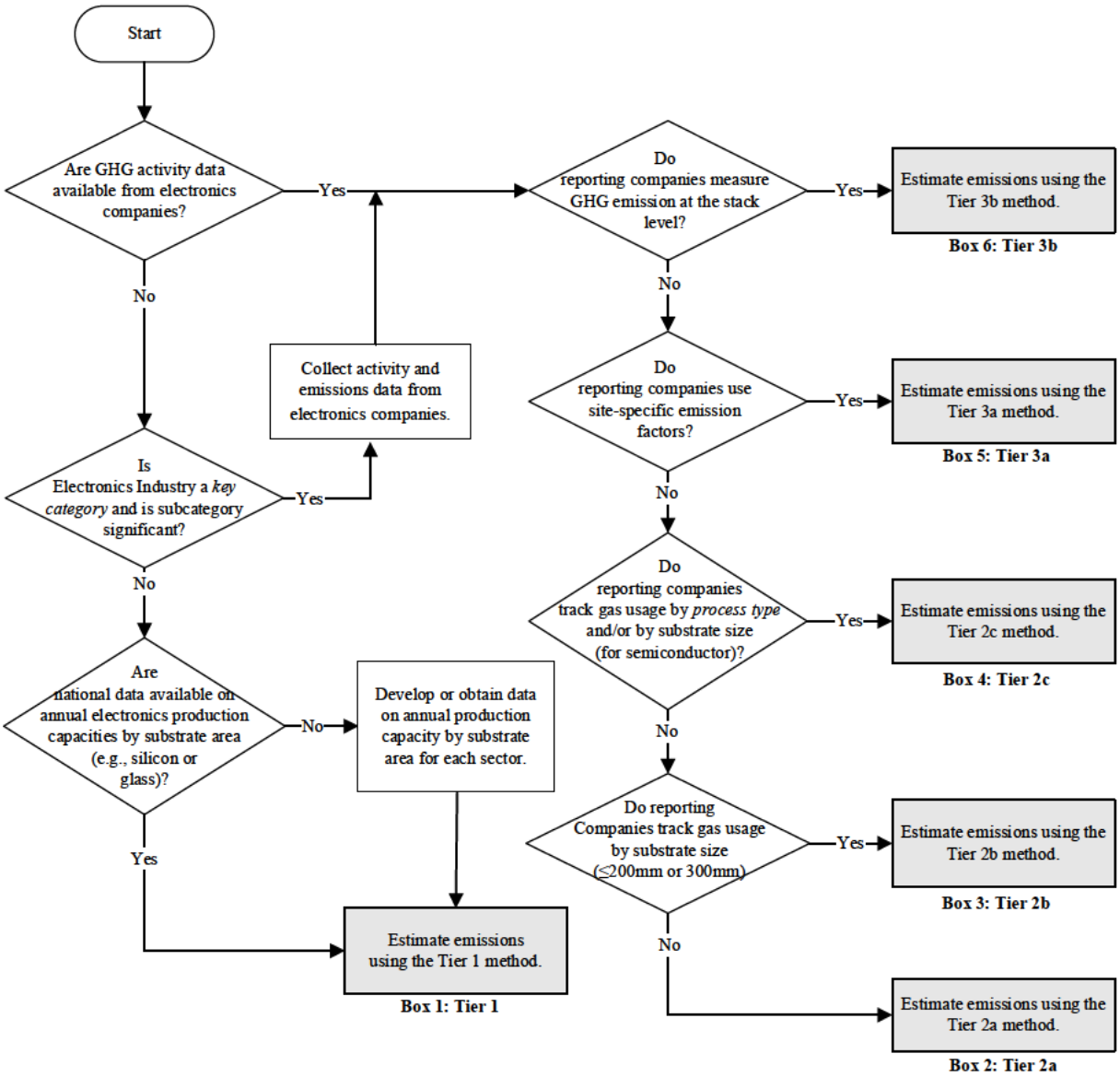
[6] Emission factors for input gas utilisation efficiencies and by-product formation rates can be strongly affected by changes in process variables other than FC gas, substrate size, and process type; these include film and tool type, combination of gases, as well as process recipes variables such as pressure, flow, temperature and plasma power. Further, emission factors for a recipe 'tuned' for a particular purpose or product can differ from those of the centreline process recipe that may have been used for measuring emissions (see Footnote 2). Emission factors can also be affected by the design of the process reactors and can substantially fluctuate from one tool manufacturer to another, even when the process function is similar (e.g. deposition of un-doped silicon dioxide using N_2O, cleaning a TFD reactor after deposition of silicon nitride using NF_3, etching of a trench in an interconnect structure using C_4F_6, etc.).

[7] The term 'fab' is synonymous with clean room/manufacturing facility. Semiconductor and flat panel display manufacturing plants are often called fabrication plants, from which the abbreviation 'fab' follows.

update is the consideration of the uptime of emissions control systems. Another update is guidance to determine the suitability of using particular emissions control technologies (e.g., cartridge, catalyst, hot-wet, plasma, combustion, new technology) for specific gases. Further, an applicability condition for using default DRE values (Tier 2 and Tier 3 methods) is to obtain a certification by the emissions control system manufacturers that their emissions control systems are capable of removing a particular gas to at least the default DRE in the worst-case flow conditions, as defined by each reporting site. This is important because the efficacy of greenhouse gas emissions control equipment depends on whether it is designed to abate the target gas and on whether it is operated and maintained according to the manufacturer's specifications, especially as regards to not exceeding the individual process gas and total gas flow rates (including any added purge gases) as stated by the emissions control equipment supplier. Guidance is also provided for using site-specific (measured) destruction removal efficiencies to claim DREs that may be different than the default values.

Finally, it should be noted that, even though the logic depicted in Figure 6.1 does not show the possibility of combining tiers, such an approach can be used to improve the accuracy of emissions estimates. If default emission factors are not available under Tier 2 (e.g. if a new wafer size or process type is introduced), or when a default emission factor is known to substantially differ from a facility-specific emission factor, inventory compilers can undertake process emissions characterization under Tier 3a and measure (1-U) and B factors for those new processes without defaults (or with an emission factor different than the default) while using Tier 2 defaults for existing processes (hybrid approach). Similarly, the Tier 2c method might be used for a particular sub-section of a facility and then combined with the Tier 3b method to estimate emissions from another sub-section of a facility, where emissions estimates would be based on measured (stack) emission factors. However, reporting companies should not combine the Tier 1 method with any other method.

Figure 6.1 (Updated) Decision tree for estimation of GHG emissions from electronics manufacturing



For semiconductor 450 mm substrate size, facilities should test and develop measured emission factors (Tier 3a). Tier 2a should not be used for 450 mm. Measured factors can be phased in over time; previous generation Tier 2c default factors can be used during the phase in period. Tier 3a measured factors should be submitted to IPCC EFDB to allow development of Tier 2 defaults. See section "Adapting Tier 2 Methods to account for technological changes" for more details.

Tables 6.3 (for gaseous FCs) and 6.4 (for liquid FCs) present the information necessary for completing emissions estimates for each tiered method and list all the variables that appear in the equations of each method. Depending on the method, variables may either be default values (denoted as 'D' and provided within this document (see section 6.2.2)), or variables may be measured (denoted as 'Me'), modelled (denoted as 'Mo'), or calculated (denoted as 'C' for every variable appearing on the left side of the equal sign in an equation).

TABLE 6.3 (UPDATED)
INFORMATION SOURCES NECESSARY FOR COMPLETING THE TIERED EMISSIONS ESTIMATING METHODS FOR GASEOUS FCS FOR ELECTRONICS MANUFACTURING

Note: The names of the variables have been simplified for the purpose of Table 6.3; please refer to the equations in each tiered methodology for the complete definitions of the variables and their units.
Legend: (Me) = measured; (Mo) = modelled (calculated but no equation specified in this chapter); (D) = default factors from guidance; (C) = calculated using an equation in this chapter.
* These variables are applicable to both sampling period and total year.

	Variables	Tier 1	Tier 2			Tier 3	
			2a	2b	2c	3a	3b
Production	Annual production	P (Me/Mo)					
	Fraction of PV manufacture that uses FC gases	F_{PV} (Me/Mo)					
	δ = 1 when applied to PV industry and zero when applied to either semiconductor or TFT-Display industries, dimensionless	δ (D)					
	Total number of tools that use gas i to run process type p (e.g., chamber cleaning processes)		$n_{i,p}$, $n_{k,i,p}$ (Me)	$n_{i,p}$, $n_{k,i,p}$ (Me)	$n_{i,p}$, $n_{k,i,p}$ (Me)	$n_{i,p}$, $n_{k,i,p}$ (Me)	$n_{i,p}$, $n_{k,i,p}$ (Me)
	Number of tools that use gas i to run process type p and that are equipped with suitable emissions control technologies		$n_{i,p,a}$, $n_{k,i,p,a}$ (Me)	$n_{i,p,a}$, $n_{k,i,p,a}$ (Me)	$n_{i,p,a}$, $n_{k,i,p,a}$ (Me)	$n_{i,p,a}$, $n_{k,i,p,a}$ (Me)	$n_{i,p,a}$, $n_{k,i,p,a}$ (Me)
	Total number of tools that use gas i to run reference process type q (e.g., etch and/or wafer cleaning (EWC) processes)		$m_{i,q}$, $m_{k,i,q}$ (Me)	$m_{i,q}$, $m_{k,i,q}$ (Me)			$m_{i,q}$, $m_{k,i,q}$ (Me)
	Number of tools that use gas i to run reference process type q and that are equipped with suitable emissions control technologies		$m_{i,q,a}$, $m_{k,i,q,a}$ (Me)	$m_{i,q,a}$, $m_{k,i,q,a}$ (Me)			$m_{i,q,a}$, $m_{k,i,q,a}$ (Me)
Process Gas Entering Tool	Annual consumption of gas		C_i(C)	C_i (C)	$C_{i,p}$ (C)	$C_{i,p}$ (C)	$C_{i,f}$ (Me/Mo)
	Inventory of input gas stored in containers at the beginning of the reporting year		IB_i (Me)	IB_i (Me)	IB_i (Me)	IB_i (Me)	IB_i (Me)
	Inventory of input gas stored in containers at the end of the reporting year		IE_i (Me)	IE_i (Me)	IE_i (Me)	IE_i (Me)	IE_i (Me)
	Acquisitions of input gas during the year		A_i (Me)	A_i (Me)	A_i (Me)	A_i (Me)	A_i (Me)
	Transfers of input gas		T_i (C)	T_i (C)	T_i (C)	T_i (C)	T_i (C)
	Heel factor		$h_{i,c}$ (D/Me)	$h_{i,c}$ (D/Me)	$h_{i,c}$ (D/Me)	$h_{i,c}$ (D/Me)	$h_{i,c}$ (D/Me)
	Number of containers		$N_{i,c}$ (Me)	$N_{i,c}$ (Me)	$N_{i,c}$ (Me)	$N_{i,c}$ (Me)	$N_{i,c}$ (Me)
	Full capacity of containers		$F_{i,c}$ (Me)	$F_{i,c}$ (Me)	$F_{i,c}$ (Me)	$F_{i,c}$ (Me)	$F_{i,c}$ (Me)
	Total number of container types		M (Me)	M (Me)	M (Me)	M (Me)	M (Me)
	Apportioning factor		$\Phi_{i,p}$ (Me/Mo)	$\Phi_{i,p}$ (Me/Mo)	$\Phi_{i,p}$ (Me/Mo)	$\Phi_{i,p}$ (Me/Mo)	

TABLE 6.3 (UPDATED) (CONTINUED)
INFORMATION SOURCES NECESSARY FOR COMPLETING THE TIERED EMISSIONS ESTIMATING METHODS FOR GASEOUS FCS FOR ELECTRONICS MANUFACTURING

Note: The names of the variables have been simplified for the purpose of Table 6.3; please refer to the equations in each tiered methodology for the complete definitions of the variables and their units.
Legend: (Me) = measured; (Mo) = modelled (calculated but no equation specified in this chapter); (D) = default factors from guidance; (C) = calculated using an equation in this chapter.
* These variables are applicable to both sampling period and total year.

	Variables	Tier 1	Tier 2			Tier 3	
			2a	2b	2c	3a	3b
Process	Emission Factor	EF_i (D)					
	Use rate of gas		U_i (D)	U_i (D)	$U_{i,p}$ (D)	$U_{i,p}$ (Me)	
	Byproduct emission factor		$B_{k,i}$ (D)	$B_{k,i}$ (D)	$B_{k,i,p}$ (D)	$B_{k,i,p}$ (Me)	
Downstream Emissions Control	Destruction Removal Efficiency (DRE)		d_i, d_k (D)	d_i, d_k (D)	d_i, d_k (D)	d_i, d_k (D/Me)	d_i , d_k (D/Me)
	Overall reduction of emissions		D_i, $D_{k,i}$ (C)	D_i, $D_{k,i}$ (C)	$D_{i,p}$, $D_{k,i,p}$ (C)	$D_{i,p}$, $D_{k,i,p}$ (C)	
	Mass fraction of F_2 in process exhaust gas that is converted into CF_4 by direct reaction with hydrocarbon fuel in a combustion emissions control system.		$AB_{CF4,F2}$ (D)	$AB_{CF4,F2}$ (D)	$AB_{CF4,F2}$ (D)	$AB_{CF4,F2}$ (D)	
	Ratio of uncontrolled emissions per-tool from tools running weighted process types p (e.g., chamber cleaning processes) to uncontrolled emissions per-tool from process tools running reference process types q (e.g., EWC processes)		$\gamma_{i,p}$, $\gamma_{k,i,p}$ (D)	$\gamma_{i,p}$, $\gamma_{k,i,p}$ (D)			$\gamma_{i,p}$, $\gamma_{k,i,p}$ (D)
	Estimate of the fraction of gas exhausted from process tools equipped with suitable emissions control technologies		a_i, $a_{k,i}$ (C)	a_i, $a_{k,i}$ (C)	$a_{i,p}$, $a_{k,i,p}$ (C)	$a_{i,p}$, $a_{k,i,p}$ (C)	$a_{i,f}$, $a_{k,i,f}$ (C)
	Uptime factor of emissions control systems		UT (C)	UT (C)	UT_p (C)	UT_p (C)	UT_f (C)*
	Total time that emissions control system connected to process tool(s) in the plant is not in operational mode when at least one of the manufacturing tools connected to emissions control system is in operation		Td_n (Me)	Td_n (Me)	$Td_{n,p}$ (Me)	$Td_{n,p}$ (Me)	$Td_{n,f}$ (Me)*
	Total time during which emissions control system has at least one associated manufacturing tool in operation		TT_n (Me)	TT_n (Me)	$TT_{n,p}$ (Me)	$TT_{n,p}$ (Me)	$TT_{n,f}$ (Me)*

TABLE 6.3 (UPDATED) (CONTINUED)
INFORMATION SOURCES NECESSARY FOR COMPLETING THE TIERED EMISSIONS ESTIMATING METHODS FOR GASEOUS FCS FOR ELECTRONICS MANUFACTURING

Note: The names of the variables have been simplified for the purpose of Table 6.3; please refer to the equations in each tiered methodology for the complete definitions of the variables and their units.
Legend: (Me) = measured; (Mo) = modelled (calculated but no equation specified in this chapter); (D) = default factors from guidance; (C) = calculated using an equation in this chapter.
* These variables are applicable to both sampling period and total year.

	Variables	Tier 1	Tier 2			Tier 3	
			2a	2b	2c	3a	3b
Stack Test Specific	Flow rate of stack system during the sampling period						Q_s (Me)
	Molecular weight of gas						MW_i, MW_k (D)
	Standard molar volume of gas						SV (D)
	Average concentration of input gas in stack system during sampling						$X_{i,s,m}$, $X_{k,s,m}$ (Me)
	Length of time interval m in the FTIR sampling period						Δt_m (Me)
	Total number of time intervals m in sampling period						N (C)
	Consumption of input gas during the sampling period						$Activity_{i,f}$ (Me)
	Facility-specific emission factor						$EF_{i,f}$, $EF_{k,f}$ (C)
Emissions	Emissions of FC gases or N_2O	$\{E_i\}_n$ (C)					
	Emissions of unreacted input gas		E_i (C)	E_i (C)	E_i (C)	E_i (C)	$EA_{i,f}$, $ES_{i,s}$ (C)
	Emissions of by-products		BPE_k (C)	BPE_k (C)	BPE_k (C)	BPE_k (C)	$EA_{k,f}$, $ES_{k,s}$ (C)
	Emissions of CF_4 from hydrocarbon-fuel-based combustion emissions control systems		$EAB_{i,CF4}$ (C)	$EAB_{i,CF4}$ (C)	$EAB_{i,CF4}$ (C)	$EAB_{i,CF4}$ (C)	

TABLE 6.4 (UPDATED)
INFORMATION SOURCES NECESSARY FOR COMPLETING THE TIERED EMISSIONS ESTIMATING METHODS FOR LIQUID FCS FOR ELECTRONICS MANUFACTURING

Legend: (Me) = measured; (Mo) = modelled (calculated but no equation specified in this chapter); (D) = default factors from guidance; (C) = calculated using an equation in this chapter.
* These variables are applicable to both sampling period and total year.

	Tier 1	Tier 2
Annual production either in m^2 of substrate used during the production of electronic devices (for heat transfer fluid applications) or in thousands of packaged devices (for testing, packaging and soldering)	P (Me)	
Emission factor for fluorinated liquid aggregate emissions either per m^2 of substrate consumed during the period (kg/m^2, for heat transfer fluid applications), or per thousand packaged devices (kg/kpcs, for testing, packaging and soldering)	EF_i (D)	
Density of fluorinated liquid		ρ_i (Me)
Inventory of fluorinated liquid in containers other than equipment at the beginning of the reporting year		I_{it-1} (Me)
Acquisitions of fluorinated liquids during the reporting year, including amounts purchased from chemical suppliers, amounts purchased from equipment suppliers with or inside of equipment, and amounts returned to the facility after off-site recycling		$P_{i,t}$ (Me)
Total nameplate capacity of equipment that uses fluorinated liquids and that is newly installed in the facility during the reporting year		$N_{i,t}$ (Me)
Total nameplate capacity of equipment that uses fluorinated liquids and that is removed from service in the facility during the reporting year		$R_{i,t}$ (Me)
Inventory of fluorinated liquids in containers other than equipment at the end of the reporting year		$I_{i,t}$ (Me)
Disbursements of fluorinated liquids, including amounts returned to chemical suppliers, sold with or inside of equipment, and sent off-site for verifiable recycling or destruction		$D_{i,t}$ (Me)
Emissions of fluorinated liquid	FC_i (C)	FC_i (C)

TIER 1 METHOD – DEFAULT EMISSION FACTORS BASED ON PRODUCTION

The Tier 1 method is the least accurate estimation method and should be used only in cases where facility-specific data are not available. The Tier 1 method is based on production figures (surface area of substrate used during the production of electronic devices, e.g. silicon, glass). Unlike the Tier 2 or Tier 3 methods, the Tier 1 method is designed to give an aggregated estimate of greenhouse gas and N_2O emissions with an estimated but uncertain break-out among specific gases. Estimates are made simultaneously for all the gases listed in Table 6.6, and the Tier 1 method can only be used if these gases are reported as a complete set. For each class (sub-sector) of electronic products being manufactured (semiconductors, display, PV, MEMS), the calculation of emissions relies on a different set of default, gas-specific emission factors. Each default emission factor expresses the average emissions of the relevant gas per unit area of the relevant substrate used during manufacture (including test substrates).

For any class of electronic products (input material), the default emission factors are multiplied by the annual production (P, in units of square meters (m^2)). The result is a set of annual emissions estimates expressed in kg of the gases emitted during the manufacture of that class of electronic products. Because the use of greenhouse gases varies widely during PV manufacture, a third factor to account for the proportion of PV manufacture that employs

process greenhouse gases is needed to estimate emissions from PV cells manufacturing. The Tier 1 formula is shown in Equation 6.1.

EQUATION 6.1 (UPDATED)
TIER 1 METHOD FOR ESTIMATION OF THE SET OF GHG EMISSIONS

$$\{E_i\}_n = \{EF_i \bullet P \bullet [F_{PV} \bullet \delta + (1-\delta)]\}_n \quad (i = 1, \ldots, n)$$

Where:

$\{E_i\}_n$ = emissions of fluorinated compound gas i (FC_i) or N_2O, kg for semiconductors and MEMS, g for display and PV

Note: $\{\}_n$ denotes the set for each class of products (semiconductors, display, MEMS, or PV) and *n* denotes the number of gases included in each set ({12} for semiconductors, {6} for display, {3} for MEMS, and {2} for PV, see Table 6.6). The estimates are only valid if made and reported for all members of the set using this Tier 1 methodology

EF_i = emission factor for gas i expressed as annual mass of emissions per square meters of substrate surface area for the product class, mass of gas i/m^2. See default factors of Table 6.6

P = annual production, m^2 of substrate used as measured by the surface area of substrate used during the production of electronic devices, including test substrates. If annual production is not available from an electronics producer, P may be calculated as the product of the annual manufacturing capacity and annual plant production capacity utilisation (fraction) of that producer

F_{PV} = fraction of PV manufacture that uses FC gases, fraction

δ = 1 when Equation 6.1 is applied to PV industry and zero when Equation 6.1 is applied to semiconductor, MEMS, or TFT-Display industries, dimensionless

i = input gas

This method does not account for actual gas consumption or for differences in emission factors among process types (etching versus cleaning), individual processes, or tools. It also does not account for the possible use of emission-control devices.

In using Tier 1, inventory compilers should not modify, in any way, the set of the gases assumed in Table 6.6. For any given manufacturing facility, inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 or 3 methods. Neither may inventory compilers use, for example, the Tier 1 factor for CF_4 to estimate the emissions of CF_4 from semiconductors and combine it with the results of other FC gases from a Tier 2 or Tier 3 method. (See also Section 6.2.2.1.)

GAS CONSUMPTION AND APPORTIONING FOR TIERS 2 AND 3

In using the Tier 2 and Tier 3a methods, input gas consumption (C_i) should be determined and apportioned to specific process types ($C_{i,p}$). Where the Tier 2c or 3a methods are used to estimate emissions from a semiconductor facility that manufactures on multiple wafer sizes, gas consumption should be apportioned to specific wafer sizes as well. In this situation, the equations below can be used twice, substituting "wafer size" for "process" as a first step and then using the equation again for "process". Total annual input gas i consumption (C_i) on a facility basis for each fluorinated compound and N_2O is calculated using Equation 6.2 below.

EQUATION 6.2 (NEW)
CONSUMPTION OF INPUT GAS I

$$C_i = \left(IB_i - IE_i + A_i - T_i\right)$$

Where:

C_i = annual consumption of input gas i (site specific), kg per year

IB_i = inventory of input gas i stored in containers at the beginning of the reporting year, including heels, kg. For containers in service at the beginning of a reporting year, account for the quantity in these containers as if they were full.

IE_i = inventory of input gas i stored in containers at the end of the reporting year, including heels, kg. For containers in service at the end of a reporting year, account for the quantity in these containers as if they were full

A_i = acquisitions of input gas i during the year through purchases or other transactions, including heels in containers returned to the electronics manufacturing facility, kg

T_i = transfers of input gas i through sales or other transactions during the year, including heels in containers returned by the electronics manufacturing facility to the chemical supplier, as calculated using Equation 6.3, kg

i = input gas.

Transfers (T_i) are calculated using Equation 6.3.

EQUATION 6.3 (NEW)
TRANSFERS OF INPUT GAS I

$$T_i = \sum_{c=1}^{M} h_{i,c} \bullet N_{i,c} \bullet F_{i,c}$$

Where:

T_i = transfers of input gas i through sales or other transactions during the reporting year for the reporting facility, including heels in containers returned by the electronics manufacturing fab to the gas distributor, kg

$h_{i,c}$ = gas-specific heel factor for input gas i and container size and type c, fraction. A default $h_{i,c}$=0.1 may be used instead of developing gas-specific, container-specific factors

$N_{i,c}$ = number of containers of size and type c used at the reporting facility and returned to the gas distributor containing the standard heel of input gas i

$F_{i,c}$ = full capacity of containers of size and type c containing input gas i, kg

i = input gas

c = size and type of gas container

M = total number of different sized container types for the reporting facility. If only one size and container type is used for an input gas i, M = 1

A site-specific heel factor for each type of gas and container used in a facility ($h_{i,c}$) can be determined by monitoring the pressure and converting the pressure to mass using the ideal gas law or based on the weight of the gas provided to the facility in gas supplier documents. If the reporting facility uses less than 50 kg of an FC gas or N_2O in one reporting year, inventory compilers may assume that any $h_{i,c}$ for that FC gas or N_2O is equal to zero.

For the Tier 2 and Tier 3a methods, varying degrees of gas use apportioning are required. For the semiconductor sub-sector, the Tier 2a and 2b methods require apportioning of NF_3 and C_3F_8 consumption between the remote plasma clean (RPC) process type and other NF_3- or C_3F_8-using process types, while N_2O is apportioned between the N_2O TFD process type and "Other" N_2O-using process types. The Tier 2c (for the semiconductor, MEMS, and display sub-sectors) and the Tier 3a (for all sub-sectors) methods require apportioning for each input gas i and each process type p. Apportioning is calculated using Equation 6.4.

EQUATION 6.4 (NEW)
APPORTIONING OF C TO PROCESS TYPES/SUB-TYPES

$$C_{i,p} = C_i \bullet \Phi_{i,p}$$

Where:

$C_{i,p}$ = annual amount of input gas i consumed by the reporting facility for process type p, kg

$\Phi_{i,p}$ = process type p-specific apportioning factor for input gas i, fraction

C_i = annual consumption of input gas i for the reporting facility, as calculated using Equation 6.2, kg

i = input gas

To minimize apportioning uncertainty and increase accuracy, it is *good practice* to implement a gas consumption monitoring system using direct measurement to apportion gas use at the process type-, stack system- or facility-level as appropriate. This can be achieved by various methods including monitoring and integrating the signal of Mass Flow Controllers (MFCs) and using weigh scales; however, it is noted that measurement to specific tools or processes may not be feasible. If gas consumption measurement at the process level is not deemed feasible for a particular facility, apportioning factors ($\Phi_{i,p}$) can be calculated using a site-specific engineering model. This model should be based on a quantifiable metric, such as substrate passes or substrate starts. To verify the apportioning model, it is *good practice* to demonstrate its precision and accuracy as follows:

(1) Demonstrate that the FC gases and N_2O apportioning factors are developed using calculations that are repeatable, which means that the variables used in the formulas for the facility's engineering model for gas apportioning factors should be based on observable and measurable quantities that govern gas consumption rather than engineering judgment about those quantities or gas consumption. Note that research and development (R&D) and tool commissioning activities may be excluded from the apportioning calculations, but that gas purchases in support of these activities should be included in the emissions calculation. In the event of the introduction of new manufacturing technologies or new gases, this demonstration should be repeated.

(2) Demonstrate the accuracy of the site-specific apportioning model by comparing the actual amount of input gas i consumed and the modelled amount of input gas i consumed in the facility, by:

   (i) Analysing actual and modelled gas consumption for a sustained period (at least 30 days) when the fab is at a representative operating level (at least 70 percent of the average production rate for the year in terms of monthly substrate starts). In the event of the introduction of new technologies or substrate size this analysis should be repeated.

   (ii) Comparing the actual gas consumed to the modelled gas consumed for the highest use fluorinated compound (or compounds) used in multiple process types at the facility (e.g., NF_3 use in remote plasma clean and other processes).

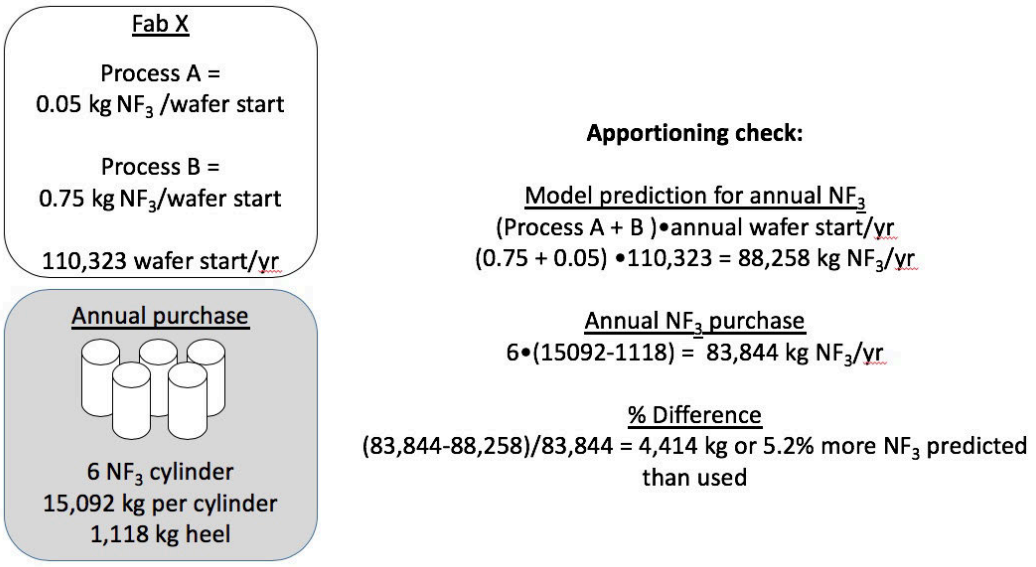
   (iii) Demonstrating that the comparison performed for the largest quantity of gas(es), on a mass basis, consumed in the facility, does not result in a difference between the actual and modelled gas consumption that exceeds 20 percent relative to actual gas consumption.

   (iv) If 20 percent is not achieved, the model should be revised until the difference between actual and the modelled gas consumption does not exceed 20 percent.

Note that inventory compilers may use a combination of apportioning factors developed using a facility-specific engineering model and apportioning factors developed through the use of direct measurement.

Box 6.1 provides an example of a site-specific apportioning model verification.

BOX 6.1 (NEW)
SITE-SPECIFIC APPORTIONING MODEL VERIFICATION EXAMPLE



TIER 2 METHODS – DEFAULT EMISSION FACTORS BASED ON GAS CONSUMPTION

Tier 2a Method

The Tier 2a method is applicable to semiconductor manufacturing and to MEMS manufacturing that is carried out using tools and processes similar to those used to manufacture semiconductors (for further details see discussion in the Choice of method section, in particular footnote 3). As discussed above, the Tier 2a method does not distinguish between wafer sizes or among process types for most FCs; however, the Tier 2a method does provide different default emission factors for C_3F_8 RPC vs. other C_3F_8-using processes, for NF_3 RPC vs. other NF_3-using processes, and for N_2O TFD processes vs. 'other' N_2O-using processes. Thus, when using the Tier 2a method, the consumption of C_3F_8 and NF_3 should be apportioned between RPC and other processes, and consumption of N_2O should be apportioned between TFD and "Other" N_2O-using processes, as applicable to each reporting site.

The Tier 2a method uses the default emission factors provided in Table 6.7, which represent average utilisation efficiencies of the gases used in manufacturing processes (U_i) and the formation of by-products during the use of each input gas i ($B_{k,i}$). The other default factors used for the Tier 2a method include the destruction removal efficiency of gases i and by-products k (d_i, d_k - see Table 6.17) and the ratio of per-tool uncontrolled emissions of gases i (and by-products k) from TFD process tools to per-tool uncontrolled emissions of gases i (and by-products k) from EWC process tools ($\gamma_{i,p}$, $\gamma_{k,i,p}$ - see Table 6.8).

The Tier 2a method also uses site-specific data on gas consumption and emissions control. Inventory compilers using the Tier 2a method should directly communicate with industry to gather consumption and emissions control-related data and to ensure that reductions are not attributed to emissions control devices unless the devices are installed and used in accordance with the guidance provided in section 6.2.2.1. Inventory compilers should note that the consumption of gas i (Ci) takes into account the heel factor (hi,c), which represents the fraction of gas i remaining in the shipping container after use, and which can be based on industry-wide default or site-specific measured values (see Section on Gas Consumption and Apportioning).

Total Tier 2a emissions are calculated using Equations 6.5, 6.6, and 6.7 below, and are equal to the sum of emissions from all unreacted gases i used in the production process (E_i), plus emissions of all by-products k (BPE_k) resulting from the conversion of all input gases i used during production, plus emissions of CF_4 from hydrocarbon-fuel-based combustion emissions control systems ($EAB_{i,CF4}$). However, note that $EAB_{i,CF4}$ may be set equal to zero if the emissions control equipment manufacturer can certify that reactions between hydrocarbon fuel and F_2 to form CF_4 are not occurring within their emissions control systems (i.e. certify that $AB_{i,CF4} = 0$).

EQUATION 6.5 (UPDATED)
EMISSIONS OF INPUT GAS I

$$E_i = C_i \bullet (1 - U_i) \bullet (1 - D_i)$$

Where:

E_i = emissions of unreacted input gas i, kg

C_i = consumption of input gas i, kg

U_i = use rate of gas i (fraction destroyed or transformed in process), fraction

D_i = overall reduction of mass of gas i emissions, site-specific fraction, calculated per Equation 6.8

i = input gas or, for NF_3, C_3F_8, and N_2O, input gas and process type combination

EQUATION 6.6 (UPDATED)
BY-PRODUCT EMISSIONS

$$BPE_k = \sum_i [C_i \bullet B_{k,i} \bullet (1 - D_{k,i})]$$

Where:

BPE_k = emissions of by-product k generated from the conversion of all input gases i, kg

C_i = consumption of input gas i, kg

$B_{k,i}$ = emission factor for by-product k generated from input gas i, kg of by-product gas k created/kg of gas i consumed

$D_{k,i}$ = overall reduction of mass of emissions of by-product gas k formed from input gas i, site-specific fraction, calculated per Equation 6.9

i = input gas or, for NF_3, C_3F_8, and N_2O, input gas and process type combination

k = by-product gas

BOX 6.2 (NEW)
FLUORINATED GREENHOUSE GAS BY-PRODUCTS

As discussed briefly in the introduction, the formation of fluorinated GHG by-products resulting from the decomposition of input gases or from the reaction with the materials being etched or cleaned should be taken into account. To this effect, by-product emission factors ($B_{CF4,i}$, $B_{C2F6,i}$, $B_{C3F8,i}$, $B_{C4F6,i}$, $B_{C4F8,i}$, $B_{C5F8,i}$, $B_{CH3F.i}$ $B_{CH2F2,i}$, and $B_{CHF3,i}$, emission factors indicating the mass ratio of by-product produced from the use of input gas i) are included as part of the default emission factors tables for the Tier 2 methods. In some cases, perfluorinated carbon by-product emission factors are provided, even when the etching or cleaning gas i itself contains fluorine but does not contain carbon (e.g. NF_3, SF_6, F_2). This is because the fluorine atoms and other excited F species generated from the decomposition of NF_3, SF_6 or F_2 can react with the carbon contained in the film to form CF_4 and other carbon-containing greenhouse gas by-products. Such reactions are particularly significant during the etching or cleaning of 'low k' (low dielectric constant) materials that often present high carbon content, but formation of carbon-containing by-products also occur when small amounts of carbon are present in the film, for example in the case of thin films deposited with organic precursors such as tetraethylorthosilicate (TEOS). However, when using NF_3, SF_6, F_2 or other etching or cleaning precursors that do not contain carbon, and when the film being etched or cleaned does not contain carbon, then no CF_4 or other carbon-containing greenhouse gases are expected to be formed during the process.

As noted in Box 6.2 the formation of FC gas by-products such as CF_4, C_2F_6, CH_3F, CH_2F_2, and CHF_3 can occur when etching or cleaning carbon-containing films, even when input gases do not contain carbon (e.g. NF_3, SF_6, F_2). However, when using NF_3, SF_6, F_2 or other etching or cleaning precursors that do not contain carbon, and when the film being etched or cleaned does not contain carbon, then no CF_4 or other carbon-containing greenhouse gases are formed during the process. Thus, in such cases (and in such cases only), the $B_{k,i}$ factors may be set equal

to zero in Equation 6.6. It should be noted, however, that sometimes both carbon-containing and non-carbon-containing films are included in the film stacks forming final electronic devices. In such cases, there are two options: 1) if it is practical to track the gas consumption used to clean or etch films containing carbon vs. not containing carbon, the non-zero and zero $B_{k,i}$ factors may be applied accordingly, or 2) if it is not practical or desired to track gas consumption to this level of detail, the non-zero BPE factors should be applied to all consumption of a gas if any film containing carbon is run with that gas during the year.

Emissions and emission reductions from emission control devices

When NF_3 is used in RPC processes or F_2 is used as an input gas and when hydrocarbon-fuel-based combustion emissions control technology is used, direct reaction with hydrocarbon fuel and F_2 (including F_2 resulting from the decomposition of NF_3 in RPC processes) to form CF_4 can occur. Unless the emissions control system manufacturer (referred to below as the "original equipment manufacturer" or "OEM") or electronics manufacturer can certify that the rate of conversion from F_2 to CF_4 or from NF_3 to CF_4 is <0.1 percent on a mass basis, Equation 6.7 should be used to estimate the amount of CF_4 produced within and emitted from the emissions control equipment.

EQUATION 6.7 (NEW)
BY-PRODUCT EMISSIONS FROM HYDROCARBON FUELLED COMBUSTION EMISSIONS CONTROL SYSTEMS

$$EAB_{i,CF_4} = C_i \bullet (1 - U_i) \bullet (1 - \eta) \bullet AB_{i,CF_4}$$

Where:

i = input gas (i = only NF_3 used in RPC processes or F_2 for the purpose of Equation 6.7)

$EAB_{i,CF4}$ = emissions of CF_4 from hydrocarbon-fuel-based combustion emissions control systems when direct reaction with hydrocarbon fuel and fluorinated species is not certified not to occur by the emissions control OEM or electronics manufacturer, kg

C_i = consumption of gas i (i = only NF_3 used in RPC processes or F_2 for the purpose of Equation 6.7), kg

U_i = use rate of gas i, fraction destroyed or transformed in process

η of ratio of emissions control systems certified not to form CF_4 within emissions control systems to the total number of emissions control systems in the facility, site-specific fraction

$AB_{i,CF4}$ (i = only NF_3 used in RPC processes or F_2 for the purpose of Equation 6.7) = mass fraction of NF_3 used in RPC processes or F_2 in process exhaust gas that is converted into CF_4 by direct reaction with hydrocarbon fuel and F_2 gas in a combustion emissions control system. $AB_{i,CF4}$ is set to zero if the emissions control OEM or electronics manufacturer can certify that the rate of conversion from F_2 to CF_4 or from NF_3 to CF_4 is <0.1 percent; otherwise, a default value of $AB_{NF3,CF4} = 0.093$ or $AB_{F2,CF4} = 0.116$ should be used.

Inventory compilers should calculate the overall reductions in emissions of process gas i and by-product k (D_i, $D_{k,i}$) based on site-specific information using Equations 6.8 and 6.9, factoring in the mass fraction of gas i and by-product k exhausted from process tools equipped with suitable emissions control technologies (a_i, $a_{k,i}$), the destruction removal efficiency of gas i and by-product k (d_i, d_k), and the average uptime of emissions control systems (UT).

EQUATION 6.8 (NEW)
EMISSIONS REDUCTION IMPACT OF EMISSIONS CONTROL TECHNOLOGY FOR GAS I

$$D_i = a_i \bullet d_i \bullet UT$$

Where:

D_i = overall reduction of mass of gas i emissions, site-specific fraction

a_i = estimate of the fraction of gas i emitted from process tools equipped with suitable emissions control technologies, site-specific fraction as determined in Equation 6.10 or Equation 6.18, as applicable

d_i = Destruction Removal Efficiency (DRE) for gas i, fraction

UT = average uptime factor of all emissions control systems, site-specific fraction, calculated per Equation 6.12

i = input gas, or, for NF_3, C_3F_8, and N_2O, input gas and process type combination

EQUATION 6.9 (NEW)
EMISSIONS REDUCTION IMPACT OF EMISSIONS CONTROL TECHNOLOGY FOR BY-PRODUCT K

$$D_{k,i} = a_{k,i} \bullet d_k \bullet UT$$

Where:

$D_{k,i}$ = overall reduction of mass of emissions of by-product k formed from input gas i, site-specific fraction

$a_{k,i}$ = estimate of the fraction of by-product k that is formed from input gas i and that is exhausted from process tools equipped with suitable emissions control technologies, site-specific fraction, as determined in Equation 6.11 or Equation 6.19, as applicable

d_k = Destruction Removal Efficiency (DRE) for by-product k, fraction

UT = average uptime factor of all emissions control systems, site-specific fraction, calculated per Equation 6.12

i = input gas, or, for NF_3, C_3F_8, and N_2O, input gas and process type combination

k = by-product gas

Calculation of a_i and $a_{k,i}$ using the default weighting factors $\gamma_{i,p}$ and $\gamma_{k,i,p}$

When using the Tier 2a method, inventory compilers should calculate the fractions of gas i and by-products k formed from gas i (based on mass) exhausted from process tools equipped with suitable emissions control technologies (a_i and $a_{k,i}$). "Suitable" means that an emissions control technology is capable of abating a particular gas to a minimum destruction removal efficiency in a site-specific worst-case scenario (please see Section 6.2.2.1 on Emissions Control Technology Factors for more details).

For NF_3 and C_3F_8 used in RPC processes, and for N_2O used in either TFD or "other" processes, inventory compilers should use Equations 6.18 and 6.19 to estimate the fractions of the input gas and associated by-product abated for each of those process types ($a_{i,p}$ and $a_{k,i,p}$). For other input-gas and process-type combinations, inventory compilers using the Tier 2a method (or the Tier 2b or Tier 3b method) should use Equations 6.10 and 6.11 to estimate the fractions of input gas and by-product abated across multiple process types (a_i and $a_{k,i}$).

In all of these equations (6.10, 6.11, 6.18, and 6.19), the fraction of pre-control emissions that is exhausted to emissions control systems is approximated using the fraction of the total number of tools that exhaust to emissions control systems.[8] This approximation is expected to be reasonably good by itself if all the tools are running the same process type (e.g., chamber cleaning vs. etching). However, the approximation may be poor by itself if the tools are running different process types, because emissions per tool can vary greatly across different process types. In Equations 6.10 and 6.11, the fraction of emissions destroyed is estimated across different process types. Thus, in these equations, new default weighting factors ($\gamma_{i,p}$ for input gases and $\gamma_{k,i,p}$ for by-product gases, provided in Table 6.8) are applied to tools that run chamber cleaning processes to increase the accuracy of the estimate.

As discussed in Box 6.3, the gamma factors reflect the ratio of the uncontrolled emissions per tool of gas i or by-product k from tools running the weighted process type "p" to the uncontrolled emissions per tool of gas i or by-product k from tools running the reference process type "q." When Equation 6.10 or 6.11 is used for the Tier 2a or Tier 2b method, p includes the in-situ plasma cleaning (IPC) and the in-situ thermal cleaning (ITC) process types, while q consists of the etching and wafer cleaning (EWC) process type. (These terms include additional

[8] If a facility monitors input gas consumption by tool (e.g., using MFCs), this information rather than tool counts may be used to calculate $a_{i,p}$ and $a_{k,i,p}$. Similarly, if a facility using the 3b method monitors or otherwise apportions gas consumption by process type, Equations 6.18 and 6.19 may be used to estimate $a_{i,p}$ and $a_{k,i,p}$ for all process types at the facility.

process types for Tier 3b; see the definitions of the terms "p" and "q" in Equations 6.10 and 6.11. [9]) For Tiers 2a and 2b, taking gamma values into account is necessary when (1) an input gas is consumed (or a by-product k is produced) both by chamber cleaning processes and by EWC processes, (2) the use of the input gas is not apportioned between chamber cleaning processes and EWC processes, and (3) the fractions of tools equipped with emissions control technologies are different for chamber cleaning processes and EWC processes. To calculate a_i and $a_{k,i}$, inventory compilers should use Equations 6.10 and 6.11 and the default gamma factors, as well as the numbers of tools in the reporting facility using gas i or producing by-product k from gas i while running process type p or q ($n_{i,p}$, $m_{i,q}$, $n_{k,i,p}$, $m_{k,i,q}$), and the numbers of those tools equipped with suitable emissions control technology for gas i or by-product k while running process type p or q ($n_{i,p,a}$ $m_{i,q,a}$, $n_{k,i,p,a}$, $m_{,k,i,q,a}$).

For each gas where a value for $\gamma_{i,p}$ or $\gamma_{k,i,p}$ exists, Table 6.8 provides gamma values relating per-tool emissions from the weighted process type p to per-tool emissions from the reference process type q. The gamma value column selected by a facility depends on the gas(es) emitted by the facility and the process(es) used by the facility. The gamma value row depends on the method used by the facility (Tier 2a, 2b, or 3b), whether the gas is emitted as an input gas or by-product, and (for Tier 2b and 3b), the wafer size. For example, a facility emitting CF_4 from both IPC processes and ITC processes would use a gamma value from the second column from the left in Table 6.8. If the facility were using the Tier 2a method to estimate emissions of CF_4 as an input gas, it would use the γ_i value in the row immediately below the "Tier 2a" title row in the table. The corresponding tool counts $n_{i,p}$ would be the total numbers of tools that emit CF_4 as an input gas and that run IPC and ITC processes, respectively, and the corresponding tool counts $n_{i,p,a}$ would be the total numbers of tools that emit CF_4 as an input gas, that run IPC and ITC processes, respectively, and that are abated.

Where a facility requires a gamma value for a gas-process type combination that is not covered by the table (e.g., c-C_4F_8 IPC), the facility should use a default gamma value of 10.

[9] For the Tier 3b method (stack testing), gamma values are also provided for remote plasma clean (RPC) for FCs and for thin-film deposition (TFD) for N_2O. The Tier 2a and 2b methods require apportioning between TFD and "Other" N_2O processes and between RPC and other FC processes and therefore do not need gamma values for TFD and RPC.

BOX 6.3 (NEW)
THE IMPORTANCE AND LIMITATIONS OF THE DEFAULT GAMMA VALUES FOR CALCULATING A_I AND $A_{K,I}$

To estimate the fraction of an FC abated when that FC is exhausted from both chamber cleaning processes and EWC processes, the Tier 2a, Tier 2b, and Tier 3b methods apply default weighting factors ($\gamma_{i,p}$ and $\gamma_{k,i,p}$) to the numbers of abated and unabated tools running chamber cleaning processes (see Equations 6.10 and 6.11). (As discussed above, the Tier 3b method also applies default weighting factors to the numbers of abated and unabated tools running N_2O-using TFD processes.) These default weighting factors have been introduced in the Refinement because, for most FCs, the Tier 2a, Tier 2b, and Tier 3b methods do not otherwise track per-tool emissions by process type (i.e., through apportioning), and per-tool emissions can vary significantly between process types. For example, C_2F_6 input gas flows (and emissions) for chamber cleaning processes can typically be in the order of one or more litres per minute while C_2F_6 input gas flows (and emissions) for etching processes are only typically in the order of one tenth to a few tenth of litres per minute. These differences are reflected in the default gamma values, which range from 1.4 to 26 for FC input gases, for example. Not accounting for such differences (that is, using unweighted tool counts) could result in large errors in the emissions estimate when the fraction of process tools equipped with emissions control technologies is different for different process types. *(Note: Where the Tier 2a and 2b methods do track emissions and emission reductions by process type, that is, for NF_3 and C_3F_8 used in RPC and for N_2O used in either TFD or "other" processes, Equations 6.18 and 6.19 should be used to calculate the fractions of input gas and by-products abated for each of those process types.)*

Default gamma values have been calculated based on the consumption patterns of representative semiconductor manufacturing facilities, accounting for the emissions of unreacted gases i and by-products k as well as for the number of tools emitting gases i or by-products k in such facilities. The default gamma values therefore represent industry averages. However, the gammas found for individual facilities are highly variable depending on gas usage patterns at those facilities. For example, two facilities could have similar numbers of etching tools and use similar total quantities of a particular FC in their etching processes. However, one of the facilities may concentrate their use of that FC in a relatively small subset of their etching tools (e.g., because that FC is the only gas used in that subset of tools), while the other facility may spread their use of that FC across all of their etching tools (e.g., because that FC is used in combination with other FCs in the tools). The per-tool emissions of the FC from etching for the first facility would be much higher than the per-tool emissions of the FC from etching at the second. If the per-tool emissions from TFD tools were the same at both facilities, the first facility's gamma factor (ratio of per-tool emissions from TFD tools to per-tool emissions from etch tools) would be much smaller than the second facility's gamma factor. As a result of such variability, the gamma values are highly uncertain (see Table 6.22) and can lead to errors in emissions estimates.

Because actual (site-specific) $\gamma_{i,p}$ and $\gamma_{k,i,p}$ values may significantly differ from the defaults used in the Tier 2a and 2b methods, and because – as a result – the Tier 2a method is highly uncertain, inventory compilers are strongly encouraged to apportion gas consumption by process type and to use the Tier 2c method, a hybrid Tier 2c / Tier 3a method, or ultimately a full Tier 3a method. If apportioning gas usage proves problematic for a particular facility, the Tier 3b method could be an alternate approach providing higher accuracy without the need to develop a complex apportioning model for the facility.

EQUATION 6.10 (NEW)
ESTIMATE OF THE MASS FRACTION OF GAS I EXHAUSTED FROM PROCESS TOOLS EQUIPPED WITH EMISSION CONTROL TECHNOLOGIES

$$a_i = \frac{\sum_p \gamma_{i,p} \bullet n_{i,p,a} + m_{i,q,a}}{\sum_p \gamma_{i,p} \bullet n_{i,p} + m_{i,q}}$$

Where:

a_i = estimate of the fraction of gas i exhausted from process tools equipped with suitable emissions control technologies, site-specific fraction

$n_{i,p,a}$ = number of tools that use gas i, that run process type p, and that are equipped with suitable emissions control technologies for gas i, site-specific

$m_{i,q,a}$ = number of tools that use gas i, that run process type q, and that are equipped with suitable emissions control technologies for gas i, site-specific

$n_{i,p}$ = total number of tools using gas i and running process type p, site-specific

$m_{i,q}$ = total number of tools using gas i and running process type q, site-specific

$\gamma_{i,p}$ = default factor reflecting the ratio of uncontrolled emissions per tool of input gas i from tools running process type p to uncontrolled emissions per tool of input gas i from process tools running process type q, fraction

i = input gas

p = weighted process type. When Equation 6.10 is being used for the Tier 2a or Tier 2b method, p includes IPC and/or ITC. When Equation 6.10 is being used for the Tier 3b method and gas i is an FC, p includes RPC, IPC, and/or ITC. When Equation 6.10 is being used for the Tier 3b method and gas i is N_2O, p consists of thin-film deposition.

Q = reference process type. When gas i is an FC, q consists of the combination of etching and/or wafer-cleaning processes. When gas i is N_2O, q consists of the "Other" process type.

EQUATION 6.11 (NEW)
ESTIMATE OF THE MASS FRACTION OF BY-PRODUCT K EXHAUSTED FROM PROCESS TOOLS EQUIPPED WITH EMISSION CONTROL TECHNOLOGIES

$$a_{k,i} = \frac{\sum_p \gamma_{k,i,p} \bullet n_{k,i,p,a} + m_{k,i,q,a}}{\sum_p \gamma_{k,i,p} \bullet n_{k,i,p} + m_{k,i,q}}$$

Where:

$a_{k,i}$ = estimate of the fraction of by-product k formed from input gas i that is exhausted from process tools that are equipped with suitable emissions control technologies, site-specific fraction

$n_{k,i,p,a}$ = number of tools that exhaust by-product k formed from input gas i, that run process type p, and that are equipped with suitable emissions control technology for by-product k, site-specific

$m_{k,i,q,a}$ = number of tools that exhaust by-product k formed from input gas i, that run process type q, and that are equipped with suitable emissions control technology for by-product k, site-specific

$n_{k,i,p}$ = total number of tools exhausting by-product k formed from input gas i and running process type p, site-specific

$m_{k,i,q}$ = total number of tools exhausting by-product k formed from input gas i and running process type q, site-specific

$\gamma_{k,i,p}$ = default factor reflecting the ratio of uncontrolled emissions per tool of by-product k from process tools using gas i and running process type p to uncontrolled emissions per tool of by-product k from process tools using gas i and running process type q, fraction

i = input gas

k = by-product gas

p = weighted process type. When Equation 6.11 is being used for the Tier 2a or Tier 2b method, p includes IPC and/or ITC. When Equation 6.11 is being used for the Tier 3b method and gas i is an FC, p includes RPC, IPC, and/or ITC. When Equation 6.11 is being used for the Tier 3b method and gas i is N_2O, p consists of thin-film deposition.

Q = reference process type. When gas i is an FC, q consists of the combination of etching and/or wafer-cleaning processes. When gas i is N_2O, q consists of the "Other" process type.

Finally, inventory compilers should calculate, for each reporting site, the average uptime of all emissions control systems connected to process tools (UT), using Equation 6.12. To this end, inventory compilers should account for the total time (Td_n) that any emissions control system n connected to process tool(s) in the reporting facility is not in operational mode when at least one of the manufacturing tools connected to emissions control system n is in operation, and the total time (TT_n) in which emissions control system n has at least one associated manufacturing tool in operation. For determining the amount of tool operating time, inventory compilers may assume that tools that were installed for the whole of the year were operated for 525,600 minutes per year. For tools that were installed or uninstalled during the year, inventory compilers should prorate the operating time to account for the days in which the tool was not installed and treat any partial day that a tool was installed as a full day (1,440 minutes) of tool operation. For an emissions control system that has more than one connected tool, the tool operating time is 525,600 minutes per year if at least one tool was installed at all times throughout the year. For tools that are idle with no gas flowed through the tool for part of the year, inventory compilers may calculate total tool time using the actual time that gas is flowing through the tool. Inventory compilers should also note that UT may be set to one (1) if suitable backup emissions control equipment or interlocking with the process tool is implemented for each emissions control system. Thus, using interlocked process tools or backup emissions control systems reduces uncertainty by eliminating the need to estimate UT for the reporting facility.

EQUATION 6.12 (NEW)
UPTIME OF EMISSIONS CONTROL SYSTEMS

$$UT = 1 - \frac{\sum_n Td_n}{\sum_n TT_n}$$

Where:

UT = Average uptime factor of all emissions control systems connected to process tools, fraction.

Td_n = Total time that emissions control system n connected to process tool(s) in the plant, is not in operational mode when at least one of the manufacturing tools connected to emissions control system n is in operation, minutes per year.

TT_n = Total time during which emissions control system n has at least one associated manufacturing tool in operation, minutes per year.

n = emissions control system.

Tier 2b method

The Tier 2b method is applicable to the semiconductor sub-sector and to MEMS manufacturing that uses tools and processes similar to those used to manufacture semiconductors (for further details see discussion in the Choice of method section, in particular footnote 3). As discussed in section 6.2.1, the Tier 2b method is preferred over the Tier 2a method unless it is not possible to distinguish gas consumption by wafer size (e.g., for semiconductor manufacturing facilities that process multiple wafer sizes and cannot apportion gas consumption between them). The Tier 2b method uses the same set of equations as the Tier 2a method (Equations 6.5 to 6.12), but distinct U_i, $B_{k,i}$, $\gamma_{i,p}$, and $\gamma_{k,i,p}$ default factors are provided by the wafer size being manufactured (≤200 mm vs. 300 mm, see Tables 6.8 and 6.9). With this distinction in mind, all other site-specific Tier 2b factors (which are the same as for the Tier 2a method)-are estimated in the same manner as for the Tier 2a method. Thus, inventory compilers using the Tier 2b method should have direct communication with industry to gather consumption and emissions control-related data and verify that emissions control technologies for which reductions are being claimed are installed and used in accordance with the guidance provided in section 6.2.2.1.

Total Tier 2b emissions are calculated using Equations 6.5, 6.6, and 6.7 and are equal to the sum of emissions from all unreacted gases i used in the production process (E_i), plus emissions of all by-products k (BPE_k) resulting from the conversion of all input gases i used during production, plus emissions of CF_4 from hydrocarbon-fuel-based combustion emissions control systems ($EAB_{i,CF4}$). As in the Tier 2a method, $EAB_{i,CF4}$ may be set to zero if the emissions control equipment manufacturer can certify that reactions between hydrocarbon fuel and F_2 to form CF_4 is not occurring within their emissions control system (i.e. certify that $AB_{i,CF4} = 0$).

Tier 2c method

The Tier 2c method is applicable to the semiconductor, display, and PV sub-sectors, and to MEMS manufacturing that is carried out using tools and processes similar to those used to manufacture semiconductors (for further details see discussion in the Choice of method section, in particular footnote 3). The Tier 2c method is based on a set of equations that account for default emission factors that are provided for distinct process types p ($U_{i,p}$ and $B_{k,i,p}$). In the Tier 2c method for the semiconductor sub-sector, there are six process types p defined as 1) etching and wafer cleaning (EWC), 2) remote plasma cleaning (RPC), 3) in-situ plasma cleaning (IPC), 4) in-situ thermal cleaning (ITC), 5) N_2O TFD, and 6) N_2O 'Other'. In the Tier 2c method for the display sub-sector there are only 4 process types p defined as 1) etching, 2) remote plasma cleaning (RPC), 3) in-situ plasma cleaning (IPC), and 4) N_2O TFD. In the case of the Tier 2c method for the PV subsector, process types are defined as 1) etch and 2) TFD chamber cleaning. In addition, the Tier 2c method provides distinct emission factors for different substrate sizes for the semiconductor sub-sector (≤200 mm and 300 mm), but the Tier 2c method does not distinguish emission factors for different substrate size for the display sub-sector (the same Tier 2c default emissions factors are applicable to display manufacturing tools for generations 4, 5, 6, 7, etc.) and the PV sub-sector.

The $U_{i,p}$ and $B_{k,i,p}$ default emission factors for the Tier 2c method are included in Tables 6.10 to 6.11 for the semiconductor sub-sector (≤200 mm and 300 mm substrate sizes respectively), Table 6.12 for the display sub-sector, and Table 6.13 for the PV sub-sector. The other default emission factors used for the Tier 2c method are the destruction removal efficiencies (DRE) of gases i and by-products k (d_i, d_k - see Table 6.17), which are assumed to be the same across all sub-sectors and across all Tier 2 methods. The Tier 2c method also uses site-specific factors ($C_{i,p}$, $D_{i,p}$, $D_{k,i,p}$, $a_{i,p}$, $a_{k,i,p}$, $n_{i,p,a}$, $n_{i,p}$, $n_{k,i,p,a}$, $n_{k,i,p}$, UT_p, $Td_{n,p}$, $TT_{n,p}$), and inventory compilers using the Tier 2c method should directly communicate with industry to gather consumption and emissions control-related data and to ensure that reductions are not attributed to emissions control devices unless the devices are installed and used in accordance with the guidance provided in section 6.2.2.1. Inventory compilers should note that the consumption of gas i ($C_{i,p}$) takes into account the heel factor ($h_{i,l}$), which represents the fraction of gas i remaining in the shipping container after use, and which can be based on industry-wide default or site-specific measured values (see Section on Gas Consumption and Apportioning).

As discussed in section 6.2.1, the use of the Tier 2c method is preferred over the Tier 2a or Tier 2b methods in the semiconductor sub-sector because the Tier 2c default emission factors are expected to be more accurate than the Tier 2b or 2a factors. However, using the Tier 2c method requires apportioning gas consumption for all gases and process types, which introduces additional complexity. Please see the section on Gas Consumption and Apportioning for further detail.

Tier 2c total emissions are equal to the sum of emissions from all unreacted gases i used in the production process (E_i) plus the emissions of all by-products k (BPE_k) resulting from the conversion of all input gases i used during production, plus emissions of CF_4 from hydrocarbon-fuel-based combustion emissions control systems ($EAB_{i,CF4}$, which may be set to zero if the emissions control equipment manufacturer can certify that reactions between hydrocarbon fuel and F_2 to form CF_4 is not occurring within their emissions control systems). Tier 2c emissions are calculated using process-type-dependent Equations 6.13 to 6.20.

EQUATION 6.13 (UPDATED)
EMISSION OF INPUT GAS I

$$E_i = \sum_p [C_{i,p} \bullet (1 - U_{i,p}) \bullet (1 - D_{i,p})]$$

Where:

E_i = emissions of unreacted input gas, kg

$C_{i,p}$ = consumption of input gas i for process type p, kg

$U_{i,p}$ = use rate of gas i for process p, fraction destroyed or transformed in process p

$D_{i,p}$ = overall reduction of mass of gas i emitted from process type p, site-specific fraction calculated per Equation 6.16

i = input gas

p = process type

EQUATION 6.14 (UPDATED)
PROCESS BY-PRODUCT EMISSIONS FROM INPUT GAS I

$$BPE_k = \sum_i [\sum_p [C_{i,p} \bullet B_{k,i,p} \bullet (1 - D_{k,i,p})]]$$

Where:

BPE_k = emissions of by-product k generated from the conversion of all input gases i for all process types p, kg

$B_{k,i,p}$ = emission factor for by-product k generated from use of input gas i in process type p, kg of by-product k created per kg of gas i consumed for process type p

$C_{i,p}$ = consumption of input gas i for process type p, kg

$D_{k,i,p}$ = overall reduction of mass of gas k by-product emissions from use of input gas i in process type p, site-specific fraction calculated per Equation 6.17

i = input gas

k = by-product gas

p = process type

When neither the gases used nor the films etched or cleaned contain carbon, the $B_{k,i,p}$ factors may be equated to zero in Equation 6.14. When both carbon-containing and non-carbon-containing films are included in the film stacks forming final electronic devices, there are two options: 1) if it is practical to track the gas consumption used to clean or etch films containing carbon vs. not containing carbon, the non-zero and zero $B_{k.i,p}$ factors may be applied accordingly, or 2) if it is not practical or desired to track gas consumption to this level of detail, the non-zero BPE factors should be applied to all consumption of a gas if any film containing carbon is run with that gas during the year. (See Box 6.2 and the discussion under Equation 6.6 for more on this issue.)

When NF_3 is used in RPC processes or F_2 is used as an input gas and when hydrocarbon-fuel-based combustion emissions control technology is used, direct reaction with hydrocarbon fuel and F_2 (including F_2 resulting from the decomposition of NF_3 in RPC processes) to form CF_4 can occur. Unless the emissions control equipment original equipment manufacturer (OEM) or electronics manufacturer can certify that the rate of conversion from F_2 to CF_4 or from NF_3 to CF_4 is <0.1 percent on a mass basis, Equation 6.15 should be used to estimate the amount of CF_4 produced within and emitted from the emissions control device.

EQUATION 6.15 (NEW)
BY-PRODUCT EMISSIONS FROM HYDROCARBON-FUELLED COMBUSTION EMISSIONS CONTROL SYSTEMS

$$EAB_{i,CF_4} = \sum_p C_{i,p} \bullet (1 - U_{i,p}) \bullet (1 - \eta_p) \bullet AB_{i,CF_4}$$

Where:

i = input gas (i = only NF_3 used in RPC processes or F_2 for the purpose of Equation 6.15)

$EAB_{i,CF4}$ = emissions of CF_4 from hydrocarbon-fuel-based combustion emissions control systems when direct reaction with hydrocarbon fuel and fluorinated species is not certified not to occur by the emissions control equipment OEM or electronics manufacturer, kg

$C_{i,p}$ = consumption of input gas i for process type p (i = only NF_3 used in RPC processes or F_2 for the purpose of Equation 6.15), kg

$U_{i,p}$ = use rate of gas i for process p, fraction destroyed or transformed in process p

η_p = ratio of emissions control systems connected to tools running process type p and certified not to form CF_4 within emissions control systems to the total number of all emissions control systems, site-specific fraction

$AB_{i,CF4}$ (i = only NF_3 used in RPC processes or F_2 for the purpose of Equation 6.15)

= mass fraction of NF_3 used in RPC processes or F_2 in process exhaust gas that is converted into CF_4 by direct reaction with hydrocarbon fuel and F_2 gas in a combustion emissions control system. $AB_{i,CF4}$ is set to zero if the emissions control equipment OEM or electronics manufacturer can certify that the rate of conversion from F_2 to CF_4 or from NF_3 to CF_4 is <0.1 percent; otherwise, a default value of $AB_{NF3,CF4} = 0.093$ or $AB_{F2,CF4} = 0.116$ should be used.

p = process type (RPC using NF_3 or any process type using F_2 for the purpose of Equation 6.15)

Inventory compilers should calculate the overall reductions in emissions of process gas i and by-product k ($D_{i,p}$, $D_{k,i,p}$) based on site-specific information using Equations 6.16 and 6.17, factoring in the mass fraction of gas i and by-product k exhausted from process tools running process type p and equipped with suitable emissions control technologies ($a_{i,p}$, $a_{k,i,p}$), the destruction removal efficiency of gas i and by-product k (d_i, d_k), and the average uptime of emissions control systems connected to process tools running process type p (UT_p).

EQUATION 6.16 (NEW)
EMISSIONS REDUCTION IMPACT OF EMISSIONS CONTROL EQUIPMENT ON INPUT GAS I

$$D_{i.p} = a_{i,p} \bullet d_i \bullet UT_p$$

Where:

$D_{i,p}$ = overall reduction of mass of gas i emitted from process type p, fraction

$a_{i,p}$ = estimate of the fraction of gas i exhausted from process tools running process type p and equipped with suitable emissions control technologies, site-specific fraction calculated using Equation 6.18

d_i = Destruction Removal Efficiency (DRE) for gas i, fraction

UT_p = average uptime factor of all emissions control systems connected to tools running process type p, site-specific fraction calculated per Equation 6.20

i = input gas

k = by-product gas

p = process type

EQUATION 6.17 (NEW)
EMISSIONS REDUCTION IMPACT OF EMISSIONS CONTROL EQUIPMENT ON BY-PRODUCT K

$$D_{k,i,p} = a_{k,i,p} \bullet d_k \bullet UT_p$$

Where:

$D_{k,i,p}$ = overall reduction of mass of gas k by-product emitted from use of input gas i in process type p, site-specific fraction

$a_{k,i,p}$ = estimate of the fraction of by-product k exhausted from process tools using input gas i in process type p and equipped with suitable emissions control technologies, site-specific fraction calculated using Equation 6.19

d_k = Destruction Removal Efficiency (DRE) for by-product k, fraction

UT_p = average uptime of all emissions control systems connected to tools running process type p, site-specific fraction calculated per Equation 6.20

i = input gas

k = by-product gas

p = process type

The use of gamma weighting factors is not required in the Tier 2c method because uncontrolled emissions from different process types are accounted for separately through gas consumption allocation. Instead, to estimate the site-specific $a_{i,p}$ value, inventory compilers may calculate the ratio of the number of tools running process type p (emitting gas i) that are equipped with suitable emissions control technologies ($n_{i,p,a}$) to the total number of tools running process type p and emitting gas i, using Equation 6.18."Suitable" means that an emissions control technology is capable of abating a particular gas to a minimum destruction removal efficiency in a site-specific worst-case scenario (please see Section 6.2.2.1 on Emissions Control Technology Factors for more details). Note that inventory compilers may obtain more refined estimates of $a_{i,p}$ by counting the number of process chambers running process type p (emitting gas i) that are connected to suitable emissions control technologies, or by using other site-specific approaches that may be more accurate.

EQUATION 6.18 (NEW)
ESTIMATE OF THE FRACTION OF MASS OF GAS I EMITTED FROM PROCESS P FROM TOOLS EQUIPPED WITH EMISSIONS CONTROL EQUIPMENT

$$a_{i,p} = \frac{n_{i,p,a}}{n_{i,p}}$$

Where:

$a_{i,p}$ = estimate of the fraction of gas i exhausted from process tools running process type p and equipped with suitable emissions control technologies, site-specific fraction

$n_{i,p,a}$ = number of process tools running process type p (emitting gas i) that are equipped with suitable emissions control technologies, site-specific

$n_{i,p}$ = total number of process tools running process type p and emitting gas i, site-specific

i = input gas

p = process type

To estimate the site-specific $a_{k,i,p}$ value, use Equation 6.19 calculate the ratio of the number of tools that run process type p, emit by-product k from use of input gas i, and are equipped with suitable emissions control technologies ($n_{k,i,p,a}$) to the total number of tools that run process type p and emit by-product k from use of input gas i ($n_{k,i,p}$). Note also that inventory compilers may obtain more refined estimates of $a_{k,i,p}$ by counting the number of process chambers that run process type p, emit by-product k from use of input gas i, and are connected to suitable emissions control technologies, or by using other site-specific approaches that may be more accurate.

EQUATION 6.19 (NEW)
ESTIMATE OF THE FRACTION OF MASS OF BY-PRODUCT K EXHAUSTED FROM USE OF INPUT GAS I IN PROCESS P FROM TOOLS EQUIPPED WITH EMISSIONS CONTROL EQUIPMENT

$$a_{k,i,p} = \frac{n_{k,i,p,a}}{n_{k.i.p}}$$

Where:

$a_{k,i,p}$ = estimate of the fraction of by-product k exhausted from process tools running process type p and equipped with suitable emissions control technologies, site-specific fraction

$n_{k,i,p,a}$ = number of process tools that run process type p, emit by-product k from use of input gas i, and are equipped with suitable emissions control technologies, site-specific

$n_{k,i,p}$ = total number of process tools running process type p and emitting by-product k from use of input gas i, site-specific

i = input gas

k = by-product gas

p = process type

Finally, inventory compilers should calculate, for each reporting site, the average uptime of all emissions control systems connected to process tools running process type p (UT_p), using Equation 6.20. To this end, inventory compilers should account for the total time ($Td_{n,p}$) that any emissions control system n connected to process tool(s) running process type p in the reporting facility is not in operational mode when at least one of the manufacturing tools connected to emissions control system n is in operation, and the total time ($TT_{n,p}$) in which emissions control system n has at least one associated manufacturing tool in operation. For determining the amount of tool operating time, inventory compilers may assume that tools that were installed for the whole of the year were operated for 525,600 minutes per year. For tools that were installed or uninstalled during the year, inventory compilers should prorate the operating time to account for the days in which the tool was not installed and treat any partial day that a tool was installed as a full day (1,440 minutes) of tool operation. For an emissions control system that has more than one connected tool, the tool operating time is 525,600 minutes per year if at least one tool was installed at all times throughout the year. For tools that are idle with no gas flowed through the tool for part of the year, inventory compilers may calculate total tool time using the actual time that gas is flowing through the tool. Inventory compilers should also note that UT_p may be set to one (1) if suitable backup emissions control equipment or interlocking with the process tool is implemented for each emissions control system. Thus, using interlocked process tools or backup emissions control systems reduces uncertainty by eliminating the need to estimate UT for the reporting facility.

EQUATION 6.20 (NEW)
UPTIME OF EMISSIONS CONTROL SYSTEMS

$$UT_p = 1 - \frac{\sum_n Td_{n,p}}{\sum_n TT_{n,p}}$$

Where:

UT_p = average uptime of all emissions control systems connected to process tools running process type p, site-specific fraction

$Td_{n,p}$ = total time that emissions control system n connected to process tools running process type p in the facility is not in operational mode when at least one of the manufacturing tools connected to emissions control system n is in operation, minutes per year

$TT_{n,p}$ = total time during which emissions control system n has at least one associated manufacturing tool running process type p in operation, minutes per year

n = emissions control system

P = process type

ADAPTING TIER 2 METHODS TO ACCOUNT FOR TECHNOLOGICAL CHANGES

Given the rapid pace of technological change in electronics manufacturing, Tier 2 default emission factors may need to be supplemented or updated in order to remain representative of industry emission rates. A change in any of the following parameters can result in the Tier 2 default emission factors becoming unrepresentative:

- Substrate type (e.g. Si, SiC, or glass) and size (e.g., moving to 450 mm wafers in semiconductor manufacturing);

- Use of a new gas in an existing process type (i.e. in-situ plasma cleaning, remote plasma cleaning, or in-situ thermal cleaning; etching; thin film deposition process) or use of a new process type;
- Film type introduced after 2018;
- Tool platform introduced by a supplier after 2018 or those introduced earlier but used for a new process type;
- Use of new input process GHGs, use of new combinations of process greenhouse gases, or use of low- or no-GWP materials that have the potential to form GHG by-products.

If default emission factors are not available under Tier 2 (e.g., a new gas or process type is introduced), facilities can estimate emissions using Tier 2 and assume a default emission factor (1-U) = 0.8 with by-product emission factors of 0.15 for CF_4 and 0.05 for C_2F_6. [10] Alternatively, facilities can undertake process emissions characterization under Tier 3a and use a hybrid method. A hybrid method would involve applying the Tier 2 defaults to processes and technologies that have not changed while applying Tier 3a site-specific emission factors to processes and technologies that have changed. It is *good practice* to undertake process emissions characterization and use a hybrid method when the new gas and process type combination accounts for 1 percent or more of facility GHG consumption by mass and results in estimated emissions of more than 500 $mtCO_2e$, based on the 0.8, 0.15, and 0.05 default emission factors above.

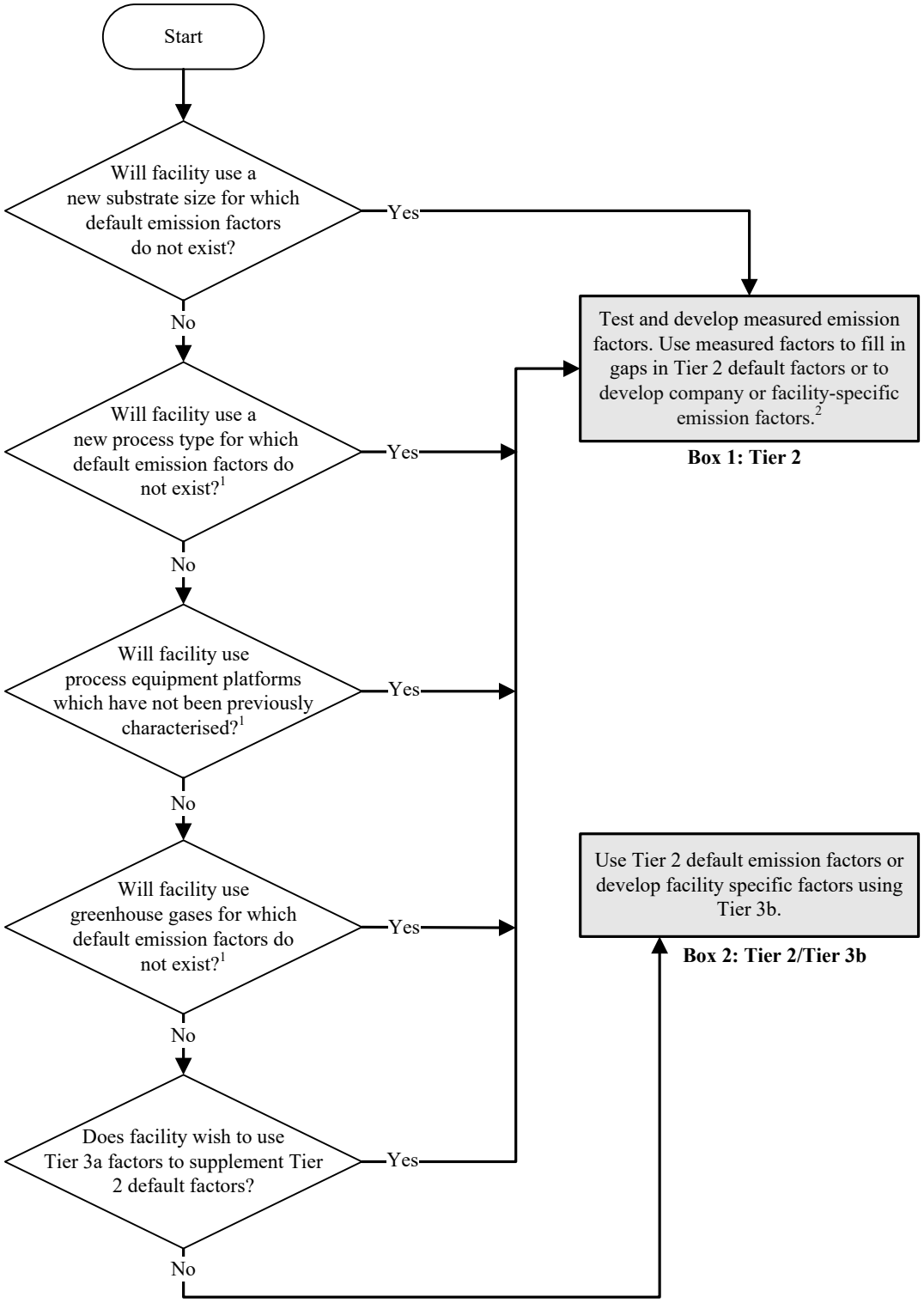
It is *good practice* for inventory compilers to work with electronics manufacturers to periodically assess whether Tier 2 defaults remain representative of manufacturing conditions, considering the criteria above. If the Tier 2 defaults are found not to be representative in one or more respects, inventory compilers should work with electronics manufacturers to encourage use of hybrid Tier 2 and Tier 3a methods, or to develop country-specific default emission factors that reflect the applicable technological and process changes cited above. Any country-specific default emission factors should represent the full range of processes in the country for each process type, including not only the emission factors for the new or changed processes, but also emission factors for previously existing processes that are still used. Most countries are likely to find it challenging to develop robust, representative country-specific emission factors, and technological changes in a particular country are likely to quickly diffuse into other countries. Thus, it is generally preferable to refine default emission factors at the global rather than at the country level. In this context, facilities are encouraged to report measured emission factors to the IPCC Emission Factor Database (EFDB) in a transparent manner through a process allowing protection of any underlying confidential information.

Figure 6.2. Decision tree to determine need for measured emission factors, should be used to determine when Tier 3a measured emission factors may be necessary to supplement Tier 2 default emission factors.

In the case where a new substrate type or size will be used in a facility (e.g., 450 mm wafers), emission factors may be measured and applied in phases. For example, in the first year of operation of the 450 mm fab, 300 mm Tier 2c default factors could be used to estimate emissions. In subsequent years, Tier 2 defaults should be used to estimate emissions for up to 50 percent of total gas used in year 2; 25 percent in year 3; 10 percent in year 4; and 0 percent in year 5. See the discussion of the Tier 3a method below for criteria to prioritize these measurements. Once measurements of the 450 mm processes are complete, inventory compilers should work with semiconductor manufacturers to recalculate emissions from years 1-4 to ensure time series consistency.

[10] These defaults assume that all of the input gas is either emitted or converted into CF_4 or C_2F_6. In the majority of cases where emission factor data are available, both CF_4 and C_2F_6 are emitted as by-products. The default (1-U) is conservatively based on the least efficient (1-U) for etch or wafer cleaning processes (0.8 for C_2F_6 in Table 6.10). Due to a generally higher CF_4 by-product emission factor for most input gas/process combinations, the majority (75 percent) of the remaining mass is assigned to CF_4 and the rest to C_2F_6.

Figure 6.2 (New) Decision tree to determine need for measured emission factors



Note:

1. If a new gas and process combination are used that accounts for less than 1 percent of facility fluorinated GHG consumption by mass and (1-U) is not measured or not listed, compiler may assume (1-U) = 0.8, B_{CF4} = 0.15, B_{C2F6} = 0.05.

2. Mechanism to submit Tier 3a data to EFDB is still to be designed at the time of writing of this *2019 Refinement*.

TIER 3 METHODS – SITE-SPECIFIC PARAMETERS

Tier 3a – Measured process-specific parameters

The Tier 3a method can be applied to all sub-sectors covered in Chapter 6 (semiconductor, display, PV and MEMS) and uses the same set of equations as the Tier 2c method; however, Tier 3a uses measured values for parameters in Equations 6.13 to 6.20 (see Table 6.3 for details). As discussed earlier, Tier 3a measured emission factors may be used to supplement Tier 2 default factors where some, but not all, processes and technologies have changed. Tier 3a can also be undertaken to develop facility-specific emission factors for broader application in the facility. For example, a facility may have abatement efficiencies that are different from the default DRE values for emission control systems installed on a certain subset of process tools, or may account for emissions from a particular recipe or technology that is more efficient or that may have been developed for the purpose of reducing emissions. Note that in the case of a comprehensive technology change, such as the adoption of a new substrate size (e.g., 450 mm in semiconductor industry), the Tier 3a method would be broadly applied.

For the Tier 3a method, the $(1\text{-}U_{i,p})$ and $B_{k,i,p}$ emission factors in Equations 6.13 to 6.15 and 6.18 to 6.19 are measured for recipes or for families of similar recipes. Thus, the main distinction between the Tier 3a method and the Tier 2c method is that, for the Tier 3a method, p in Equations 6.13 to 6.20 is to be interpreted as meaning a 'recipe' or a family of similar recipes. A recipe can be defined as a specific combination of process conditions (input gas type and flows, plasma power, pressure, temperature, duration, etc.) and technologies used to etch patterns onto electronics devices, to clean film deposition chambers, or to deposit films on substrates. A centreline recipe can be used to establish Tier 3a emission factors for a recipe and each family of similar recipes. Recipes are deemed 'similar' when the centreline process can reasonably be deemed representative of facility-specific process conditions despite potential variability of such process conditions around the centreline process during normal manufacturing operations, and when the substrate size, process type, tool platform and process chamber, film type (SiO_x, SiO_xN_y, Si_xN_y, W, etc.), and input process gas(es) are the same. However, even when similar recipes are grouped, it may not be practicable or economically feasible to implement the Tier 3a methodology across all families of similar recipes or across the many emissions control systems that may be used in a particular electronics manufacturing facility. For this reason, it is *good practice* for facilities undertaking a more comprehensive Tier 3a approach to prioritize testing as follows:

1. Recipe families with highest GHG usage (e.g., chamber cleans) and/or expected emissions should be tested first (e.g., testing should account for the top 75 percent of total process greenhouse gas usage in kg and the top 50 percent of emissions in kg CO_2e.).

2. Stable processes which do not change from wafer to wafer or run to run should have higher priority than processes that change frequently.

Whenever Tier 3a measurements are made, the reporting facility should document the following:

- Date measurements were made;
- Industry sub-sector;
- Substrate size;
- Process type;
- Film type;
- Tool manufacturer, platform and model/chamber name;
- Input gases;
- Process conditions (gas flows, pressure, temperature, power, duration, etc.);
- Input gas emission factors;
- By-product emission factors;
- Fluorine mass balance closure;
- Measurement protocol used.

In addition, facilities using the 3a approach should document all facility-specific process emission factors or emissions control equipment DREs that have been measured by the reporting facility, document which recipes are deemed similar to the measured centreline process, use the measured Tier 3a factors for all similar recipes, and be

able to demonstrate to a reasonable degree of certainty that the Tier 3a approach does lead to increased accuracy in reporting emissions. When facility-specific emission factors or destruction removal efficiencies have been measured for a particular recipe or for a family of similar recipes and for a particular emissions control technology or emissions control system, it is NOT *good practice* to revert to default Tier 2 emission factors when such default emission factors are more favourable than the corresponding measured Tier 3a factors as such practice would result in knowingly underestimating emissions.

Tier 3b method—Stack testing

The Tier 3b method may be applied to all sub-sectors covered in Chapter 6 (semiconductor, display, PV and MEMS). Stack testing measures the amount of greenhouse gases emitted from a specific facility through stack systems. A stack system is considered to be one or more stacks that are connected by a common header or manifold, through which an FC- or N_2O-containing gas stream originating from one or more processes is, or has the potential to be, released to the atmosphere. Stack testing is a method commonly used by electronic devices manufacturing facilities to quantify emissions and demonstrate compliance for regulated pollutants used in manufacturing, such as acid gases (e.g., hydrogen fluoride, hydrogen chloride, fluorine, nitric acid, ammonia) and volatile organic compounds (VOCs). The individual process chamber operations that use greenhouse gases, as is the case with acid gases and VOCs, are conducted as batch processes. The fact that they are run concurrently, in rapid succession on a large number of tools which are exhausted to typically a relatively small number of stacks, leads to the expectation that the emissions will largely emulate a continuous process.

The analytical methods available for measuring greenhouse gas emissions from facility stack systems are Fourier Transform Infrared spectroscopy (FTIR) and gas chromatography followed by mass spectrometry (GC/MS). In the case of FTIR, the analytical instrument is brought to the stack system for in-situ analysis. In the case of the GC/MS approach, stack emission samples are collected using sample containers and transported to a laboratory for analysis.

Stack testing may be used to develop site-specific emission factors. The stack method may not be appropriate for facilities with many stacks, frequent changes in production technology or product mix, or an inability to track gas use during testing or emissions control equipment uptime during testing. It is important to perform stack testing when production levels in the fab are representative of year-round production, and when emissions control system uptime is representative of year-round uptime.

Testing Frequency

It is *good practice* for reporting facilities to test all stack systems at the reporting facility that have the potential to emit greenhouse gases in the first year of testing. Typically, this means all acid and caustic/alkali stack systems at the facility should be tested because these are generally the stack systems connected to processes using FC compounds in a fab. It is also important to test all stacks on relevant stack systems during the first year of testing to determine that there are negligible differences in flow or concentration between these stacks. If a facility determines that no substantive changes have occurred in the year following a stack test, the emission factors determined may remain unchanged and retesting is not required; however, stack testing should occur every 3 years at a minimum. In subsequent years, reporting facilities may consider less frequent testing for stack systems that comprise less than 10 percent of total process GHG emissions (expressed in CO_2e). On the other hand, facilities with a highly variable product mix should consider undertaking annual testing for the first three years to assess the impact that the changing product mix has on their measured emission factors. For all facilities, the following are considered to be substantive changes, and testing should be undertaken in the subsequent year after a stack test if any of the following are met:

(i) If annual consumption, in terms of CO_2e, for any individual FC gas compared with the total of all FC gases changes by more than 10 percentage points from the most recent emissions test. For example, if the use of a single gas converted to CO_2e goes from 25 percent of total gas consumption to greater than 35 percent of total gas consumption, a retest would be triggered for the subsequent year.

(ii) Annual consumption of an FC that was not used during the emissions test and that is not included in the facility-specific emission factors rises to 5 percent (expressed in CO_2e) of the annual FC consumption of the fab. (For FCs that were not used during the emissions test and whose consumption falls below 5% of annual fab consumption, Tier 2 or 3a methods should be used to estimate emissions to ensure completeness.)

(iii) A change by more than 20 percent in the fraction of process tools equipped with emissions control systems, compared to the fraction during the most recent emissions test.

(iv) A change in the substrate size used by the facility since the most recent emissions test.

Stack test method

For each stack system in the reporting facility for which testing is required, inventory compilers should measure the emissions of each FC gas and N_2O from the stack system by conducting an emission test using the methods mentioned in Table 6.14, or their equivalents. In addition, inventory compilers should measure the facility-specific emissions and consumption of each FC and N_2O according to the following steps:

- Measure total gas flow rate up the stack on the test day using EPA Method 1 or 2 or an equivalent method.
- Measure process GHG concentrations of designated gases from relevant stacks using an analytical method with demonstrated accuracy. The analytical method should be validated using US EPA Method 320 or an equivalent validation method.
- Emissions testing should be conducted during a period of 8 hours or longer per stack system while the facility is operating at a representative level with representative emissions control system uptime. (Representative uptime is particularly important for emission control systems that have not been certified not to form CF_4 from F_2 exhausted by the process.) Representative in this case means that normal process tools' or emissions control systems' maintenance is being performed during the stack emissions test and that processes running during the test are indicative of normal facility operations.
- Measurements should be taken for N_2O and all FC gases known to be used by the facility and any possible FC gas by-products. It is recommended measurements be taken for CF_4, C_2F_6, C_3F_8, C_4F_8, C_5F_8, CHF_3, CH_2F_2, and CH_3F as these gases may be formed as by-products.
- The amount of each FC and N_2O gas consumed by each facility during the sampling period should be determined. Where starting and ending gas container pressures are used to estimate consumption, appropriate adjustments for temperature and deviations from ideal gas law behaviour should be made (e.g., by applying the Redlich, Kwong, Soave equation of state with appropriate values for each FC gas and N_2O). Because stack testing is conducted over a relatively brief period, measurements and calculations of gas consumption during that period should be precise to ensure that the resulting emission factors are accurate.
- If consumption of an FC gas is too low to be accurately measured during the testing period, then in order to account for usage, either the testing period should be increased or consumption should be calculated for the testing period by pro-rating long-term consumption data.

Inventory compilers should calculate the emissions of each FC gas and N_2O consumed as an input gas using Equation 6.21 and each FC gas formed as a by-product using Equation 6.22. If a stack system is comprised of multiple stacks, inventory compilers should sum the emissions from each stack in the stack system when using Equation 6.21 or Equation 6.22.

EQUATION 6.21 (NEW)
TOTAL GHG INPUT GAS EMITTED FROM STACK SYSTEM DURING SAMPLING PERIOD

$$ES_{i,s} = MW_i \bullet Q_s \bullet \frac{1}{SV} \bullet \frac{1}{10^3} \bullet \sum_{m=1}^{N} \frac{X_{i,s,m}}{10^9} \bullet \Delta t_m$$

Where:

$ES_{i,s}$ = emissions of input gas i from stack system s during the sampling period, kg

MW_i = molecular weight of gas i , g/g-mole

Q_s = flow rate of stack system s during the sampling period, m^3/min.

SV = standard molar volume of gas, 0.0240 m^3/g-mole at 68°F and 1 atm.

$X_{i,s,m}$ = average concentration of input gas i in stack system s during time interval m, ppbv

Δt_m = length of time interval m in the FTIR sampling period, minutes. Each time interval in the FTIR sampling period should be less than or equal to 60 minutes (for example an 8-hour sampling period would consist of at least 8-time intervals).

$1/10^3$ = conversion factor, 1 kilogram/1,000 grams

i = input gas

s = stack system

N = total number of time intervals m in sampling period

m = time interval

EQUATION 6.22 (NEW)
TOTAL FC BY-PRODUCT EMITTED FROM STACK SYSTEM DURING SAMPLING PERIOD

$$ES_{k,s} = MW_k \bullet Q_s \bullet \frac{1}{SV} \bullet \frac{1}{10^3} \bullet \sum_{m=1}^{N} \frac{X_{k,s,m}}{10^9} \bullet \Delta t_m$$

Where:

$ES_{k,s}$ = emissions of by-product k emitted from stack system s during the sampling period, kg

MW_k = molecular weight of by-product gas k, g/g-mole

Q_s = flow rate of stack system s during the sampling period, m 3/min

SV = standard molar volume of gas, 0.0240 m 3/g-mole at 68 °F and 1 atm.

$X_{k,s,m}$ = average concentration of by-product k in stack system s during time interval m, ppbv

Δtm = length of time interval m in the FTIR sampling period, minutes. Each time interval in the FTIR sampling period should be less than or equal to 60 minutes (for example an 8-hour sampling period would consist of at least 8-time intervals).

$1/10^3$ = conversion factor, 1 kilogram/1,000 grams

k = by-product gas

s = stack system

N = total number of time intervals m in sampling period

m = time interval

When calculating emissions, inventory compilers should use the following guidance and the accompanying requirements of recognized maximum field detection limits (FDLs) as detailed in Table 6.15. Field detection limits for instrumentation used in stack testing should not exceed those depicted in Table 6.15

a. If an FC gas or N_2O is consumed during the sampling period, but its emissions are not detected, the ½ FDL value determined for the target compound should be used for the value of $X_{i,s,m}$ in Equation 6.21 .

b. If an FC gas or N_2O is consumed during the sampling period but only detected intermittently during the sampling period, the detected concentration should be used for the value of $X_{i,s,m}$ in Equation 6.21 when available, and a concentration corresponding to one-half of the FDL determined for the target compound should be used for the value of $X_{i,s,m}$ when the target compound is not detected.

c. If an FC gas is not consumed during the sampling period, is not detected during the sampling period, but is an expected by-product, a concentration corresponding to one-half of the FDL determined for the target compound should be used for the value of $X_{k,s,m}$ in Equation 6.22. Expected by-products are CF_4, C_2F_6, CHF_3, CH_2F_2, and CHF_3.

d. If an FC gas or N_2O is not consumed during the sampling period, is not detected during the sampling period, and is not an expected by-product listed in c above, then inventory compilers may assume that emissions for the target compound for the tested stack system are zero.

After calculating $ES_{i,s}$ and $ES_{k,s}$, inventory compilers should calculate a facility-specific emission factor for each input gas consumed (in kg of FC gas or N_2O emitted per kg of input gas i consumed) in the tools that vent to stack systems that are tested, as applicable. For FC gases, use Equations 6.23a and 6.23b or 6.23a and 6.23c of this section. For N_2O, always use Equation 6.23b, even if this results in an emission factor greater than 1.

Equation 6.23a calculates $ES_{imax,f}$, the controlled emissions that would result during the sampling period if the utilization rate for the FC input gas i were equal to 0.2 (the minimum discussed above in "Adapting Tier 2 Methods to Account for Technological Changes"). If $\sum_s ES_{i,s}$ (the total measured emissions of the FC across all stack systems) falls below $ES_{imax,f}$, then use Equation 6.23b to calculate $EF_{i,f}$ (the abated 1-U factor for the FC input gas

i). If $\sum_s ES_{i,s}$ equals or exceeds $ES_{imax,f}$, use Equation 6.23c to calculate $EF_{i,f}$, and treat the difference between $\sum_s ES_{i,s}$ and $ES_{imax,f}$ as a by-product of the other input gases, using Equation 6.24 of this section.

EQUATION 6.23A (NEW)
MAXIMUM CONTROLLED EMISSIONS OF FCI FROM ITS USE AS INPUT GAS

$$ES_{i\max,f} = 0.8 \bullet Activity_{i,f} \bullet [1-(a_{i,f} \bullet UT_f \bullet d_i)]$$

Where:

$ES_{imax,f}$ = maximum expected controlled emissions of FC_i from the fab from its use as an input gas during the sampling period, kg

$Activity_{i,f}$ = consumption of FC input gas i for facility f during the sampling period, kg

UT_f = total uptime of all emissions control systems for facility f during the sampling period, site-specific fraction as calculated in Equation 6.27

$a_{i,f}$ = estimate of the fraction of FC input gas i exhausted from process tools equipped with suitable emissions control technologies for facility f, site-specific fraction as determined in Equation 6.10

d_i = Destruction Removal Efficiency (DRE) for FC input gas i, fraction

i = FC input gas

f = facility

EQUATION 6.23B (NEW)
GAS SPECIFIC EMISSION FACTOR FOR INPUT GAS

$$EF_{i,f} = \frac{\sum_s ES_{i,s}}{Activity_{i,f} \bullet (UT_f + \frac{1-UT_f}{1-(a_{i,f} \bullet d_i)})}$$

Where:

$EF_{i,f}$ = emission factor for input gas i and facility f representing 100 percent emissions control system uptime, kg emitted per kg of input gas consumed

$ES_{i,s}$ = emissions of input gas i from stack system s during the sampling period, kg

$Activity_{i,f}$ = consumption of input gas i for facility f during the sampling period, kg

UT_f = total uptime of all emissions control systems for facility f during the sampling period, as calculated in Equation 6.27, site-specific fraction

$a_{i,f}$ = estimate of the fraction of gas i exhausted from process tools equipped with suitable emissions control technologies for facility f, site-specific fraction as determined in Equation 6.10

d_i = Destruction Removal Efficiency (DRE) for gas i, fraction

i = input gas

s = stack system

f = facility

EQUATION 6.23C (NEW)
MAXIMUM CONTROLLED GAS-SPECIFIC EMISSION FACTOR FOR INPUT GAS FCI

$$EF_{i,f} = 0.8 \bullet [1-(a_{i,f} \bullet d_i)]$$

Where:

$EF_{i,f}$ = emission factor for FC input gas i and facility f representing a 20-percent utilization rate and 100-percent emissions control system uptime, kg emitted per kg of input gas consumed

$a_{i,f}$ = estimate of the fraction of FC input gas i exhausted from process tools equipped with suitable emissions control technologies for facility f, site-specific fraction as determined in Equation 6.10

d_i = Destruction Removal Efficiency (DRE) for FC input gas i, fraction

i = FC input gas

f = facility

After calculating $EF_{i,f}$, inventory compilers should calculate a facility-specific emission factor for each FC by-product k (in kg of by-product k per kg of total FC input gases i consumed) in the tools vented to stack systems that are tested, as applicable, using Equation 6.24 of this section. When calculating the by-product emission factor for an FC input gas i for which $\sum_s ES_{i,s}$ equals or exceeds $ES_{imax,f}$, inventory compilers should exclude the consumption of that input gas from the term $\sum$ $Activity_{i,f}$.

EQUATION 6.24 (NEW)
FC BY-PRODUCT SPECIFIC EMISSION FACTOR

$$EF_{k,f} = \frac{\sum_s ES_{k,s}}{\sum_i Activity_{i,f} \bullet (UT_f + \frac{1 - UT_f}{1 - (a_{k,i,f} \bullet d_k)})}$$

Where:

$EF_{k,f}$ = emission factor for FC by-product gas k emitted from facility f, representing 100 percent emissions control system uptime, kg emitted per kg of all FC input gases i consumed

$ES_{k,s}$ = emissions of FC by-product gas k, emitted from stack system s during the sampling period, kg

$Activity_{i,f}$ = consumption of FC input gas i for facility f during the sampling period, kg

UT_f = total uptime of all emissions control systems for facility f during the sampling period, as calculated in Equation 6.27, site-specific fraction. If the stack system does not have emissions control systems on the tools vented to the stack system, the value of this parameter is zero

$a_{k,i,f}$ = estimate of the fraction of by-product k formed from input gas i that is exhausted from process tools equipped with suitable emissions control technologies for facility f, site-specific fraction as determined in Equation 6.11

d_k = Destruction Removal Efficiency (DRE) for FC by-product k, fraction

i = FC input gas

k = FC by-product gas

s = stack system

f = facility

After calculating $EF_{i,f}$, inventory compilers should calculate annual facility-level emissions of each input gas i consumed during the year using Equation 6.25.

EQUATION 6.25 (NEW)
ANNUAL EMISSION OF INPUT GAS I

$$EA_{i,f} = EF_{i,f} \bullet C_{i,f} \bullet UT_f + \frac{EF_{i,f}}{1 - a_{i,f} \bullet d_i} \bullet C_{i,f} \bullet (1 - UT_f)$$

Where:

$EA_{i,f}$ = annual emissions of input gas i from the stack systems that are tested for facility f, kg/year

$EF_{i,f}$ = emission factor for input gas i and facility f representing 100 percent emissions control system uptime, as calculated in Equation 6.23b or 6.23c as appropriate, kg emitted per kg of input gas consumed

$C_{i,f}$ = total consumption of input gas i for facility f for the reporting year, kg/year

UT_f = the total uptime of all emissions control systems for facility f, during the reporting year, as calculated using Equation 6.27 of this section, site-specific fraction

$a_{i,f}$ = estimate of the fraction of gas i emitted from process tools equipped with suitable emissions control technologies, site-specific fraction, as determined in Equation 6.10 for facility f

d_i = Destruction Removal Efficiency (DRE) for gas i, fraction

i = input gas

f = facility

After calculating $EA_{i,f}$, inventory compilers should calculate annual facility-level emissions of each FC by-product k formed using Equation 6.26 of this section.

EQUATION 6.26 (NEW)
ANNUAL EMISSION OF FC BY-PRODUCT K

$$EA_{k,f} = EF_{k,f} \bullet \sum_i C_{i,f} \bullet UT_f + EF_{k,f} \bullet \sum_i \frac{C_{i,f} \bullet (1 - UT_f)}{1 - a_{k,i,f} \bullet d_k}$$

Where:

$EA_{k,f}$ = annual emissions of FC by-product k from the stack systems that are tested for facility f, kg/year

$EF_{k,f}$ = emission factor for FC by-product gas k, emitted from facility f representing 100 percent emissions control system uptime, as calculated in Equation 6.24 of this section, kg emitted/kg of all FC input gases consumed

$C_{i,f}$ = total consumption of FC input gas i for facility f for the reporting year, kg

UT_f = the total uptime of all emissions control systems for facility f, during the reporting year as calculated using Equation 6.27 of this section, fraction

$a_{k,i,f}$ = estimate of the fraction of FC by-product gas k formed from input gas i that is exhausted from process tools equipped with suitable emissions control technologies, site-specific fraction as determined in Equation 6.11 for facility f

d_k = Destruction Removal Efficiency (DRE) for FC by-product gas k, fraction

i = FC input gas

k = FC by-product gas

f = facility

Finally, inventory compilers should calculate, for each reporting site, the average uptime of all emissions control equipment connected to process tools for facility f (UT_f), using Equation 6.27. To this end, inventory compilers should account for the total time ($Td_{n,f}$) that any emissions control equipment n connected to process tool(s) in reporting facility f is not in operational mode when at least one of the manufacturing tools connected to emissions control equipment n is in operation, and the total time ($TT_{n,f}$) in which emissions control equipment n has at least one associated manufacturing tool in operation. For determining the amount of tool operating time, inventory compilers may assume that tools that were installed for the whole of the year were operated for 525,600 minutes per year. Inventory compilers should adjust the total minutes to reflect sampling time for the purposes of Equation 6.23 and Equation 6.24. For tools that were installed or uninstalled during the year, inventory compilers should prorate the operating time to account for the days in which the tool was not installed and treat any partial day that a tool was installed as a full day (1,440 minutes) of tool operation. For an emissions control equipment that has more than one connected tool, the tool operating time is 525,600 minutes per year if at least one tool was installed at all times throughout the year. For tools that are idle with no gas flowed through the tool for part of the year, inventory compilers may calculate total tool time using the actual time that gas is flowing through the tool. Inventory compilers should also note that UT_f may be set to one (1) if suitable backup emissions control equipment

or interlocking with the process tool is implemented for each emissions control system. Thus, using interlocked process tools or backup emissions control systems reduces uncertainty by eliminating the need to estimate UT for the reporting facility. Facility records such as maintenance records for emissions control systems can also be used to estimate emissions control system uptime.

EQUATION 6.27 (NEW)
AVERAGE EMISSIONS CONTROL SYSTEM UPTIME

$$UT_f = 1 - \frac{\sum_n Td_{n,f}}{\sum_n TT_{n,f}}$$

Where:

UT_f = the average uptime factor for all emissions control systems in fab f, fraction. When this term is used for Equation 6.23 and 6.24, evaluate $Td_{n,f}$, $TT_{n,f}$, and $UT_{n,f}$ for the sampling period

$Td_{n,f}$ = the total time, in minutes, that emissions control system n, connected to process tool(s) in fab f, is not in operational mode

$TT_{n,f}$ = total time, in minutes per year or in minutes of sampling time when used with Equations 6.23 and 6.24, in which the tool(s) connected at any point during the year to emissions control system n, in fab f could be in operation

n = emissions control system

f = facility

6.2.1.2 FLUORINATED LIQUIDS

Fluorinated liquids are used as HTFs for temperature control, device testing, cleaning substrate surfaces and other parts, and soldering in certain types of electronics manufacturing production processes. Leakage and evaporation of these fluids during use is a source of fluorinated greenhouse gas emissions.

Fluorinated liquid emissions consist primarily of hydrofluoroethers, perfluoropolyethers (including PFPMIE) and other fully fluorinated liquids (perfluorinated amines and perfluoroalkylmorpholines). With the exception of the hydrofluoroethers, all of these compounds are very long-lived in the atmosphere and have high GWPs (near 10,000). It should be noted that some lower GWP fluorinated liquids have been marketed in recent years for some applications, but that such materials may be regulated in some regions (e.g. as volatile organic compounds), and this should be considered when choosing alternative fluorinated liquids. Table 6.5 lists fluorinated liquids that are commonly used in the electronics industry, along with their 100-year GWPs. Note that the list of fluorinated liquids in Table 6.5 is not exhaustive and that additional fluorinated liquids may be used.

TABLE 6.5 (NEW)
FLUORINATED LIQUIDS COMMONLY USED IN THE ELECTRONICS INDUSTRY

Chemical Type	Fluorinated Liquid	AR4 or AR5 100-year GWP[1]
PFPMIE Distillates	PFPMIE fractions, boiling points 55-270 °C (Solvay Galden™ HT series, HT-55 through HT-270)	10,300[2]
	PFPMIE fractions, boiling points 200-230 °C (Solvay Galden™ LS series, LS-200 through LS-230)	10,300[2]
	PFPMIE fractions, boiling points 240-260 °C (Solvay Galden™ HS series, HS-240 through HS-260)	10,300[2]
	PFPMIE fractions, boiling points 81-230 °C (Solvay Galden™ DET, D02, D02-TS, D03, and D05)	10,300[2]
	PFPMIE fractions, boiling points 55-135 °C (Solvay Galden™ SV series, SV-55 through SV-135)	10,300[2]
	PFPMIE fractions (Solvay Galden™ Perfluorosolv series)	10,300[2]
Other Fully Fluorinated Liquids	Perfluorotripropylamine (PTPA, 3M™ Fluorinert™ FC-3283/FC-8270)	Not available[3]
	Perfluorotributylamine (PTBA, 3M™ Fluorinert™ FC40/FC-43)	Not available[3]
	Perfluoroisopropylmorpholine (3M™ Fluorinert™ FC-770)	Not available[3]
	Perfluoromethylmorpholine (3M™ Fluorinert™ FC-3284)	Not available[3]
PFCs[4]	C_6F_{14} (Perfluorohexane, 3M™ Fluorinert™ FC-72)	9,300
	C_7F_{16} (Perfluoroheptane, 3M™ Fluorinert™ FC-84)	7,820
	C_8F_{18} (Perfluorooctane, 3M™ Fluorinert™ FC-3255, FC-104)	7,620
	Blend of C_8F_{18} and perfluoro-2-butyltetrahydrofuran (3M™ Fluorinert™ FC-77)	Not available[3]
Saturated HFCs[4]	HFC-4-3-10mee (Chemours Vertrel™ XF)	1,640
	Blends including HFC-43-10mee and/or other saturated HFCs (Chemours Vertrel™ MCA, SDG, SMT, and SFR)	Approximately 150 to 1,000
Hydrofluoroethers	Methoxytridecafluoroheptene alone (Chemours Opteon™ SF10) and blended with trans-1,2-dichloroethylene (Chemours Opteon™ SF79)	Not available[5]
	HFE-347mcc3 (3M™ Novec™ 7000 Engineered Fluid)	575
	HFE-449s1 (3M™ Novec™ HFE-7100)	297
	HFE-569sf2, (3M™ Novec™ HFE-7200)	59
	1 1 1 2 2 3 4 5 5 5-decafluoro-3-methoxy-4-trifluoromethyl-pentane (3M™ Novec™ HFE-7300)	Not available[6]
	3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-trifluoromethyl-hexane (3M™ Novec™ HFE-7500)	Not available[6]
	Blends including HFE-449s1 and HFE-569sf2 (3M™ Novec™ 71DA, 71DE, 71IPA, 72DA, 72DE, 72FL Engineered Fluids)	41-284
Fluorinated Ketones	perfluoro(2-methyl-3-pentanone) (3M™ Novec™ 649 Engineered Fluid/3M™ Novec™ 1230 Fire Protection Fluid, FK 5-1-12	0.1

TABLE 6.5 (NEW) (CONTINUED)
FLUORINATED LIQUIDS COMMONLY USED IN THE ELECTRONICS INDUSTRY

[1]The GWP in the Fourth Assessment Report (AR4) is provided if the compound has a GWP in AR4. Otherwise, the GWP in the Fifth Assessment Report (AR5) is provided.

[2]This is the GWP for the PFPMIE distillate fraction that is sold under the name Solvay Galden HT-70 (Young et al). Solvay has stated that the HT, LS, HS, SV, and Perfluorosolv series, as well as DET, D02, D02-TS, D03, and D05, have similar chemical structures (varying only in their chain lengths) and are manufactured with the same production process. They differ in their molecular weights because they are different fractions of the source "bulk fluid."

[3]The GWPs for these compounds have not been published in the peer-reviewed literature. However, evaluations by the manufacturer indicate that their GWPs are near 10,000 (US Federal Register Volume 78, Issue 66 (April 5, 2013), pp. 20632-37). This is expected given that these compounds are both fully fluorinated and saturated, as are, for example, the PFCs listed above. The US EPA assigns a default 100-year GWP of 10,000 to compounds that are both saturated and fully fluorinated and that do not have chemical-specific GWPs in either the Fourth or the Fifth Assessment Reports.

[4]In addition to the PFCs and HFCs listed here, some facilities reporting emissions under the US EPA Greenhouse Gas Reporting Program have reported emissions of SF_6 and low-boiling point PFCs and HFCs that are used as heat transfer fluids.

[5]The US EPA estimates a 100-year GWP for methoxytridecafluoroheptene of 2.5 (US Federal Register Volume 80, page 42058, July 16, 2015) and a 100-year GWP for trans-1,2-dichloroethylene of less than five due to its structure and brief atmospheric lifetime (US Federal Register Volume 81, page 32241, May 23, 2016).

[6]The GWPs for these compounds have not been published in the peer-reviewed literature. However, based on their similarity to HFEs for which GWPs have been published (saturated HFEs and HCFEs with 3 or more carbon-hydrogen bonds), the US EPA assigns a default 100-year GWP of 270 to these compounds.

There are two methods for estimating emissions from the use of fluorinated liquids. The choice of methods will depend on the availability of inventory data on the use of fluorinated liquids and is outlined in the decision tree (see Figure 6.3, Decision Tree for Estimation of FC Emissions from Fluorinated Liquids, and see Section 1.5 of Chapter 1, Choosing between the Mass Balance and Emission Factor Approach).

TIER 1 – FLUORINATED LIQUIDS

Tier 1 is appropriate when company-specific data are not available on the consumption of fluorinated liquids. Tier 1 factors are available for semiconductor manufacturing (including both factors for heat transfer fluid applications and for testing, packaging and soldering) and for display (for heat transfer fluid applications). It is the less accurate of the two methods for estimating emissions from losses of fluorinated liquids. The method, unlike the Tier 2 method, gives estimates of emissions for three fluorinated liquids that represent the three main types of compounds used as heat transfer fluids globally (see Table 6.18). For any class of electronic products (semiconductor, MEMS, display), the default emission factors are multiplied by the annual production, P. For fluorinated heat transfer fluid applications, P is the area of substrate processed in units of square meters (m^2). For testing, packaging and soldering, P is the number of packaged devices in thousands (kpcs). The result is a set of annual emissions estimates expressed in kg of materials emitted during the manufacture of a particular class of electronic products. The Tier 1 method for estimating emissions from fluorinated liquids is analogous to the Tier 1 method for estimating greenhouse gas emissions during electronic devices manufacturing. The formula is shown in Equation 6.28.

EQUATION 6.28 (UPDATED)
TIER 1 METHOD FOR ESTIMATION OF TOTAL FC EMISSIONS FROM FLUORINATED LIQUIDS

$$FC_i = EF_i \bullet P$$

Where:

FC_i = emissions of fluorinated liquid i, kg

EF_i = emission factor for fluorinated liquid aggregate emissions either per m^2 of substrate consumed during the period (kg/m^2, for heat transfer fluid applications), or per thousand packaged devices, kg/kpcs, for testing, packaging and soldering

P = annual production either in m^2 of substrate used during the production of electronic devices, including test substrates (for heat transfer fluid applications), or in thousands of packaged devices (for testing, packaging and soldering). If annual production in m^2 is not available from an electronics producer, P in m^2 may be calculated as the product of the annual manufacturing capacity and annual plant production capacity utilisation (fraction) of that producer.

For semiconductor manufacturing, it is *good practice* to apply equation 6.28 twice—once to estimate emissions of fluorinated liquids from heat transfer fluid applications and again to estimate emissions of fluorinated liquids from testing, packaging, and soldering—and then to sum the results of both calculations to obtain total emissions of fluorinated liquids. Tier 1 factors for fluorinated liquids are not available for PV. Tier 1 factors are also not available for substrate cleaning. Thus, the Tier 2 approach should be used to estimate fluorinated liquid emissions from these sources.

TIER 2 METHOD – FLUORINATED LIQUIDS

There is one Tier 2 method for estimating actual emissions from the use of any and each fluorinated liquid, applicable to all electronics manufacturing sub-sectors (semiconductor, display MEMS, PV) and to each application (temperature control, device testing, cleaning substrate surfaces and other parts, and soldering). This method is a mass-balance approach that accounts for fluorinated liquid usage over an annual period. This Tier 2 method is appropriate when company-specific data are available; it is the only method applicable to the use of fluorinated liquids for cleaning substrates surfaces and other parts, and for the PV sub-sector. Over the course of a year, fluorinated liquids are used to fill newly purchased equipment and to replace fluorinated liquid loss from equipment operation through evaporation. Inventory compilers should provide the chemical composition of the fluid(s) for which emissions are estimated for each application. The method is expressed in Equation 6.29.

EQUATION 6.29 (UPDATED)
TIER 2 METHOD FOR ESTIMATION OF FC EMISSIONS FROM FLUORINATED LIQUIDS

$$FC_i = \rho_i \bullet (I_{i,t-1} + P_{i,t} - N_{i,t} + R_{i,t} - I_{i,t} - D_{i,t})$$

Where:

FC_i = emissions of fluorinated liquid i, kg

ρ_i = density of fluorinated liquid i, kg/litre

i = fluorinated liquid

$I_{i, t-1}$ = inventory of liquid FC_i in containers other than equipment at the beginning of the reporting year, litres in stock or storage. The inventory at the beginning of the reporting year should be the same as the inventory at the end of the previous year

$P_{i,t}$ = acquisitions of liquid FC_i during the reporting year, including amounts purchased from chemical suppliers, amounts purchased from equipment suppliers with or inside of equipment, and amounts returned to the facility after off-site recycling, litres

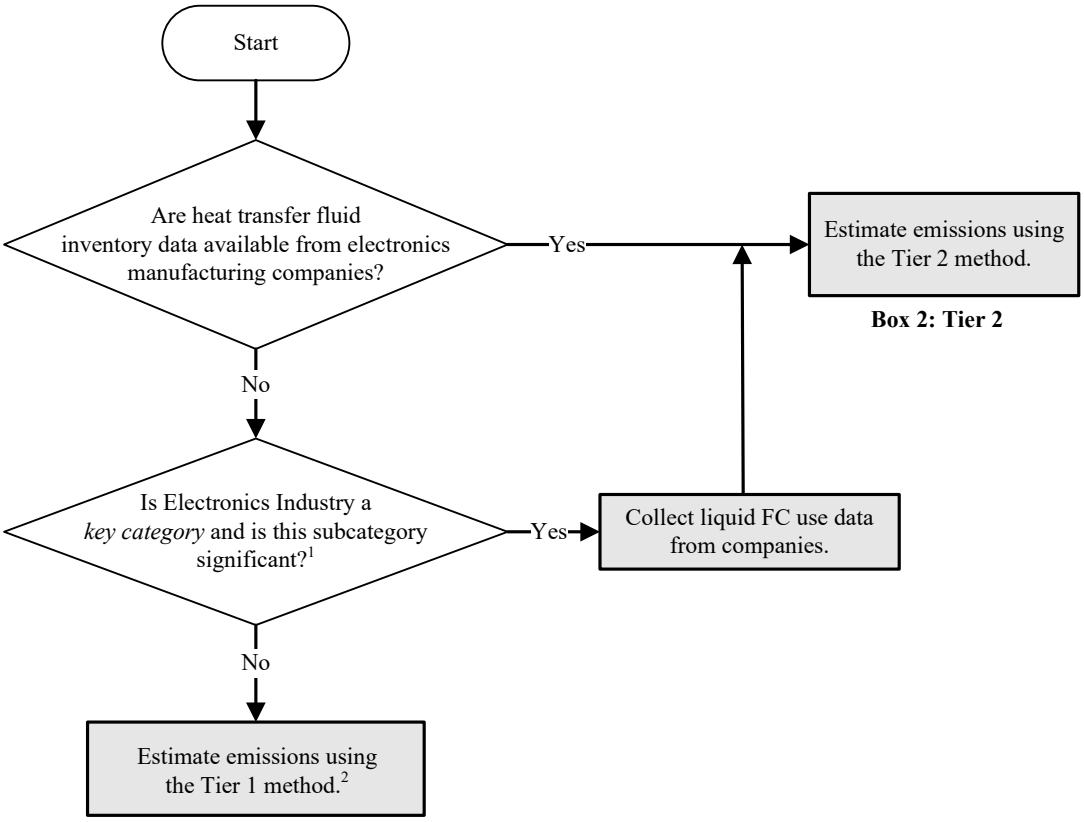
$N_{i,t}$ = total nameplate capacity (full and proper charge) of equipment that uses fluorinated liquid i and that is newly installed in the reporting facility during the reporting year, litres

$R_{i,t}$ = total nameplate capacity (full and proper charge) of equipment that uses fluorinated liquid i and that is removed from service in the reporting facility during the reporting year, litres

$I_{i,t}$ = inventory of liquid FC_i in containers other than equipment at the end of the reporting year, litres in stock or storage

$D_{i,t}$ = disbursements of fluorinated liquid i, including amounts returned to chemical suppliers, sold with or inside of equipment, and sent off-site for verifiable recycling or destruction, litres. Disbursements should include only amounts that are properly stored and transported so as to prevent emissions in transit

Figure 6.3 (Updated) Decision tree for estimation of emissions from fluorinated liquids loss from electronics manufacturing



Note:
1. See Volume 1 Chapter 4, Methodological Choice and Identification of Key Categories (noting Section 4.1.2 on limited resources), for discussion of *key categories* and use of decision trees.
2. Substrate cleaning (any sub-sector) and any application in the PV sub-sector require use of Tier 2 method.

6.2.2 Choice of emission factors

This section provides the default emission factors that should be used for reporting emissions under the Tier 1 and Tier 2 methods. Please refer to the corresponding emission factor tables (Tables 6.6 to 6.13 and Tables 6.17 and 6.18) for each method.

The main sources of default emission factors are the U.S. EPA Greenhouse Gas Reporting Rule (GHGRP, 40 U.S. Code of Federal Regulations (CFR) part 98; Subpart I), the *2006 IPCC Guidelines* (Volume 3, Chapter 6), the World Semiconductor Council (2011, 2012, 2014 and 2016), the World Display device Industry Cooperation Committee, and industry surveys conducted during the *2019 Refinement*.

In the case where a new input gas is used for which no default emission factor ($1\text{-}U_i$) has been established, facilities can estimate emissions using the Tier 2 methods and assume a default emission factor of ($1\text{-}U_i$) = 0.8 with by-product emission factors of $B_{CF4,i}$=0.15 and $B_{C2F6,i}$=0.05. However, this provision could lead to incomplete and inaccurate results if the use of the new chemical leads to the formation of by-products other than CF_4 and C_2F_6 or if the default emission factors fail to accurately represent actual emissions from the new gas or process. Thus, reporters should measure the emission factors for the new gas or process and use a partial Tier 3a method to account for emissions resulting from the use of the new chemical or new process if the consumption of the new gas exceeds 1 percent of the facility's GHG consumption by mass.

6.2.2.1 GASEOUS FLUORINATED COMPOUNDS AND NITROUS OXIDE

TIER 1

The default emission factors for the Tier 1 method are presented in Table 6.6 below. Because the Tier 1 default emission factors for the semiconductor sector in Table 6.6 are based on a 50/50 split between 200mm and 300mm production, it is *good practice to use* the Tier 1 default emission factors for the semiconductor sector that are available in the *2006 IPCC Guidelines* in cases where the wafer size produced is known to be 200 mm or smaller.

In using Tier 1, it is not *good practice* to modify, in any way, the set of greenhouse gases or the values of the emission factors assumed in Table 6.6. For any given electronics manufacturing facility, inventory compilers should not combine emissions estimated using the Tier 1 method with emissions estimated using the Tier 2 or 3 methods. For example, inventory compilers may not use the Tier 1 factor for CF_4 to estimate the emissions of CF_4 from semiconductors and combine it with the results of other gases from a Tier 2 or Tier 3 method. It should also be noted that the Tier 1 emission factors presented in Table 6.6 should not be used for any purpose other than estimating annual process gas-aggregate emissions from semiconductor, display, MEMS, or PV manufacturing for compilation of the national greenhouse gas inventory. Tier 1 emissions for the semiconductor sub-sector are calculated based on the surface area of wafer produced. Display emissions are calculated based on the surface area of input glass corresponding to array processes, i.e. the processes used to manufacture the thin film transistors that are part of the display devices. Note that the array input glass area is different than the input glass area used for the manufacturing of colour filters used in display devices, which does not involve the use (or emissions) of fluorinated GHGs. Also note that the Tier 1 factors for MEMS are highly uncertain due to the fact that they were generated from a limited data set. Additionally, as previously discussed in the Choice of Method section, the high Tier 1 emission factor for SF_6 corresponds to a MEMS-specific process consisting of etching vias through the substrate, a process which consumes significant amounts of SF_6.

TABLE 6.6 (UPDATED)
TIER 1 GAS-SPECIFIC EMISSION FACTORS FOR PROCESS GHG EMISSIONS FROM ELECTRONICS MANUFACTURING

Electronics industry subsector	CF_4	C_2F_6	C_3F_8	C_4F_6	$c\text{-}C_4F_8$	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	NF_3	SF_6	N_2O
Semiconductors, kg/m²	0.36	0.12	0.03	0.003	0.01	7E-5	0.001	0.05	0.003	0.15	0.05	1.01
Display, g/ array input glass area m²	0.65				0.001			0.0024		1.29	4.14	17.06
PV, g/m²	5	0.2										
MEMS, kg/m²	0.015				0.076						1.86	

Sources:

The Tier 1 emission factors for the display sub-sector were provided by the World Display device Industry Cooperation Committee.

The Tier 1 emission factors for the semiconductor sub-sector were provided by the World Semiconductor Council. The factors are based on seven years of data collected by the regions comprising the World Semiconductor Council (WSC), i.e. China, Chinese Taipei, Europe, Japan, Korea, and the United States. Included is data for facilities operated by WSC companies outside the WSC regions e.g., Singapore. The factors are calculated starting from the purchased quantities of the listed gases and by considering the emission factors reported in the Table 6.7 for Tier 2a, including the formation of by-products. The emissions calculated in this way have then been divided by the total area of silicon produced. As the Tier 2a default emission factors used to develop the Tier 1 default emission factors for the semiconductor sector in Table 6.7 assumed a 50/50 split between 200mm and 300mm production, it is *good practice to use* the Tier 1 default emission factors for the semiconductors sector that are available in the *2006 IPCC Guidelines* in cases where the wafer size produced is known to be 200 mm or smaller.

TIER 2

The default emission factors for the Tier 2 methods are presented in Tables 6.7 to 6.13 and Table 6.17 below.

Note that F_2 and COF_2 are included in the list of input gases for the Tier 2 methods because these gases are known to be used for TFD chamber cleaning and because the use of F_2 and COF_2 for chamber cleaning can lead to the formation of CF_4 and other high-GWP by-products, but no data was available to derive emission factors for these gases. Note also that, although COF_2 is a known by-product of chamber cleaning processes using fluorinated carbon gases (e.g. CF_4, C_2F_6, etc.), no by-product factor for COF_2 (i.e. $B_{COF2,i}$) was included in the Tier 2 default tables dues to the low GWP (~1) and short atmospheric life of COF_2.

TABLE 6.7 (UPDATED)
TIER 2A METHOD – DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM SEMICONDUCTOR MANUFACTURING AND FROM MEMS MANUFACTURING UNDER CERTAIN CONDITIONS**

Process Gas	CF_4	C_2F_6	C_3F_8	C_3F_8 Remote	C_4F_6	c-C_4F_8	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	CH_3F	C_2HF_5	NF_3 Remote	NF_3	SF_6	N_2O TFD	N_2O other	COF_2	F_2
(1-U_i)	0.73	0.55	0.4	0.063	0.15	0.13	0.14	0.086	0.46	0.2	0.34	0.064	0.02	0.18	0.55	0.78	1.0	NM	NM
B_{CF4}	NA	0.19	0.2	NA	0.06	0.099	0.13	0.053	0.081	0.061	0.029	0.077	0.034	0.067	0.12	NA	NA	NM	NM
B_{C2F6}	0.042	NA	0.000018	NA	0.062	0.02	0.045	0.047	0.046	0.044	0.01	0.024	NA	0.015	0.095	NA	NA	NM	NM
B_{C3F8}	NA	NA	NA	NA	NA	NA	NA	0.000055	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F6}	0.00066	NA	NA	NA	NA	0.0017	NA	NA	0.000041	NA	0.0011	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F8}	0.0015	NA	NA	NA	0.0051	NA	NA	NA	0.00028	0.071	0.0067	NA	NA	NA	NA	NA	NA	NA	NA
B_{C5F8}	0.00042	NA	NA	NA	NA	0.0035	NA	NA	0.00068	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{CH3F}	0.0024	NA	0*	NA	0.00064	0.0004	NA	NA	0.016	0.0043	NA	NA	NA	0.0022	0.0009	NA	NA	NA	NA
B_{CH2F2}	0.0063	NA	NA	NA	0.00003	0.00026	NA	NA	0.0011	NA	0.0021	NA	NA	0.00023	0.0000021	NA	NA	NA	NA
B_{CHF3}	0.039	0.002	0.0000012	NA	0.018	0.022	NA	0.0053	NA	0.057	0.015	NA	NA	0.0068	0.0014	NA	NA	NA	NA

Source: Data collected under the U.S. EPA Greenhouse Gas Reporting Rule (GHGRP, 40 U.S. Code of Federal Regulations (CFR) part 98; Subpart I); subsets of the data are available at https://www.regulations.gov/docket?D=EPA-HQ-OAR-2011-0028.

*$<10^{-7}$

** Tier 2a default factors for semiconductor manufacturing may be applied to MEMS manufacturing processes that are carried out using semiconductor manufacturing tools when such MEMS processes are similar to semiconductor manufacturing processes (for further details see discussion in the Choice of method section, in particular footnote 3).

NA = Not Applicable; NM = Not Measured (but known to occur). If a new gas and process combination are used that accounts for less than 1 percent of facility fluorinated GHG consumption by mass and (1-U) is NM or not listed, compiler may assume (1-U) = 0.8, B_{CF4} = 0.15, B_{C2F6} = 0.05.

TABLE 6.8 (NEW)
TIER 2A, 2B AND 3B METHODS – DEFAULT WEIGHTING FACTORS $\gamma_{I,P}$ AND $\gamma_{K,I,P}$ FOR SEMICONDUCTOR AND MEMS MANUFACTURING UNDER CERTAIN CONDITIONS*

Tier, input gas ($\gamma_{i,p}$) vs. byproduct ($\gamma_{k,i,p}$), and wafer size	CF_4 (IPC or ITC)/ EWC	C_2F_6 IPC/ EWC	c-C_4F_8 IPC/ EWC	NF_3 (IPC or ITC) / EWC	SF_6 IPC/ EWC	NF_3 RPC/ EWC	CF_4 RPC/ EWC	C_3F_8 RPC/ EWC	N_2O TFD/ other
Tier 2a									
$\gamma_{i,p}$	13†	9.3	4.7	14†	11				
$\gamma_{CF4,i,p}$	NA	23	6.6	63	8.5				
$\gamma_{C2F6,i,p}$	NA	NA	NA	NA	3.4				
Tier 2b									
$\gamma_{i,p}$ (≤200 mm wafer size)	13†	9.3	4.7	2.9†	11				
$\gamma_{CF4,i,p}$ (≤200 mm wafer size)	NA	23	6.6	110	8.5				
$\gamma_{C2F6,i,p}$ (≤200 mm wafer size)	NA	NA	NA	NA	3.4				
$\gamma_{i,p}$ (300 mm wafer size)	NM	NM	NM	26†	NM				
$\gamma_{CF4,i,p}$ (300 mm wafer size)	NA	NA	NA	17	NA				
Tier 3b									
$\gamma_{i,p}$ (both ≤200 mm and 300 mm wafer size)	13†	9.3	4.7	14†	11	5.7	NM	NM	25
$\gamma_{CF4,i,p}$ (both ≤200 mm and 300 mm wafer size)	NA	23	6.6	63	8.5	57	NA	NA	NA
$\gamma_{C2F6,i,p}$ (both ≤200 mm and 300 mm wafer size)	NA	NA	NA	NA	3.4	NA	NA	NA	NA
$\gamma_{i,p}$ (≤200 mm wafer size)	13†	9.3	4.7	2.9†	11	1.4	NM	NM	48
$\gamma_{CF4,i,p}$ (≤200 mm wafer size)	NA	23	6.6	110	8.5	35	NM	NA	NA
$\gamma_{C2F6,i,p}$ (≤200 mm wafer size)	NA	NA	NA	NA	3.4	NA	NA	NA	NA
$\gamma_{i,p}$ (300 mm wafer size)	NM	NM	NM	26†	NM	10	NM	NM	2.4
$\gamma_{CF4,i,p}$ (300 mm wafer size)	NA	NA	NA	17	NA	78	NA	NA	NA

Source: Survey of industrial facility data conducted by the authors of Chapter 6.
*Gamma weighting factors for semiconductor manufacturing may be applied to MEMS manufacturing processes that are carried out using tools and processes similar to those used to manufacture semiconductors (for further details see discussion in the Choice of method section, in particular footnote 3).
† The gamma values for (IPC or ITC)/EWC for 200 mm were developed based on IPC only and the values for 300 mm were developed based on the total emissions and tool count from ITC and IPC. Gamma is assigned based on analogy due to similar emission factors for IPC and ITC, where known, for the same gas and wafer size. For all other cases where no gamma has been measured and a gamma is needed, compiler may assume $\gamma_i = 10$, $\gamma_k = 10$.

TABLE 6.9 (NEW)
TIER 2B METHOD – DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM SEMICONDUCTOR MANUFACTURING AND FROM MEMS MANUFACTURING UNDER CERTAIN CONDITIONS*

Process Gas	CF_4	C_2F_6	C_3F_8	C_3F_8 Remote	C_4F_6	c-C_4F_8	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	CH_3F	C_2HF_5	NF_3 Remote	NF_3	SF_6	N_2O TFD	N_2O other	COF_2	F_2
≤200 mm wafer size																			
(1-U_i)	0.79	0.55	0.4	NA	0.083	0.12	0.14	0.072	0.51	0.13	0.7	0.064	0.028	0.18	0.58	1.0	1.0	NM	NM
B_{CF4}	NA	0.19	0.2	NA	0.095	0.11	0.13	NA	0.085	0.079	NA	0.077	0.015	0.11	0.13	NA	NA	NM	NM
B_{C2F6}	0.027	NA	NA	NA	0.073	0.019	0.045	0.014	0.035	0.025	0.0034	0.024	NA	0.0059	0.10	NA	NA	NM	NM
B_{C3F8}	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{C5F8}	0.00077	NA	NA	NA	NA	0.0043	NA	NA	0.0012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{CHF3}	0.06	0.002	NA	NA	0.066	0.02	NA	0.0039	NA	0.049	NA	NA	NA	NA	0.0011	NA	NA	NA	NA
300 mm wafer size																			
(1-U_i)	0.65	0.8	0.3	0.063	0.15	0.18	NA	0.1	0.38	0.2	0.32	NA	0.018	0.18	0.29	0.5	1.0	NM	NM
B_{CF4}	NA	0.21	0.21	NA	0.059	0.045	NA	0.11	0.076	0.06	0.031	NA	0.038	0.04	0.034	NA	NA	NM	NM
B_{C2F6}	0.061	NA	0.18	NA	0.062	0.027	NA	0.083	0.062	0.044	0.011	NA	NA	0.02	0.041	NA	NA	NM	NM
B_{C3F8}	NA	NA	NA	NA	NA	NA	NA	0.00012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
--B_{C4F6}	0.0015	NA	NA	NA	NA	0.0090	NA	NA	0.0001	NA	0.0012	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F8}	0.0033	NA	NA	NA	0.0051	NA	NA	NA	0.00067	0.072	0.007	NA	NA	NA	NA	NA	NA	NA	NA
B_{CH3F}	0.0053	NA	0.00073	NA	0.00065	0.0022	NA	NA	0.037	0.0044	NA	NA	NA	0.0036	0.0082	NA	NA	NA	NA
B_{CH2F2}	0.014	NA	NA	NA	0.00003	0.0014	NA	NA	0.0026	NA	0.0023	NA	NA	0.00039	0.00002	NA	NA	NA	NA
B_{CHF3}	0.013	NA	0.012	NA	0.017	0.029	NA	0.0069	NA	0.057	0.016	NA	NA	0.011	0.0039	NA	NA	NA	NA

Source: Data collected under the U.S. EPA Greenhouse Gas Reporting Rule (GHGRP, 40 U.S. Code of Federal Regulations (CFR) part 98; Subpart I); subsets of the data are available at https://www.regulations.gov/docket?D=EPA-HQ-OAR-2011-0028.

* Tier 2b default factors for semiconductor manufacturing may be applied to MEMS manufacturing processes that are carried out using semiconductor manufacturing tools when such MEMS processes are similar to semiconductor manufacturing processes (for further details see discussion in the Choice of method section, in particular footnote 3).

NA = Not Applicable; NM = Not Measured (but known to occur). If a new gas and process combination are used that accounts for less than 1 percent of facility fluorinated GHG consumption by mass and (1-U) is NM, compiler may assume (1-U) = 0.8, B_{CF4} = 0.15, B_{C2F6} = 0.05.

TABLE 6.10 (NEW)
TIER 2C METHOD (≤200 MM) – DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM SEMICONDUCTOR MANUFACTURING AND FROM MEMS MANUFACTURING UNDER CERTAIN CONDITIONS*

Process Gas	CF_4	C_2F_6	C_3F_8	C_4F_6	$c\text{-}C_4F_8$	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	CH_3F	C_2HF_5	NF_3	SF_6	N_2O TFD	N_2O other	COF_2	F_2
Etching or Wafer Cleaning (EWC)																	
(1-U_i)	0.73	0.72	NA	0.083	0.14	NM	0.072	0.51	0.13	0.7	0.064	0.19	0.55	NA	NA	NM	NM
B_{CF4}	NA	0.1	NA	0.095	0.11	NM	NA	0.085	0.079	NA	0.077	0.004	0.13	NA	NA	NM	NM
B_{C2F6}	0.041	NA	NA	0.073	0.037	NM	0.014	0.035	0.025	0.0034	0.024	0.025	0.11	NA	NA	NM	NM
B_{C5F8}	0.0012	NA	NA	NA	0.0086	NA	NA	0.0012	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{CHF3}	0.091	0.047	NA	0.066	0.04	NA	0.0039	NA	0.049	NA	NA	NA	0.0012	NA	NA	NA	NA
Remote Plasma Cleaning (RPC)																	
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.028	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.015	NA	NA	NA	NA	NA
In-situ Plasma Cleaning (IPC)																	
(1-U_i)	0.92	0.55	0.4	NA	0.1	0.14	NA	NA	NA	NA	NA	0.18	NM	NA	NA	NM	NA
B_{CF4}	NA	0.19	0.2	NA	0.11	0.13	NA	NA	NA	NA	NA	0.14	NM	NA	NA	NM	NA
B_{C2F6}	NA	NA	NA	NA	NA	0.045	NA	NA	NA	NA	NA	NA	NM	NA	NA	NM	NA
Thin Film Deposition (TFD)																	
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.0	NA	NA	NA
Other																	
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.0	NA	NA

Source: Data collected under the U.S. EPA Greenhouse Gas Reporting Rule (GHGRP, 40 U.S. Code of Federal Regulations (CFR) part 98; Subpart I); subsets of the data are available at https://www.regulations.gov/docket?D=EPA-HQ-OAR-2011-0028.

* Tier 2c default factors for semiconductor manufacturing may be applied to MEMS manufacturing processes that are carried out using semiconductor manufacturing tools when such MEMS processes are similar to semiconductor manufacturing processes (for further details see discussion in the Choice of method section, in particular footnote 3).

NA = Not Applicable; NM = Not Measured (but known to occur). No emission factor data was available for in-situ thermal cleaning for ≤200 mm, but the process is known to be used. If a new gas and process combination are used that accounts for less than 1 percent of facility fluorinated GHG consumption by mass and (1-U) is NM, compiler may assume (1-U) = 0.8, B_{CF4} = 0.15, B_{C2F6} = 0.05.

TABLE 6.11 (NEW)
TIER 2C METHOD (300 MM) – DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM SEMICONDUCTOR MANUFACTURING AND FROM MEMS MANUFACTURING UNDER CERTAIN CONDITIONS*

Process Gas	CF_4	C_2F_6	C_3F_8	C_4F_6	c-C_4F_8	C_5F_8	CHF_3	CH_2F_2	CH_3F	NF_3	SF_6	N_2O TFD	N_2O other	COF_2	F_2
Etching and Wafer Cleaning (EWC)															
$(1-U_i)$	0.65	0.8	0.3	0.15	0.18	0.1	0.38	0.2	0.32	0.16	0.29	NA	NA	NM	NM
B_{CF4}	NA	0.21	0.21	0.059	0.045	0.11	0.076	0.06	0.031	0.045	0.034	NA	NA	NM	NM
B_{C2F6}	0.061	NA	0.18	0.062	0.027	0.083	0.062	0.044	0.011	0.045	0.041	NA	NA	NM	NM
B_{C3F8}	NA	NA	NA	NA	NA	0.00012	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F6}	0.0015	NA	NA	NA	0.0094	NA	0.0001	NA	0.0012	NA	NA	NA	NA	NA	NA
B_{C4F8}	0.0033	NA	NA	0.0051	NA	NA	0.00067	0.072	0.007	NA	NA	NA	NA	NA	NA
B_{CH3F}	0.0053	NA	0.00073	0.00065	0.0022	NA	0.037	0.0044	NA	0.008	0.0082	NA	NA	NA	NA
B_{CH2F2}	0.014	NA	NA	0.00003	0.0014	NA	0.0026	NA	0.0023	0.00086	0.00002	NA	NA	NA	NA
B_{CHF3}	0.013	NA	0.012	0.017	0.029	0.0069	NA	0.057	0.016	0.025	0.0039	NA	NA	NA	NA
Remote Plasma Cleaning (RPC)															
$(1-U_i)$	NA	NA	0.063	NA	NA	NA	NA	NA	NA	0.018	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.038	NA	NA	NA	NA	NA
In-situ Plasma Cleaning (IPC)															
$(1-U_i)$	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.037	NA	NA	NA	NA	NA
In-situ Thermal Cleaning (ITC)															
$(1-U_i)$	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.28	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	NA	NA	NA	NA	NA

TABLE 6.11 (NEW) (CONTINUED)
TIER 2C METHOD (300 MM) – DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM SEMICONDUCTOR MANUFACTURING AND FROM MEMS MANUFACTURING UNDER CERTAIN CONDITIONS*

Process Gas	CF_4	C_2F_6	C_3F_8	C_4F_6	$c\text{-}C_4F_8$	C_5F_8	CHF_3	CH_2F_2	CH_3F	NF_3	SF_6	N_2O TFD	N_2O other	COF_2	F_2
TFD															
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5	NA	NA	NA
Other															
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.0	NA	1.0

Source: Data collected under the U.S. EPA Greenhouse Gas Reporting Rule (GHGRP, 40 U.S. Code of Federal Regulations (CFR) part 98; Subpart I); subsets of the data are available at https://www.regulations.gov/docket?D=EPA-HQ-OAR-2011-0028.

* Tier 2c default factors for semiconductor manufacturing may be applied to MEMS manufacturing processes that are carried out using semiconductor manufacturing tools when such MEMS processes are similar to semiconductor manufacturing processes (for further details see discussion in the Choice of method section, in particular footnote 3).

NA = Not Applicable; NM = Not Measured (but known to occur). If a new gas and process combination are used that accounts for less than 1 percent of facility fluorinated GHG consumption by mass and (1-U) is NM, compiler may assume (1-U) = 0.8, B_{CF4} = 0.15, B_{C2F6} = 0.05.

TABLE 6.12 (UPDATED)
TIER 2C METHOD – DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM DISPLAY MANUFACTURING

Process Gas	CF_4	c-C_4F_8	CHF_3	NF_3	SF_6	N_2O
Etching						
(1-U_i)	0.6	0.1	0.2	0.11	0.3	NA
B_{CF4}	NA	0.009	0.07	NA	NA	NA
B_{C2F6}	NA	NA	0.05	NA	NA	NA
B_{CHF3}	NA	0.02	NA	NA	NA	NA
Remote plasma cleaning (RPC)						
(1-U_i)	NA	NA	NA	0.03	NA	NA
In-situ plasma cleaning (IPC)						
(1-U_i)	NA	NA	NA	0.3	0.9	NA
Thin film deposition (TFD)						
(1-U_i)	NA	NA	NA	NA	NA	0.63

TABLE 6.13 (UPDATED)
TIER 2C METHOD -- DEFAULT EMISSION FACTORS (FRACTIONS) FOR GHG EMISSIONS FROM PV MANUFACTURING

Process Gas (i)	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	c-C_4F_8	NF_3 Remote	NF_3	SF_6	C_4F_6	C_5F_8	C_4F_8O	F_2	COF_2
Etch 1-Ui	0.7	0.4	0.4	NA	NA	0.2	NA	NA	0.4	NA	NA	NA	NA	NA
TFD 1-Ui	NA	0.6	NA	NA	0.1	0.1	NA	0.3	0.4	NA	NA	NA	NA	NA
Etch B_{CF4}	NA	0.2	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	NA	NA
Etch B_{C2F6}	NA	NA	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	NA	NA
TFD B_{CF4}	NA	0.2	NA	NA	0.2	0.1	NA	NA	NA	NA	NA	NA	NA	NA

Notes: NA denotes not applicable based on currently available information

TABLE 6.14 (NEW)
METHODS AND PROCEDURES FOR CONDUCTING EMISSIONS TESTS FOR STACK SYSTEMS

For each stack system for which you use Tier 3b method to calculate annual emissions	You should	Using the method cited below or equivalent
For each fluorinated GHG	Measure the concentration in the stack system.	Using U.S. EPA Method 320 at 40 CFR part 63, appendix A or ASTM D6348-03. Conduct the test run for a minimum of 8 hours for each stack system.
	Select sampling port locations and the number of traverse points.	U.S. EPA Method 1 or 1A at 40 CFR part 60, appendix A-1.
	Determine gas velocity and volumetric flow rate.	U.S. EPA Method 2, 2A, 2C, 2D, 2F or 2G at 40 CFR part 60, appendix A-1 and A-2.
	Determine gas molecular weight.	U.S. EPA Method 3, 3A, or 3B at 40 CFR part 60, appendix A-2 using the same sampling site and time as the fluorinated GHG sampling.
	Measure gas moisture content.	U.S. EPA Method 4 at 40 CFR part 60, appendix A-3 or using FTIR.

TABLE 6.15 (NEW)
MAXIMUM FIELD DETECTION LIMITS (FDL) APPLICABLE TO FLUORINATED COMPOUNDS (FC) CONCENTRATION MEASUREMENTS FOR STACK SYSTEMS

Fluorinated GHG Analyte	Maximum Field detection limit (ppbv*)
CF_4	20
C_2F_6	20
C_3F_8	20
C_4F_6	20
c–C_4F_8	20
C_5F_8	20
CHF_3	20
CH_2F_2	40
CH_3F	40
NF_3	20
SF_6	4
Other fully fluorinated GHGs	20
Other fluorinated GHGs	40

* ppbv = parts per billion by volume

EMISSIONS CONTROL TECHNOLOGY FACTORS

Since 2006, the performance of emissions control devices in production conditions has been more extensively characterized, and the *2019 Refinement* provides revised default DRE values for a larger basket of gases (see Table 6.17). Figure 6.4 provides guidance for deciding when a particular emissions control technology may be suitable to abate fluorinated compounds (FCs) and N_2O emissions from electronic devices manufacturing, when default emissions control technology factors may be used, or when site-specific destruction removal efficiencies can or should be measured. With regards to emissions control equipment, "exhaust gases" refers to the combination of all gases exiting the process chamber (unreacted precursors plus by-products formed in the process), plus any gases subsequently added such as pump purge gases.

First, in the case of emissions control technologies using hydrocarbon fuel, inventory compilers should consider whether emissions to be abated originate from NF_3- or F_2-based remote plasma clean (RPC) applications (step [1] in Figure 6.4). These processes lead to the formation of significant amounts of molecular fluorine (F_2) originating from the conversion of NF_3 into F_2 or the limited utilization efficiency of F_2 (when the latter is used as a cleaning precursor). When the exhaust gases contain large amounts of F_2 and when hydrocarbon-fuel-based combustion emissions control technology is used, direct reaction with the hydrocarbon fuel and F_2 to form CF_4 can occur.[11,12,13] Unless the emissions control system manufacturer (referred to below as the "original equipment manufacturer" or OEM") or the electronic devices manufacturer can certify that the rate of conversion from F_2 to CF_4 or from NF_3 to CF_4 is <0.1 percent on a mass basis, a default value of $AB_{NF3,CF4} = 0.093$ or $AB_{F2,CF4} = 0.0116$ should be used in Equations 6.7 (Tier 2a/2b) or Equation 6.15 (Tier 2c/3a) to estimate the amount of CF_4 produced within and emitted from the emissions control device (step [2] in Figure 6.4).

Second, inventory compilers should verify whether site-specific emissions control technologies are suitable for the gas to be abated (step [3] in Figure 6.4). In doing so, inventory compilers should consult Table 6.16, where an 'X' indicates which technology is, in principle, capable of abating a certain gas. Definitions of common emissions control technologies are provided in the footnotes of Table 6.16. Note that the absence of an 'X' in Table 6.16 for a particular combination of gas and emissions control technology does not necessarily preclude the ability of the technology to abate a particular gas, but such ability should be supported by experimental data from the original equipment manufacturer (OEM) or the electronic devices manufacturer. Because new emissions control technologies could emerge, a 'T' in last row of Table 6.16 indicates that, to be considered as being suitable for treating a specific gas, the OEM or the electronic devices manufacturer would need to provide testing data to show that, when the new emissions control technology is tested under representative gas flow conditions, defaults (or site-specific) DREs can be achieved using an industry-accepted measurement methodology that accounts for dilution.[14,15,16]

Third, inventory compilers should verify that emissions control systems have been tested and are certified by the OEM(s) to meet the default DRE values indicated in Table 6.17 (step [4] in Figure 6.4). To do so, the reporting facility should define its worst-case scenarios as the highest total FC or N_2O flows through each model of emissions control systems (gas by gas and process type by process type across the facility) and highest total flow scenarios (with N_2 dilution accounted for, see step [6]), and the reporting facility should request the emissions control equipment manufacturer(s) to certify that the default DREs can be met in the worst-case scenarios for each model of emissions control systems. In the case that the OEM(s) cannot certify that the emissions control system(s) can meet the default DRE values of Table 6.17 (step [5] of Figure 6.4), the corresponding DRE value should be set to zero (0 percent), or the reporting facility may set the DRE value using DREs measured by the electronics device manufacturer (site-specific DREs) or certified by the OEM using an industry-accepted measurement methodology for the site-specific worst case scenarios as previously described (OEM certified DREs). If a facility wishes to claim a DRE value higher than the default DRE values of Table 6.17, it should perform site specific testing (step [7] of Figure 6.4). When using site-specific DREs, a suitable DRE testing frequency should be adopted to ensure

[11] Gray, Fraser, and Afroza Banu, "Influence of CH4-F2 mixing on CF4 by-product formation in the combustive abatement of F2," Research Disclosure

[12] Czerniak, Mike, "Mechanisms for PFC Formation in CVD Applications," presented at SESHA 2018

[13] Li, Shou-Nan, Jung-Nan Hsu, Hui-Ya Shih, Shu-Jen Lin and Jen-Liang Hong (2002). "FTIR spectrometers measure scrubber abatement efficiencies." Solid State Technology, 45: 157-165.

[14] Protocol for Measuring Destruction or removal Efficiency (DRE) of Fluorinated Greenhouse Gas Abatement Equipment in Electronics Manufacturing. United States Environmental Protection Agency. EPA 430-R-10-003 (2010). https://www.epa.gov/sites/production/files/2016-02/documents/dre_protocol.pdf

[15] Guideline for Environmental Characterization of Semiconductor Process Equipment – Revision 2. International SEMATECH Manufacturing Initiative. Technology Transfer #06124825B-ENG (2009). http://www.lexissecuritiesmosaic.com/gateway/FedReg/document_4825beng.pdf

[16] JEITA Guideline for F-GHG Characterization and Management. Japan Electronics and Information Technologies Industries Association (2011). http://semicon.jeita.or.jp/committee/docs/F-GHG_guideline_20110520_en.pdf

that at least 5 percent of the installed emissions control equipment population is tested annually for a representative sample of process applications. To use OEM-specific DREs, it is *good practice* to state the test conditions and range of input process gas and total gas for which the DRE is applicable.

Fourth, to ensure that DRE values remain accurate, it is essential that facilities ensure that emissions control equipment is installed, maintained and operated per manufacturer's specifications. Proper operation requires all parameters to be within manufacturer's specifications, including items such as vacuum pumps' purges, fuel / oxidizer settings, supply and exhaust flows and pressures, and utilities to the emissions control equipment (fuel gas flow and pressure, calorific value, water quality, flow & pressure, extract flow and pressure, etc.). Please note that not exceeding the emissions control equipment suppliers' maximum flow specifications requires that all gases, including post-process-chamber purges, are taken into account. Also note that some vacuum pumps' purge flow indicators are inaccurate and could deliver higher-than-indicated purge flows, exceeding the emissions control equipment suppliers' maximum flow specifications. Accurate flows can be determined using a calibrated portable mass flow meter (MFM) with a minimum accuracy of +/- 5 percent. It is suggested to perform calibration every time a vacuum pump is serviced or exchanged.

TABLE 6.16 (NEW)
EMISSIONS CONTROL EQUIPMENT SUITABILITY TABLE FOR DESTRUCTION REMOVAL EFFICIENCY (DRE) OF PROCESS GHG EMISSIONS

Emissions Control Equipment Technology	Process GHG Emission														
	CF_4	C_2F_4	C_2F_6	C_3F_8	C_4F_6	$c\text{-}C_4F_8$	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	CH_3F	C_2HF_5	NF_3	SF_6	N_2O
Cartridge (Media consumed)						X			X				X	X	X
Catalyst (Media not consumed)	X												X	X	X
Hot-wet (electrical) < 850° C															
Hot-wet (electrical) > 850° C				X	X	X							X		
Plasma	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Combustion	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
New technology	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T

'X' indicates that the technology is potentially suitable to use the default DRE for the particular gas.

"T" indicates that, to be considered as being suitable for treating a specific gas, the OEM would need to provide testing data to show that, when the new emissions control technology is tested on worst-case gas flow conditions, defaults (or site-specific) DREs can be achieved using an industry-accepted measurement methodology that accounts for dilution.

Emissions Control Equipment technology definitions:

Cartridge – Any form of dry-bed passive gas treatment, either heated or working at ambient-temperature. The active media is consumed by reaction with the target gas.

Catalyst – This includes wet or dry beds, possible heating of the catalyst bed, and possible wet pre- or post-scrubbing. The media is not consumed by reaction with the target gas, it simply reduces the energy barrier of the reaction chemistry.

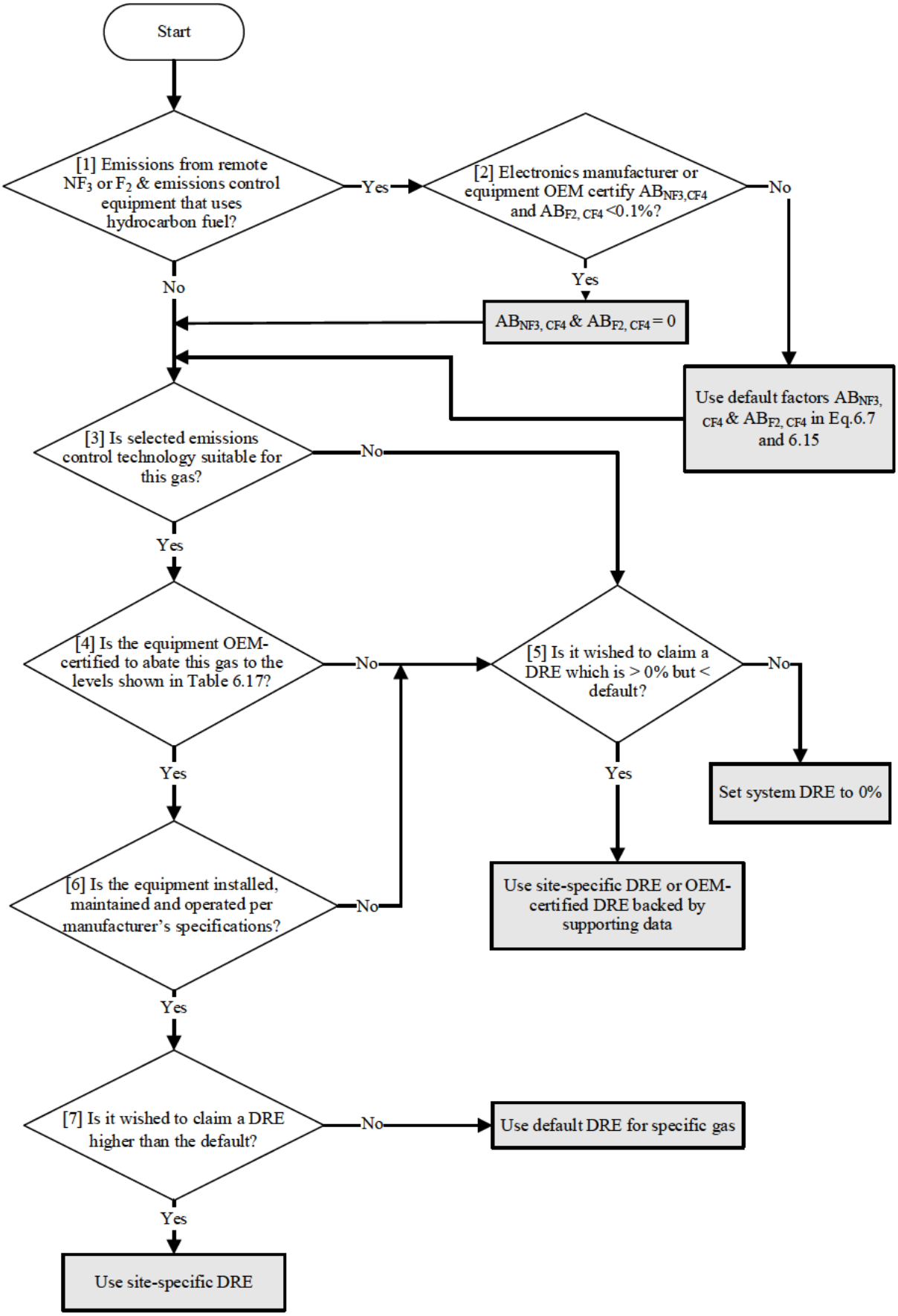
Hot-wet – This includes emissions control equipment described as "thermal wet" and indicates electrical heating followed by wet scrubbing. May also include a pre-wet scrubber.

Plasma – This involves the use of plasmas (e.g. RF, DC, or microwave) operated at atmospheric or sub-atmospheric pressures potentially combined with wet or dry scrubbing of by-products. May also include introduction of water, air, hydrogen and/or oxygen as chemical reagents.

Combustion – This includes all configurations of fuel combustion and reaction zone design, water- or air-cooled, and dry or wet post-scrubbing.

New Technology – This is to account for the possibility of new emissions control technologies emerging that are not included in the categories above.

Figure 6.4 (New) Decision tree for process GHG emission control equipment default emission factors



Note: references to equipment in the above figure mean emission control equipment.

TABLE 6.17 (UPDATED)
TIER 2 DEFAULT DRE PARAMETERS FOR ELECTRONICS INDUSTRY PROCESS GAS EMISSIONS REDUCTION TECHNOLOGIES (DECIMAL FRACTION)

Process Gas	CF_4	C_2F_4	C_2F_6	C_3F_8	C_4F_6	c-C_4F_8	C_4F_8O (b)	C_5F_8 (a)	CHF_3	CH_2F_2	CH_3F	C_2HF_5 (a)	NF_3	SF_6	N_2O
DRE	0.89	0.98	0.98	0.99	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.98	0.95	0.96	0.60

Source: Data collected under the U.S. EPA Greenhouse Gas Reporting Rule (GHGRP, 40 U.S. Code of Federal Regulations (CFR) part 98; Subpart I) and survey of industrial facility and original equipment manufacturers (OEMs) data conducted by the authors of Chapter 6.

Notes: The average DRE values were derived from individual experimental DRE data points measured under actual or representative production conditions for each specific gas, using industry-accepted measurement protocols.

a) Insufficient data to determine a meaningful average value; analogue used instead (see below)

b) No data available to determine a meaningful average value; analogue used instead (see below)

c) C_4F_8 is used as the analogue for C_5F_8, and C_4F_8O as it has 4-carbon. C_2F_6 is used as the analogue for C_2HF_5 and C_2H_5F as it is linear 2-carbon. For future compounds, apply C_4F_8 for any cyclic compound, and follow linear analogue relative to C for those remaining.

6.2.2.2 FLUORINATED LIQUIDS

TABLE 6.18 (NEW)
TIER 1 DEFAULT EMISSION FACTORS FOR FLUORINATED LIQUIDS

Representative Fluorinated Liquids	Electronics Industry Sector		
	Semiconductor or MEMS heat transfer fluid applications during manufacturing (kg/m^2)	**Semiconductor or MEMS testing, packaging and soldering (kg/kpcs)**	**Display heat transfer fluid applications during manufacturing (kg/m^2)**
HFE-449sl	0.06	1×10^{-4}	0.00002
C_6F_{14}	0.07	3×10^{-5}	0.00004
PFPMIE	0.04	1×10^{-5}	0.00004

Note:

1. The default emission factors for semiconductor manufacturing from heat transfer fluid applications are based on the arithmetic average of the emission factors for the United States, Europe and Taiwan, Province of China. The US emission factors are based on reporting from several manufacturers in 2016. The European emission factors are based on reporting from four facilities, averaged over three years. The Taiwan emission factors are based on reporting from manufacturers representing 95% market share, averaged over five years. For all regions, the number of fluorinated liquids emitted was ten or more; these fluorinated liquids were sorted into three groups of chemically similar fluorinated liquids represented by the fluorinated liquids in the table. HFE-449sl is used to represent hydrofluoroethers; C_6F_{14} is used to represent fully fluorinated liquids manufactured by 3M™; and PFPMIE is used to represent fully fluorinated liquids manufactured by Solvay™.

2. Default emission factors for semiconductor testing, packaging, and soldering are based on reporting by semiconductor manufacturers in Taiwan, Province of China, averaged over three and a half years. These manufacturers represent 80% of the market share in Taiwan, Province of China.

3. The default emission factors for display are based on reporting by display manufacturers in Taiwan, Province of China, averaged over three years. These manufacturers represent 90% of market share in Taiwan, Province of China. The number of fluorinated liquids emitted was seven; these fluorinated liquids were sorted into three groups of chemically similar fluorinated liquids represented by the fluorinated liquids in the table.

4. There is no heat transfer fluid Tier 1 default for PV and thus the only solution for estimating emissions of fluorinated liquids from these subsectors is the Tier 2 method.

5. There is no Tier 1 default for substrate cleaning and, therefore, the Tier 2 method should be used to estimate emissions from this source.

6.2.3 Choice of activity data

Activity data for the electronics industry consists of data on gas consumption and/or production figures (surface area of substrate used during the production of electronic devices, e.g. silicon, glass). For the more data-intensive Tier 2 and Tier 3 methods, gas consumption data is necessary at the facility, substrate-size, process-type, or recipe levels, depending on the Tier. See the guidance regarding the calculation and apportioning of gas consumption under "Choice of Method." For the Tier 1 methods, inventory compilers will need to determine the total surface area of electronic substrates used during the production of electronic devices for a given year. The best sources of either gas usage data or substrate area data are the owners and operators of the electronics manufacturing facilities in each country. However, if it is not possible to obtain the activity data from the owners and operators, Tier 1 estimates may be developed using data on substrate area that is available from purchasable databases. Silicon consumption may be estimated using an appropriate edition of the World Fab Forecast (WFF) database, published quarterly by Semiconductor Equipment & Materials International (SEMI). The database contains a list of plants (production as well as R&D, pilot plants, etc.) worldwide, with information about location, design capacity, wafer size, product type (including MEMS), and more. Other databases are available e.g., IC Insights, Gartner and VLSI.[17, 18, 19] Similarly, SEMI's 'Flat Panel Display Fabs on Disk' database provides an estimate of glass consumption for global TFT-Display manufacturing. IHS provide market data on the Solar/PV and display industries.[20]

Table 6.7 of the *2006 IPCC Guidelines* provided design capacity figures, but these values, which were estimated for 2003 through 2005, are no longer accurate. Table 6.7 is not updated in this *2019 Refinement* because the update would lose its accuracy very quickly given the rapid pace of growth and change in the electronics industry. Nevertheless, the following guidance remains applicable to design capacity data extracted from the purchasable databases above. Note that electronic devices manufacturing plants may not be operated at design capacities for sustained periods, such as a full year, as production typically fluctuates depending on product demand. For semiconductor manufacturing, publicly available industry statistics show that the global annual average capacity utilisation during the period 1991 – 2000 varied between 76 and 91 percent, with an average value of 82 percent and most probable value of 80 percent. When country-specific capacity utilisation data are not available, the suggested capacity utilisation for semiconductor manufacturing is 80 percent, which should be used consistently for a time series of estimates. For display manufacturing, 2016 fab capacity utilisation ranged between 76 and 91 percent.[21] For PV manufacturing, published capacity utilisation data ranges between 77 – 92 percent, with the average for the years 2003 and 2004 of 86 percent. Therefore, 86 percent is the recommended default figure to use for C_u (see Equation 6.1).

When estimating emissions during PV manufacture, one should account for the fraction of the industry that actually employs FCs (F_{PV} in Equation 6.1).

6.2.4 Completeness

Completeness for electronics manufacturing requires accounting for all fluorinated GHGs, N_2O (see section 6.1.1) and fluorinated liquids (see Table 6.5[22]) emitted from all emissions sources (see Table 6.1) at all facilities in all electronics manufacturing subsectors (see Table 6.2) in a country. Complete accounting of emissions from the electronics industry should be achievable in most countries because there are a limited number of companies and plants. Inventory compilers can contact national or international industry associations (e.g., the appropriate national or regional Semiconductor Industry Association) and/or FC suppliers to obtain contact information for electronics manufacturers in their countries. Note that national statistical databases usually do not provide detailed information about electronic devices manufacturing plants, and information about the manufacturing capacities and utilization of such plants is often considered confidential (e.g. actual surface area of substrate used or quantity of final product produced). Nevertheless, commercially-available databases provide facility-specific information

[17] http://www.icinsights.com/services/global-wafer-capacity/

[18] https://www.gartner.com

[19] https://www.vlsiresearch.com/

[20] https://technology.ihs.com/

[21] https://electroiq.com/2016/11/display-panel-makers-increase-fab-utilization-rate-to-90-in-q4-2016/.

[22] Note that the list of fluorinated liquids in Table 6.5 is not exhaustive and that additional fluorinated liquids may be used. Thus, for completeness purposes, inventory compilers should check whether any fluorinated liquids other than those listed in Table 6.5 may be used at any particular facility

with production capacity estimates that can be used for the Tier 1 method (see section 6.2.3 "Choice of activity data").

FC Consumption: Generally, electronics devices manufacturers will have good records of consumption of FC gases, N_2O, and fluorinated liquids. In compiling annual consumption of the relevant chemicals, completeness requires that the inventory of gases and fluorinated liquids account for the mass or volume of such chemicals stored in containers at the beginning and at the end of the year, acquisitions during the year through purchases and other transactions, but also transfers of chemicals and of equipment that may contain chemicals, including heels. Also, when apportioning gas consumption between process types, inventory compilers should ensure that the apportioning model does not omit or double count consumption for any particular process type.

By-Product Generation: Completeness also requires tracking emissions of all FC by-products that result from reactions of input gases with each other, with carbon-containing films, and with hydrocarbon fuels. See the guidance on these by-product emissions in section 6.2.1.1.

Fluorinated Liquids: A complete accounting of fluorinated liquids requires accounting for all uses of these liquids in all electronics subsectors in the country. As discussed in section 6.1.1, fluorinated liquids are used to control temperatures during manufacturing, to test devices, for soldering, and for cleaning of substrates and other parts. Because the Tier 1 default emission factors do not cover all of these uses in all subsectors, using the Tier 1 method for fluorinated liquids could affect the completeness of emissions estimates. Specifically, insufficient data was available to devise Tier 1 emission factors for the use of fluorinated liquids in cleaning substrates for all sub-sectors, as well as for heat transfer applications in the PV sub-sector, and for testing, packaging and soldering in the display and PV sub-sectors. Thus, for such applications and sub-sectors, inventory compilers should check whether fluorinated liquids are used at any particular facility, and, to ensure completeness, use only the Tier 2 method in such cases.

Other products, research and development (R&D) and tool commissioning activities: Inventory compilers should be aware that new guidance was added to Volume 3, Chapter 8 of the *2019 Refinement* to account for fluorochemicals emissions used to waterproof electronic circuits. As mentioned above, new products and processes may be introduced from time to time during the course of electronic devices manufacturing, and *good practice* for this industry is to incorporate a mechanism that accounts for reporting the introduction of new products and processes that may affect emissions estimates, and for periodically reporting newly measured emission factors to the IPCC emission factors database (EFDB). Note that it is *good practice* to include gas purchases in support of R&D and tool commissioning activities in the consumption figures used for a particular facility.

6.2.5 Developing a consistent time series

Use of FCs and N_2O by the semiconductor industry began in the late 1970s and accelerated significantly beginning in the early 1990s. Determining a base year emissions level may present difficulties because few data are available for emissions occurring before 1995. If historical emissions estimates were based on simple assumptions (e.g., use equals emissions), then these estimates could be improved by applying the methods described above. Emission factors for the electronics industry have also been revised since the publication of the *2006 IPCC Guidelines* and the consistency of the time series could be improved by applying the revised emission factors to the full time series. The 2019 Tier 2a, 2b or 2c emission factors can be applied to the historical emissions previously calculated with the 2006 Tier 2a or Tier 2b emission factors. For the semiconductor sub-sector, if the wafer size manufactured is not known, 2019 Tier 2a emission factors should be applied to data from 2005 or later. Due to the prevalence of 200 mm or smaller wafer sizes prior to 2005, the 2019 Tier 2b emission factors for 200 mm should be applied to data from 2004 or earlier instead of the Tier 2a emission factors. If historical data are not available to permit use of a Tier 3 or 2 methods, then the Tier 1 method using default emission parameters can be used retrospectively. In this case, it is *good practice* to use the Tier 1 factors from the *2006 IPCC Guidelines* for years through 2010. For 2011 and the following years, it is *good practice* to use the Tier 1 factors from the *2019 Refinement* for most sub-sectors; however, for the semiconductor sub-sector, in cases where it is known that the wafer size manufactured is 200 mm or smaller, it is *good practice* to continue to use the Tier 1 factors from the *2006 IPCC Guidelines*. Both Tier 1 and Tier 2 could then be applied simultaneously for the years in which more data become available to provide a comparison for purposes of splicing the results of the Tier 1 and Tier 2 methods. This should be done according to the guidance provided in Volume 1, Chapter 5.

In order to ensure a consistent emissions record over time, an inventory compiler should recalculate FC and N_2O emissions for all years reported whenever emissions calculation procedures are changed (e.g., if an inventory compiler changes from the use of default values to actual values determined at the plant level). If plant-specific data are not available for all years in the time series, the inventory compiler will need to consider how current plant data can be used to recalculate emissions for these years. It may be possible to apply current facility-specific emission parameters to sales data from previous years, provided that facility operations have not changed

substantially. Such a recalculation is required to ensure that any changes in emission trends are real and not an artefact of changes in procedure. If substantial changes have occurred at a facility which prevent full recalculation or new variables are introduced in the equations such as emissions control equipment uptime or apportioning abated gas use to process type, the inventory compiler can apply both the previously used and the new method for at least one year and preferably more to provide a comparison. If the trends observed using this overlap splicing technique are not consistent then use of an alternate technique provided in Volume 1, Chapter 5 should be implemented.

6.3 UNCERTAINTY ASSESSMENT

6.3.1 Emission factor uncertainties

As discussed in the Choice of Method section, the Tier 1 emission factors are expected to be highly uncertain because they do not account for the identities and quantities of the gases actually consumed, for the process types in which those gases are used, for wafer size (for semiconductors), or for the use of emission control systems. A quantitative estimate of the uncertainty of the Tier 1 emission factors (EFs) could not be developed based on the data available, but gas consumption is known to vary widely by device type (e.g., memory vs. logic for semiconductor manufacturing), and gas-specific EFs are known to vary widely by process type, by wafer size and by the fraction of emissions abated. Thus, the Tier 1 method is the least accurate estimation method and should be used only in cases where facility-specific data are not available.

The relative uncertainties at the 95 percent confidence level, estimated for each emission factor of the Tier 2b and 2c methods, are shown in Tables 6.19, and 6.20 for semiconductor manufacturing. It was not possible to estimate the uncertainty of the Tier 2a emission factors for the semiconductor sub-sector and of the Tier 2c emission factors for the display sub-sector due to lack of data. To estimate uncertainties, the relative standard deviations for each Tier 2c entry were first calculated across all experimental data points (measured utilization efficiencies and by-product emission factors) for each particular gas i, process type, and wafer size. The relative standard deviations were then rounded to one significant figure and doubled to estimate uncertainties at the 95 percent confidence level. The same method was used for the Tier 2b entries for each gas and wafer size. The large uncertainties of Tier 2 emission factors are due to the wide distributions of individual experimental emission factors, which depend on process conditions and on the design of the process chambers. Because process conditions such as gas flows, pressure, temperature, or plasma power can vary widely for a particular gas and process chamber design, the utilization efficiencies or by-product emission factors can also significantly change from one process recipe to another, even within a particular process type. Although electronic devices manufacturers can typically run hundreds or even thousands of different recipes (with differing process conditions and manufacturing tool types) – providing an averaging effect over all recipe-specific emission factors –, actual emission factors (for any particular facility) may nevertheless differ from the Tier 2c, 2b, or 2a default emission factors. Because the Tier 2a and Tier 2b methods provide lower resolution than the Tier 2c method (Tier 2a emission factors are only disaggregated by input gas i, and Tier 2b emission factors are only disaggregated by input gas and by wafer size), the overall uncertainty of the Tier 2a and 2b methods can be expected to be higher than for the Tier 2c method.

The impact of the Tier 2 emission factors' uncertainties on the overall emissions estimate for a particular electronic device manufacturing facility can be estimated by combining the probability distribution functions (PDFs) of the emission factors. Approaches to combine uncertainties include the propagation of error method and Monte Carlo simulations (see Volume 1, Chapter 3 of the *2019 Refinement*). For electronic devices manufacturing, the Monte Carlo approach is suggested because the propagation of error method theoretically requires that the standard deviation divided by the mean value of a variable is less than 0.3, which is often not the case for Tier 2 emission factors (Id.).

Using the Tier 3a method can help significantly reduce reporting uncertainties, even in the case of a hybrid method when a partial Tier 3a method is used in combination with the Tier 2c method. This is because the standard deviations of emission factors for a specific recipe or for a family of similar recipes (Tier 3a factors) can be much lower than those of default Tier 2c factors. Indeed, when running a particular recipe, process conditions such as gas flows, temperature, pressure, or plasma power are tightly controlled, and the wafer-to-wafer variability of emission factors is typically less than 5 percent in terms of relative standard deviations. When using Monte Carlo simulations to estimate the uncertainty of combined Tier 2c / Tier 3a emissions estimates for a particular facility, reporters should use a PDF describing the distribution functions of each Tier 2b or Tier 3a factor and combine such functions to determine the impact of the individual EF uncertainties on the uncertainty of the overall emissions estimate. Normal, lognormal, or other appropriate functions should be used to describe the PDFs of the variables. Then, suitable PDFs should be used to describe the variations of activity data (e.g. heel, input gas consumption, emissions control equipment efficiency – see Section 6.3.2) and such PDFs should be combined with those of the emission factors to estimate the uncertainty of the total emissions calculations.

TABLE 6.19 (UPDATED)
ESTIMATES OF RELATIVE UNCERTAINTIES (%) OF TIER 2B EMISSION FACTORS FOR SEMICONDUCTOR MANUFACTURING, 95 PERCENT CONFIDENCE INTERVALS.

Process Gas	CF_4	C_2F_6	C_3F_8	C_3F_8 Remote	C_4F_6	c-C_4F_8	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	CH_3F	C_2HF_5	NF_3 Remote	NF_3	SF_6	N_2O TFD	N_2O Other	COF_2	F_2
≤200 mm wafer size																			
$(1\text{-}U_i)$	†	40	†	NA	200	†	†	†	100	160	†	100	200	150	†	NA	NA	NA	NA
B_{CF4}	NA	120	†	NA	200	†	†	NA	80	140	NA	100	180	†	†	NA	NA	NA	NA
B_{C2F6}	400	NA	NA	NA	400	†	†	†	200	120	†	140	NA	†	†	NA	NA	NA	NA
B_{C3F8}	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{C5F8}	†	NA	NA	NA	NA	†	NA	NA	†	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{CHF3}	120	†	NA	NA	†	†	NA	†	NA	†	NA	NA	NA	NA	†	NA	NA	NA	NA
300 mm wafer size																			
$(1\text{-}U_i)$	60	†	†	†	200	140	NA	180	120	200	140	NA	400	200	140	120	NA	NA	NA
B_{CF4}	NA	†	†	NA	400	200	NA	160	200	200	200	NA	600	†	400	NA	NA	NA	NA
B_{C2F6}	200	NA	†	NA	400	160	NA	200	400	200	200	NA	NA	400	200	NA	NA	NA	NA
B_{C3F8}	NA	NA	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F6}	†	NA	NA	NA	NA	†	NA	NA	†	NA	40	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F8}	400	NA	NA	NA	†	NA	NA	NA	†	†	†	NA	NA	NA	NA	NA	NA	NA	NA
B_{CH3F}	200	NA	†	NA	†	†	NA	NA	400	†	NA	NA	NA	†	†	NA	NA	NA	NA
B_{CH2F2}	†	NA	NA	NA	†	†	NA	NA	†	NA	†	NA	NA	†	†	NA	NA	NA	NA
B_{CHF3}	200	NA	†	NA	400	200	NA	400	NA	180	200	NA	NA	400	†	NA	NA	NA	NA

† Insufficient data was available to calculate uncertainty.

TABLE 6.20 (UPDATED)
DEFAULT ESTIMATES OF RELATIVE UNCERTAINTIES (%) OF TIER 2C EMISSION FACTORS FOR SEMICONDUCTOR MANUFACTURING (≤200 MM), 95 PERCENT CONFIDENCE INTERVALS

Process Gas	CF_4	C_2F_6	C_3F_8	C_4F_6	$c\text{-}C_4F_8$	C_4F_8O	C_5F_8	CHF_3	CH_2F_2	CH_3F	C_2HF_5	NF_3	SF_6	N_2O TFD	N_2O Other	COF_2	F_2
Etching or Wafer Cleaning (EWC)																	
(1-U_i)	40	60	NA	200	140	NA	†	100	160	†	100	140	100	NA	NA	NA	NA
B_{CF4}	NA	180	NA	200	200	NA	NA	80	140	NA	100	†	†	NA	NA	NA	NA
B_{C2F6}	400	NA	NA	400	400	NA	†	200	120	†	140	†	†	NA	NA	NA	NA
B_{C5F8}	†	NA	NA	NA	†	NA	NA	†	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{CHF3}	120	†	NA	†	†	NA	†	NA	†	NA	NA	NA	†	NA	NA	NA	NA
Remote Plasma Cleaning (RPC)																	
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	200	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	180	NA	NA	NA	NA	NA
In-situ Plasma Cleaning (IPC)																	
(1-U_i)	†	40	†	NA	†	†	NA	NA	NA	NA	NA	180	NA	NA	NA	NA	NA
B_{CF4}	NA	120	†	NA	†	†	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA
B_{C2F6}	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thin Film Deposition (TFD)																	
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	†	NA	NA	NA
Other																	
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	†	NA	NA

† Insufficient data was available to calculate uncertainty.

TABLE 6.21 (UPDATED)
DEFAULT ESTIMATES OF RELATIVE UNCERTAINTIES (%) OF TIER 2C EMISSION FACTORS FOR SEMICONDUCTOR MANUFACTURING (300 MM), 95 PERCENT CONFIDENCE INTERVALS

Process Gas	CF_4	C_2F_6	C_3F_8	C_4F_6	c-C_4F_8	C_5F_8	CHF_3	CH_2F_2	CH_3F	NF_3	SF_6	N_2O TFD	N_2O Other	COF_2	F_2
Etching and Wafer Cleaning (EWC)															
(1-U_i)	60	†	†	200	140	180	120	200	140	180	140	NA	NA	NM	NM
B_{CF4}	NA	†	†	400	200	160	200	200	200	200	400	NA	NA	NM	NM
B_{C2F6}	200	NA	†	400	160	200	400	200	200	200	200	NA	NA	NM	NM
B_{C3F8}	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA	NA	NA	NA	NA
B_{C4F6}	†	NA	NA	NA	†	NA	†	NA	40	NA	NA	NA	NA	NA	NA
B_{C4F8}	400	NA	NA	†	NA	NA	†	†	†	NA	NA	NA	NA	NA	NA
B_{CH3F}	200	NA	†	†	†	NA	400	†	NA	†	†	NA	NA	NA	NA
B_{CH2F2}	†	NA	NA	†	†	NA	†	NA	†	†	†	NA	NA	NA	NA
B_{CHF3}	200	NA	†	400	200	400	NA	180	200	200	†	NA	NA	NA	NA
Remote Plasma Cleaning (RPC)															
(1-U_i)	NA	NA	†	NA	NA	NA	NA	NA	NA	400	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	600	NA	NA	NA	NA	NA
In-situ Plasma Cleaning (IPC)															
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	100	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA
In-situ Thermal Cleaning (ITC)															
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA
B_{CF4}	NA	NA	NA	NA	NA	NA	NA	NA	NA	†	NA	NA	NA	NA	NA
TFD															
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	120	NA	NA	NA

TABLE 6.21 (UPDATED) (CONTINUED)
DEFAULT ESTIMATES OF RELATIVE UNCERTAINTIES (%) OF TIER 2C EMISSION FACTORS FOR SEMICONDUCTOR MANUFACTURING (300 MM), 95 PERCENT CONFIDENCE INTERVALS

Process Gas	CF_4	C_2F_6	C_3F_8	C_4F_6	$c\text{-}C_4F_8$	C_5F_8	CHF_3	CH_2F_2	CH_3F	NF_3	SF_6	N_2O TFD	N_2O Other	COF_2	F_2
Other															
(1-U_i)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	†	NA	NA

† Insufficient data was available to calculate uncertainty.

6.3.2 Activity data uncertainty

Activity data uncertainty originates from multiple variables and particular attention should be taken to minimize the uncertainty and the potential bias of the measurements or of the models used to estimate activity data.

For the Tier 1 method, the unit of activity is annual production, preferably measured as the surface area of substrate used during the production of electronic devices. Because annual production may be considered confidential by electronic devices manufacturers, it may be difficult to accurately estimate production at the facility level, and, consequently, at the country level. Further, if annual production is calculated as the product of annual plants' manufacturing capacity and of utilization efficiencies provided by secondary sources (i.e. commercial databases), additional sources of uncertainties can be introduced. This is because manufacturing capacity figures available in commercial databases may be inaccurate, and because capacity utilization figures are often averaged for the global industry or may only be available for certain types of electronic products (e.g. memory, logic, discrete devices). Therefore, inventory compilers should keep in mind that annual production figures calculated from secondary sources may not accurately represent country-specific activities. Because of such limitations, the Tier 1 method should only be used in cases where facility-specific data are not available.

For the Tier 2 and Tier 3 methods, gas consumption constitutes the principal unit of activity to estimate emissions and can therefore be a major potential source of uncertainty and errors. Gas consumption can be either measured or estimated from data on gas purchases, and requires knowledge of the heel, the unused gas returned to gas suppliers in the shipping containers. Using facility-specific heel measurements or accurate heel modelling as opposed to using the default heel value of 0.1 can help reduce uncertainty and error. Another major source of uncertainty and potential errors in activity data is related to gas consumption apportioning, where consumption may need to be apportioned by wafer size (Tier 2b), by specific process type (Tier 2c and, to a limited extent, Tiers 2a and 2b), and/or by specific recipes or families of similar recipes (Tier 3a).

To minimize apportioning uncertainty and increase accuracy, it is *good practice* to implement a gas consumption monitoring system using direct measurement to apportion gas use at the process type-, stack system- or facility-level as appropriate. This can be achieved by various methods including monitoring and integrating the signal of MFCs and using weigh scales; however, it is noted that measurement to specific tools or processes may not be feasible.

Finally, activity data related to the effective use of emissions control systems should be accurately assessed as part of any Tier 2 or Tier 3 method to minimize uncertainties and potential errors. In particular, accurately estimating the fraction of gases used or produced in processes with emissions control technologies (a_i, a_k), the average uptime of emissions control systems (UT), and the overall reduction of input gases and by-products (D_i, $D_{k,i}$) is essential in producing reliable emissions estimates. With respect to the calculation of a_i and $a_{k,i}$ in the Tier 2a or Tier 2b estimates, using default gamma values ($\gamma_{i,p}$ and $\gamma_{k,i,p}$) to estimate the ratio of the uncontrolled emissions per tool of input gases 'i' or by-products 'k' from thin film deposition tools to the uncontrolled emissions per tool of input gases 'i' or by-products 'k' from etch and wafer cleaning or other tools, introduces a significant source of uncertainty and potential errors (see Table 6.22). Thus, to reduce uncertainty, avoiding the use of gamma default values by apportioning gas consumption by process type (i.e. using the Tier 2c method rather than the Tier 2a or Tier 2b methods) is encouraged.

For fluorinated liquids, the uncertainty of the Tier 2 method will depend on the accuracy of the inventory method. Accurately tracking the number of fluorinated liquid containers at the beginning and at the end of the year, as well as the total nameplate capacity of equipment that uses fluorinated liquids and that is newly installed in or removed from the fab during the reporting year will ensure that uncertainties are minimized and that fluorinated liquid emissions estimates are reliable.

As described in section 6.3.1, Monte Carlo simulations can be used to estimate the impact of uncertainties in activity data by measuring or modelling the probabilities of distributions functions (PDF) of uncertain activity data, and by combining the PDFs of activity-related variables and the PDFs of emission factors.

TABLE 6.22 (NEW)
TIER 2A, 2B AND 3B METHODS – ESTIMATES OF RELATIVE UNCERTAINTIES (%) FOR $\gamma_{I,P}$ AND $\gamma_{K,I,P}$ (SEMICONDUCTOR AND MEMS MANUFACTURING UNDER CERTAIN CONDITIONS), 95 PERCENT CONFIDENCE INTERVALS

Tier, input gas ($\gamma_{i,p}$) vs. byproduct ($\gamma_{k,i,p}$), and wafer size	CF4 (IPC or ITC) / EWC	C2F6 IPC / EWC	c-C4F8 IPC / EWC	NF3 (IPC or ITC) / EWC	SF6 IPC / EWC	NF3 RPC / EWC	CF4 RPC / EWC	C3F8 RPC / EWC	N2O TFD / other
Tier 2a*									
$\gamma_{i,p}$	240†	260	200	180†	340				
$\gamma_{CF4,i,p}$	NA	>260	>200	>180	>340				
$\gamma_{C2F6,i,p}$	NA	NA	NA	NA	>340				
Tier 2b									
$\gamma_{i,p}$ (≤200 mm wafer size)	240†	260	200	180†	340				
$\gamma_{CF4,i,p}$ (≤200 mm wafer size)	NA	>260	>200	>180	>340				
$\gamma_{C2F6,i,p}$ (≤200 mm wafer size)	NA	NA	NA	NA	>340				
$\gamma_{i,p}$ (300 mm wafer size)	NM	NM	NM	280†	NM				
$\gamma_{CF4,i,p}$ (300 mm wafer size)	NA	NA	NA	>280	NA				
Tier 3b									
$\gamma_{i,p}$ (both ≤200 mm and 300 mm wafer size)	240†	260	200	180†	340	320	NM	NM	400
$\gamma_{CF4,i,p}$ (both ≤200 mm and 300 mm wafer size)	NA	>260	>200	>180	>340	>320	NA	NA	NA
$\gamma_{C2F6,i,p}$ (both ≤200 mm and 300 mm wafer size)	NA	NA	NA	NA	>340	NA	NA	NA	NA
$\gamma_{i,p}$ (≤200 mm wafer size)	240†	260	200	180†	340	160	NM	NM	160
$\gamma_{CF4,i,p}$ (≤200 mm wafer size)	NA	>260	>200	>180	>340	>160	NM	NA	NA
$\gamma_{C2F6,i,p}$ (≤200 mm wafer size)	NA	NA	NA	NA	>340	NA	NA	NA	NA
$\gamma_{i,p}$ (300 mm wafer size)	NM	NM	NM	280†	NM	320	NM	NM	400
$\gamma_{CF4,i,p}$ (300 mm wafer size)	NA	NA	NA	>280	NA	>320	NA	NA	NA

Source: Survey of industrial facility data conducted by the authors of Chapter 6.

*The uncertainties for the Tier 2a gamma weighting factors are estimated using the higher of the uncertainties for the gamma factors for 200- and 300-mm wafer manufacturing for that input gas and process type combination.

† The gamma values for (IPC or ITC)/EWC for 200 mm, and their corresponding uncertainties, were developed based on IPC only, and the values (and corresponding uncertainties) for 300 mm were developed based on the total emissions and tool count from ITC and IPC. Gamma is assigned based on analogy due to similar emission factors for IPC and ITC, where known, for the same gas and wafer size. For cases where no gamma has been measured and a general default gamma factor of 10 is used (see footnote to Table 6.8), the inventory compiler may assume an uncertainty of 500 percent.

6.4 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC), REPORTING AND DOCUMENTATION

6.4.1 Quality Assurance / Quality Control (QA/QC)

It is *good practice* to conduct quality control checks as outlined in Volume 1, Chapter 6 of the *2019 Refinement*, and an expert review of the emissions estimates. Additional quality control checks as outlined in Volume 1 and quality assurance procedures may also be applicable, particularly if higher tier methods are used to determine emissions from this source category. Inventory compilers are encouraged to use higher tier QA/QC for *key categories* as identified in Volume 1, Chapter 4.

Additional general guidance for higher tier QA/QC procedures is also included in Volume 1, Chapter 6 of the *2019 Refinement*. Due to the highly competitive nature of the electronics industry, provisions for handling confidential business information should be incorporated into the verification process. Methods used should be documented, and a periodic audit of the measurement and calculation of data should be considered. A QA audit of the processes and procedures should also be considered.

It should be noted that comparing Tier 2 and Tier 3a (bottom-up) estimates with Tier 3b (top-down) estimates for representative facilities could help assess the accuracy (or inaccuracy) of the various methods. The Tier 2 and Tier 3a methods are deemed 'bottom-up' approaches because they are based upon consumption at the input of the process tools, while the Tier 3b method is considered a 'top-down' approach as it is based on measuring stack-specific (end of pipe) emission factors. Thus, comparing Tier 2 (or preferably Tier 3a) estimates with Tier 3b estimates would help assess whether biases may exist between top-down and bottom-up estimates.

6.4.2 Reporting and Documentation

Care should be taken not to include emissions of HFCs used as ODS substitutes with those used in electronic devices manufacturing. It is *good practice* to document and archive all information required to produce facility-level and national emissions inventory estimates as outlined in Volume 1, Section 6.11 of the *2019 Refinement*. It is not practical to include all documentation in the national inventory report. However, the inventory should include summaries of methods used and references to source data such that the reported emissions estimates are transparent and that steps in their calculation may be retraced.

Efforts to increase transparency should take into account the protection of confidential business information related to specific gas use. Country-level aggregation of gas-specific emissions data should protect this information in countries with three or more manufacturers. Table 6.23 (Information Necessary for Full Transparency of Estimates of Emissions from Electronics Manufacturing), shows the supporting information necessary for full transparency in reported emissions estimates.

Good practice for Tier 3a and 3b is to document the development of company-specific emission factors, and to explain deviations from default values. Given confidentiality concerns, inventory compilers may wish to aggregate this information across manufacturers. In cases where manufacturers in a country have reported different emission or conversion factors for a given fluorinated compound or N_2O and for specific recipes or families of similar recipes, inventory compilers may provide the range of factors reported and used.

TABLE 6.23 (NEW)
INFORMATION NECESSARY FOR FULL TRANSPARENCY OF ESTIMATES OF EMISSIONS FROM ELECTRONICS MANUFACTURING

Data	Tier 1 (Gaseous and Liquid FCs)	Tier 2 (Liquid FCs)	Tier 2a	Tier 2b	Tier 2c	Tier 3a	Tier 3b
Emissions by FC and electronics subsector	X						
Annual production, as measured by the surface area of substrate used during the production of electronic devices, including test substrates	X						
Fraction of PV manufacturing capacity that uses FC gases	X						
For gaseous FCs, emissions by FC, electronics subsector, process type, wafer size (if relevant), and input gas vs. by-product. For liquid FCs, emissions by FC and electronics subsector.		X	X	X	X	X	X
Inventories of input gases and heat transfer fluids (inventories of containers at the beginning and end of the year, acquisitions, transfers, and (for fluorinated liquids only) nameplate capacity of equipment added or removed during the reporting year		X	X	X	X	X	X
Sizes, types, and total number of different sized containers in the facility			X	X	X	X	X
Types and densities of fluorinated liquids used in the facility		X					
Heel values used for all gases			X	X	X	X	X
Documentation describing the facility-specific apportioning model and demonstration of its accuracy			X	X	X	X	X
Consumption data for all input gases (and, except for the Tier 3b method, apportioning factors) as a function of wafer size and/or process type, as appropriate			X	X	X	X	X
Ratio of process TFD chambers running carbon containing films to total number of TFD chambers			X	X	X	X	

TABLE 6.23 (NEW) (CONTINUED)
INFORMATION NECESSARY FOR FULL TRANSPARENCY OF ESTIMATES OF EMISSIONS FROM ELECTRONICS MANUFACTURING

Data	Tier 1	Tier 2 (Fluorinated liquids)	Tier 2a	Tier 2b	Tier 2c	Tier 3a	Tier 3b
Numbers of EWC and TFD tools equipped with suitable emissions control technologies			X	X	X	X	X
Total numbers of EWC and TFD tools			X	X	X	X	X
Mass fractions of gases and by-products exhausted from tools with emissions control technologies, by process type or facility, as appropriate			X	X	X	X	X
Number and types (manufacturer, model number, technology) of emissions control systems installed in the facility, by process type or facility, as appropriate			X	X	X	X	X
Documentation describing the facility's procedure to estimate the average uptime of emissions control systems			X	X	X	X	X
Documentation describing the emissions control systems' interlock scheme or the use of back-up emissions control systems (if applicable)			X	X	X	X	X
Average uptime factor of all emissions control systems connected to process tools, by process type or facility, as appropriate			X	X	X	X	X
Overall reduction of input gases and by-products by process type or facility, as appropriate			X	X	X	X	X
Ratio of emissions control systems certified not to form CF_4 within emissions control systems to total number of emissions control systems in the facility			X	X	X	X	
Certifications by original equipment manufacturers (OEMs) that emissions control systems are designed to abate the relevant gases and that the default DREs can be met in the worst-case scenario for the facility			X	X	X	X	X
Documentation showing that emissions control equipment is maintained and operated per manufacturers' specifications			X	X	X	X	X
Measured (facility-specific) destruction removal efficiencies (when default values are not used), and actual measurement reports, including a description of the experimental conditions			X	X	X	X	X

TABLE 6.23 (NEW) (CONTINUED)
INFORMATION NECESSARY FOR FULL TRANSPARENCY OF ESTIMATES OF EMISSIONS FROM ELECTRONICS MANUFACTURING

Data	Tier 1	Tier 2 (Fluorinated liquids)	Tier 2a	Tier 2b	Tier 2c	Tier 3a	Tier 3b
Measured (facility-specific) utilization efficiencies and by-products emission factors, as well as actual measurement reports, including a description of the experimental conditions.						X	X
Flow rates of the stack systems							X

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The Relationship Between SP and HGBIK Drift Measurement Results,
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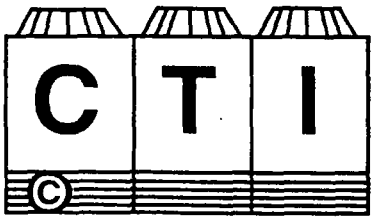
CATEGORY: DRIFT

COOLING TOWER INSTITUTE

THE RELATIONSHIP BETWEEN SP AND HGBIK DRIFT MEASUREMENT RESULTS - NEW DATA CREATES A NEED FOR A SECOND LOOK

JACK R. MISSIMER, PH.D., P.E.
DAVID E. WHEELER, P.E.
AND
KENNETH W. HENNON
POWER GENERATION TECHNOLOGIES



The studies and conclusions reported in this paper are the results of the author's own work. The paper has been presented and reviewed by the Cooling Tower Institute, and approved as a valuable contribution to cooling tower literature.

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Introduction

The CTI drift measurement code ATC-140 [1] specifies that isokinetic measurements be employed for cooling tower drift emissions measurements. The sensitive paper technique, an alternative method also referenced by the test code, provides additional information not supplied by the isokinetic test procedure. There have been few occasions, over the years when both the Sensitive Paper and HGBIK drift measurement techniques have been employed at the same location. This has allowed only periodic comparisons of the results of the two techniques. Both methods were employed at the same location during a recent test program. The results create an opportunity to revisit some of the traditionally held views of the expected relationships between the results of the two techniques. This paper compares the data supplied by each method as well as the drift rates measured by each. This paper also addresses issues relevant to the determination of the rate of the efflux from cooling towers of chemicals entrained in the drift.

Definition of Drift

There have historically been several definitions for drift including [2]:

1. the mass flux of cooling water droplets entrained from the fill and still present in liquid phase at the cooling tower exit;

2. the mass flux of liquid water at the cooling tower exit, including the recondensation droplets; and

3. the mass flux of cooling water entrained from the fill. The entrained water may be in either liquid or gaseous phase.

Drift Measurement Methodologies

Drift Measurement Methods for measuring drift can be divided into two groups:

1. sensitized surface methods; and

2. isokinetic methods.

In both methods, the sampling is conducted by traversing equal areas of the cooling tower fan stack exit plane. ATC-140 allows measurement to be conducted at any plane above the drift eliminators. The stack exit plane is the area most representative of emissions from the cooling tower. Only a limited number of field tests have been conducted comparing the results of the two methodologies, and this paper offers a new chance to revisit this issue.

Sensitized surface methods are direct methods for measuring drift. ESC's Sensitive Paper (SP) method is an example of a sensitized surface method, employing paper which "is chemically treated according to published procedures such that a droplet of water impinging on it will produce a stain whose size is related to the original droplet size and to the dynamics of its impingement. The relationship between the stain and the droplet size is obtained by calibrating

the Sensitive Paper System by means of the vibrating orifice monodisperse water droplet generator over a range of droplet sizes and impingement velocities ranging from 2.5 m/s to 15 m/s. The paper is employed in machines which offer controlled exposure of the paper to the drift droplets and protect the paper before and after the exposure period." [3]

ESC's SP technique measures droplets with diameters as small as 10 μm to ones with diameters in excess of 1000 μm. Droplets are collected by impact with the sp. The efficiency of collection si dependant on the stack velocity and droplet diameter. Droplets above 50 microns in diameter are collected at near 100% efficiency, while droplets below 10 microns are collected below 10% efficiency. The ESC data reduction algorithm compensates for the lower collection efficiency for small droplets in the range of 10μm to 50μm. Both the number of droplets and the drift rate are determined at a measurement location as a function of bin sizes (droplet diameter ranges). The total drift rate at a measurement location is the sum of the drift rates of all the bin sizes at that location. The total drift rate of a fan stack is the sum of the total drift rates of all the measurement locations. The total drift rate of a cooling tower is the sum of the total drift rates of all fan stacks. The drift droplet size distribution can likewise be characterized for a measurement location, a fan stack, and a complete tower.

There are currently two main types of isokinetic systems in use for cooling tower testing [4]. One is a wet impinger type based on the EPA Stack Gas Sampling Method 13A. The other is the Heated Glass Bead Isokinetic (HGBIK) method. Both methods may use back-up filtering systems, but the approach to filter use may differ. Isokinetic methods are indirect methods for measuring drift. These methods measure the efflux of a chemical tracer in the circulating water and determine the equivalent drift by assuming that the chemical tracer's concentration in the cooling water is the same as in the drift droplets.

Mechanisms for Drift Droplet Generation

The two primary mechanisms for the generation of droplets within the cooling tower are [5,6]:

- mechanical generation; and
  - by a pressurized spray nozzle
  - via the turbulent breakup of a gravitationally supplied stream of water from an overhead distribution box
  - by impact with cooling tower fill
  - re-entrainment of previously collected droplets on the drift eliminators. This occurs when the collected drift does not properly drain from the drift eliminators.
- condensation of the saturated tower exhaust air.

The Cooling Tower Institute (CTI) is the recognized standard setting organization for the measurement of cooling tower drift. In CTI's Isokinetic Drift Test Code, ATC-140, June 1994 [4], it is stated that "There are two basic methods for drift measurement - Isokinetic (IK) for drift rate measurement and Sensitive Surface (SS) for drift droplet size characterization." The CTI

code defines drift as droplets of circulating water which remain in the air passing through the drift eliminators. The code attempts to exclude condensed water droplets by specifying that a test be conducted under conditions in which there is no visible condensation on cooling tower surfaces.

Tower Description

The tower that was tested is a two cell counterflow cooling tower which was constructed in 1952. The cooling towers are of the coil shed type, in which the cooled water from the fill falls over a tube bundle containing the process fluid. Several modifications, including replacement of the fans and motors, have been done to the cooling tower since its original construction. Each cell contains two nominal 12 foot diameter fans, arranged parallel to the major axis of the cooling tower. The plenum area of each fan is isolated from the adjacent cell by a wall and is served by a separate water distribution system. Drift eliminators were of the wood slat type common in cooling towers of this vintage. The design water flow rate is 3000 gpm per cell. Drift measurements were made on the two fan stacks of one of the cells.

HGBIK Measurements

Selection of Chemical Tracer(s)

The HGIBK technique is dependent on the recovery of a chemical constituent of the circulating water. The selection criteria for chemical tracer compounds are:

- Stability - since the glass beads are heated to a high temperature, the tracer constituent must not be volatile or degrade at high temperatures.

- Concentration in circulating water - for reasonable collection intervals, the quantity of drift collect by the sampling apparatus will be very small. It is usually necessary to select a chemical tracer with a concentration of above 50 ppm in the circulating water in order to obtain a drift sample sufficiently above chemical analysis detection limits.

- Chemical analysis - there should be an accurate and cost efficient analysis for the tracer constituent.

- Concentration in ambient air - constituents present in the ambient air may interface with the drift analysis. High volume samplers may be used to detect the presence of tracer constituent in the ambient air. Note that there is no blank correction to the collected samples due to the influence of the ambient air.

On these bases, sodium, magnesium and calcium were selected as chemical tracers.

Drift Droplet Collection

The components of the Heated Glass Bead Isokinetic System (HGBIK or IK) are shown in Figures 1, 2 and 3. Prior to mobilization in the field, each of the sampling tubes (shown in Figure 2) was washed with warm, 10 percent by volume hydrochloric acid (HCl) and rinsed with distilled water to remove existing deposits. These tubes were then wrapped in plastic to prevent contamination during transport. Before the start of a test, the plastic was removed and the ground glass fitting of the sampling tube was clamped to the vacuum system. After installing the sampling tube, positive and negative electrical leads from a 110 VAC rheostat were connected to the heat assembly surrounding the tube. At this time, the appropriate back-up filter was also

inserted in the vacuum system downstream from the glass beads. The tube was then affixed to the support structure (Figure 2.3) for positioning over the equal area points. Once in position, a current was applied to the heat assembly, resulting in the heating of the glass beads to a temperature above the boiling point of water. After heating was begun, the vacuum pumps were started and the appropriate flow rate through the rotameter was set using the regulating valve, with this flow being a function of the local updraft air velocity. The entire assembly was rotated in order to orient the tube parallel to the direction of the local exit air flow as revealed by the telltale. This angle was measured by an electronic sensing device which generates a resistive signal proportional to the angle of rotation. Sampling times were adjusted for the cosine of the airstream at each point. After satisfying the sampling interval for an individual point, the sampling tube was moved to the next point. When the last point of each traverse was completed, the power supplies to the heating assembly and the vacuum pumps were switched off. At the conclusion of the test, the sampling tube was disconnected from the receptacle and wrapped in plastic for transfer to the analysis laboratory. The associated backup filter was also removed at this time. One backup filter and tube were used for each fan stack. An IK tube blank and a backup filter procedural blank were collected before and after the tests.

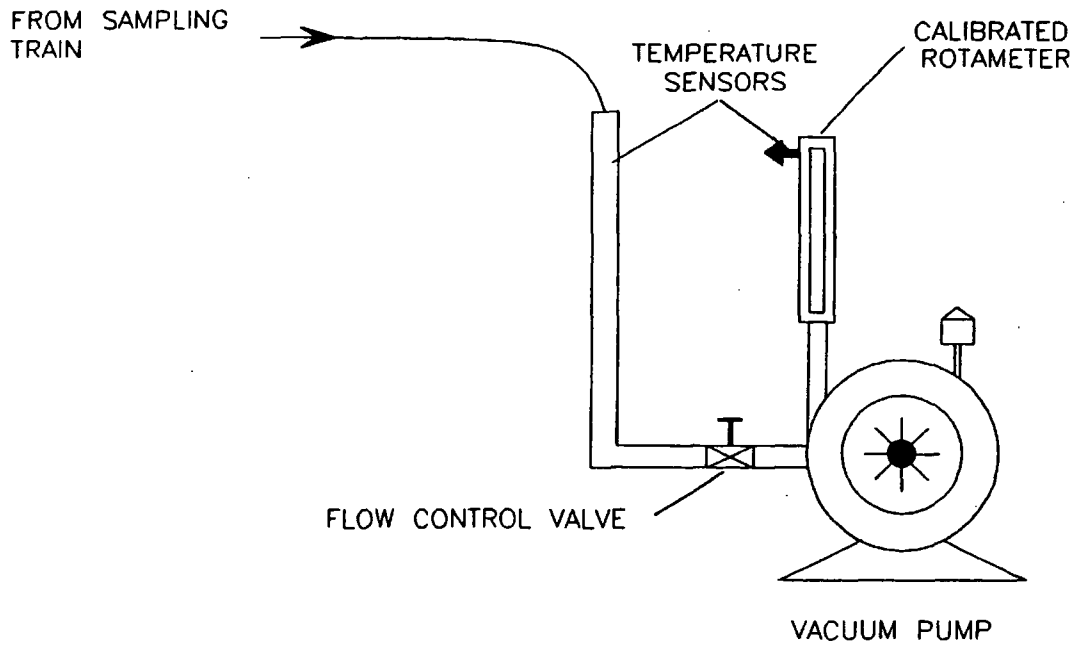


FIGURE 1

ESC HEATED GLASS BEAD SYSTEM

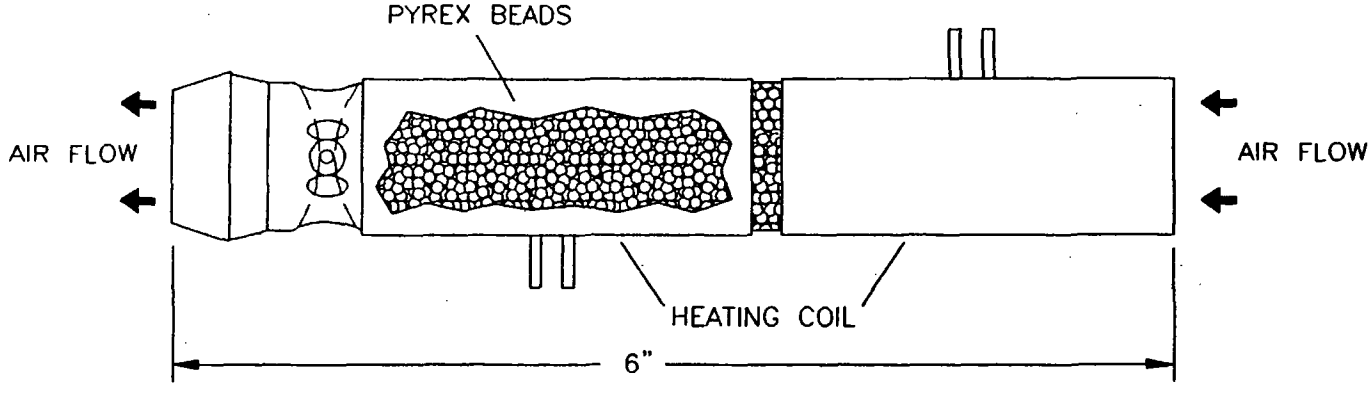


FIGURE 2

ESC HEATED GLASS BEAD SAMPLE TUBE

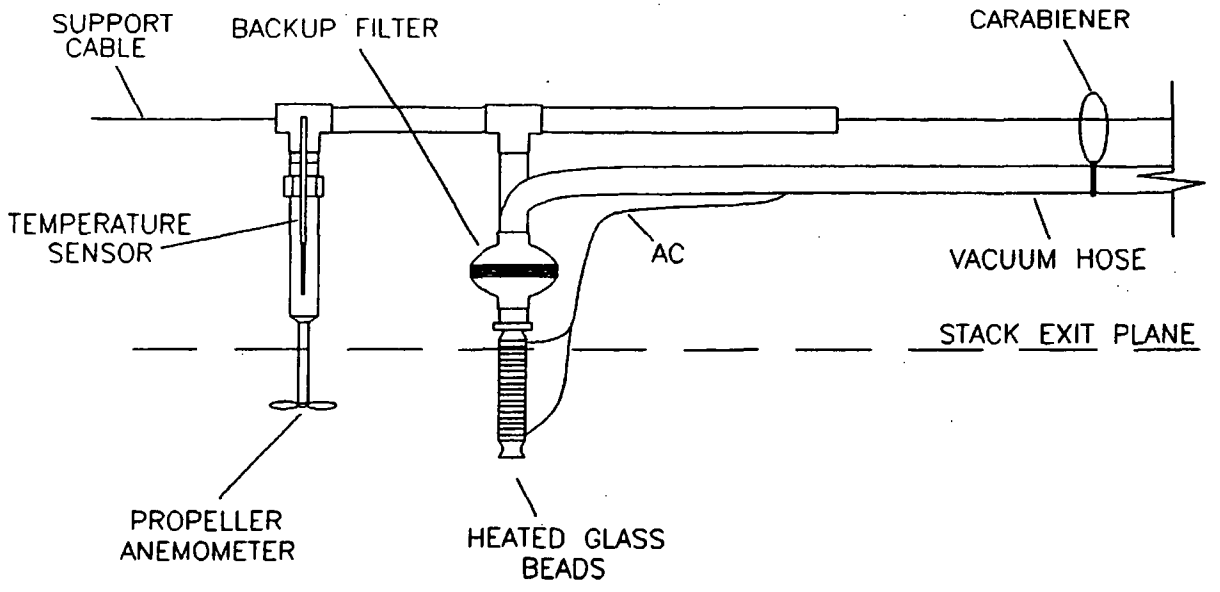


FIGURE 3

SAMPLING TRAIN SUPPORT

The laboratory recovered the collected sample masses at the conclusion of the tests. Collected sodium in the IK tubes was redissolved by washing each tube with two 15 ml rinses of a 10 percent solution of hydrochloric acid. This was followed by a single 15 ml distilled water rinse. The three rinses were composited in a 50 ml volumetric flask and 5 mls of distilled water was added to increase the total volume to 50 ml. The filters were analyzed by washing filters with concentrated hydrochloric acid and deionized water. The samples were then analyzed for trace elements by inductively coupled plasma techniques.

Updraft Air Velocity

In conjunction with the drift data, updraft air velocity was obtained at each sampling point. The local velocities were used to set the isokinetic flow rate and to compute the drift flux. Updraft air velocities were measured with a Gill propeller anemometer. Because the air in a cooling tower is not perpendicular to the fan stack exit plane, a tell-tale was attached to the anemometer to determine the direction and angle of flow. The anemometer was adjusted so that the propeller was perpendicular to the airstream before flow measurements were made.

Circulating Water Samples

Water samples were taken from the water flowing off the tube bundle before and after each traverse diameter. Each water sample bottle was labeled with the date, time and unique identification number. The water samples were analyzed to determine the concentrations of the trace elements that were used to calculate the drift fraction.

Circulating Water Flow Rate

Circulating water flow rate was calculated from pressure measurements made at the discharge of the pumps, using supplied pump curves.

The makeup flow stream was discharging into the water collection basin throughout the drift testing.

HGBIK Results and Analysis

The glass bead IK tubes and backup filters were analyzed for Ca, Mg and Na. Unexposed tubes and filters were analyzed for these elements in order to obtain blank values for the both the tube and filters. The net mass of each element was calculated by:

$$W_{net} = (W_{ik} - W_{ik,blank}) + (W_{filter} - W_{filter,blank})$$

where

W_{net} = the net mass of the tracer element collected, µg
W_{ik} = the mass of the tracer element collected on the test IK tube, µg
$W_{ik,blank}$ = the average mass of the tracer element on the IK blank tubes, µg
W_{filter} = the mass of the element collected on the test backup filter, µg
W_{filter} = the average mass of the tracer element collected on the blank backup filters, µg

The drift rate for each test, based on each of the selected elements, was calculated by:

$$D = \frac{100}{1000\frac{mg}{\mu g} \times 3.785\frac{\ell}{gal}} \times \frac{W_{net}}{C_{cw}\, T_{sampling}\, Q_{cw}}$$

where

D	=	drift rate, percent of circulating water flow
C_{cw}	=	circulating water concentration of element, mg/l
Q_{cw}	=	circulating water flow rate, gal/min
$T_{sampling}$	=	sampling time, minutes

Based on the measured pump discharge pressure and basin levels, a water flow rate for stack A of 1390 gal/min was calculated. For stack B, the water flow rate was calculated to be 1510 gal/min.

Drift data from the isokinetic tests of stacks A and B are summarized in Table 1.

Table 1: Summary of Drift Data

	Drift Rate (Percent of CW Flow)			
	Ca	Mg	Na	Average
Test 1 Stack B	0.0100	0.0132	0.0130	0.0122
Test 2 Stack B	0.0074	0.0090	0.0089	0.0084
Test 3 Stack B	0.0084	0.0077	0.0073	0.0078
Average	0.0086	0.0100	0.0100	**0.0095**
Test 1 Stack A	0.0049	0.0051	0.0046	0.0049
Test 2 Stack A	0.0085	0.0110	0.0107	0.0101
Test 3 Stack A	0.0053	0.0061	0.0056	0.0057
Average	0.0062	0.0074	0.0070	**0.0069**

The drift rate for stack B was 0.0095 percent while that for stack A was 0.0069 percent of the respective water flow. The average drift rate for the two stacks tested was 0.0083 percent of the circulating water flow.

The total drift for the two fan stacks is therefore:

Stack A Drift	=	1390 gpm x 0.000069
	=	0.10 gpm
Stack B Drift	=	1510 gpm x 0.000095
	=	0.14 gpm
Stacks A & B Drift	=	0.24 gpm
or		
Stacks A & B Drift	=	$\frac{0.24 \times 100}{(1510 + 1390)} = 0.0083\%$

The repeated tests yielded drift rates that varied by up to 30 percent from the average value. This variability is explained by variability of the emission rate across the fan stack. Much of the drift from cooling towers arises from small gaps in the drift eliminators and imperfections in the water distribution system. Such anomalies lead to high emission rates in local regions of the fan stack. Small variations in the wind speed and direction move the regions of high emission rates to different regions of the fan stack. Thus, the repeated tests may sample different proportions of these regions. The average drift rates based on each of the elements for both cells were within 10 percent of the average value. Since it is unlikely that contamination of the samples would contain three elements in the same proportion as the circulating water, contamination of the sampling tubes would seem to be ruled out as a source of the variation in the drift rate.

SP Measurements

Drift Droplet Collection

With the sensitive paper technique, sensitized papers are exposed at 16 equal area positions at the exit plane of the fan stack. The exposure is initiated by pulling a lanyard which opens a shutter mechanism exposing the sensitive paper to the drift. The exposure is terminated by releasing the lanyard. Exposures are timed with a stop watch. Drift droplets striking the paper produce blue stains which are sized and counted to determine the liquid drift flux.

Updraft Air Velocity

In conjunction with the drift data, updraft air velocity was obtained at each sampling point. The local velocities were used to calculate the impact velocity of the drift striking the SP. Updraft air velocities were measured with a Gill propeller anemometer. Because the air in a cooling tower is not perpendicular to the fan stack exit plan, a tell-tale was attached to the anemometer to determine the direction and angle of flow. The anemometer was adjusted so that the propeller was perpendicular to the airstream before flow measurements were made.

Circulating Water Flow Rate

Circulating water flow rate was calculated from pressure measurements made at the discharge of the pumps, using pump curves supplied by PG&E.

SP Results and Analysis

The Sensitive Paper (SP) System relies on droplet collection by inertial impaction on water-sensitive paper. The paper is chemically treated so that a droplet impinging on it will generate a well-defined dark blue stain on the pale yellow background of the paper. The size and shape of the stain are functions of the impingement dynamics, i.e., speed and angle, and of the original droplet diameter. If the technique is employed correctly, the stain will be circular, or nearly circular, in shape. The relationship between the stain and the droplet size was obtained by calibrating the SP System by means of a monodisperse water droplet generator over a range of droplet sizes and impaction velocities.

The processing of these exposed sensitive papers consisted of measuring the stain diameters by means of a microscope and a semi-automated Graf Pen digitizer linked to a personal computer which groups the counts of all stains by stain size ranges. Once the stain sizes are counted and grouped according to size, calibration curves for specific droplet sizes and impaction velocities are employed via computer programs to generate the original droplet sizes from which the stains were formed. In addition, a correction factor is applied to compensate for the collection efficiency of each droplet size range. This factor, which is important only for the droplets of less than approximately 50 μm, is computed by the procedures of Ranz and Wong.

Since the SP head is stationary, the paper collects those droplets which are transported to it by the updraft air flow. Large droplets in the updraft air do not move at the same speed as the air due to their settling velocities. Consequently, even if they were present in the same numbers as the small droplets, not as many would strike the sensitive paper surface during the sampling time. Therefore, the stationary SP head measures the droplet number flux directly. The droplet number flux is the number of droplets that cross a unit area per unit time. For a size range i and measurement position j, this can be written as:

$$\frac{\Delta N_{ij}}{A_s \cdot t_s}$$

$$= \frac{\textit{number of droplets in size range } \Delta d_i}{(\textit{area of the sensitive paper}) \times (\textit{sampling time})}$$

The drift mass flux in the size range Δd_i is then:

$$\Delta f_{ij} = \frac{\Delta N_{ij}}{A_j \cdot t_j} \frac{\pi}{6} s_i d_i^3 \ (gm/m_2 \cdot s)$$

where s_i is the specific density (assumed here to be 1 gm/cm^3) of the droplet and d_i is the middle of droplet diameter size range Δd_i. The drift mass emission through the local area associated with the measurement point can then be found by multiplying the drift mass flux by the area. The total drift mass emission of the cell is then found by summation of the drift emission through these areas.

The results of the droplet size distribution measurements are summarized in Table 2 and illustrated in Figure 4.

The mass emission rates for each size range on stacks A and B were added to compute the overall droplet size distribution for the test cell. Most of the droplets larger than 500 microns, as well as one third of the mass emission rate for the cell occurred on two of the SP exposures on fan stack B. This indicates a highly localized source of the large droplets and is not unusual even for cooling towers in good repair. This could be a small gap in the drift eliminators or an area where water from a broken nozzle is spraying directly on the drift eliminators. The mass mean diameter of 252 microns is typical of a mechanical draft cooling towers with wooden drift eliminators in good condition.

The drift rate for the two stacks is therefore:

$$Stacks\ A\ \&\ B\ Drift = 1705 \frac{g}{\sec} \times \frac{60\ \sec}{\min} \times \frac{lb}{454\ g} \frac{Ft^3}{62.4\ lb} \frac{7.48\ gal}{Ft^3}$$

$$= 0.27\ gpm$$

$$or \qquad = \frac{0.27 \times 100}{(1510 + 1390)} = 0.0093\%$$

Ambient Air Sampling

High volume samplers were continuously operated during the drift tests. Filters from these devices were analyzed for sodium, calcium and magnesium. Collected concentrations for sodium, calcium, and magnesium were below detection limits.

Discussion of Results

It is a historically held belief [4] that it is not possible to account for all of the drift by a drop size count. One study [7] found the ratio of IK to SP liquid mass emissions values varied between 1.3 to 6.2, with an average of 2.8. The conclusion that was presented at that time was that the evaporation in the fill may be more significant than previously recognized, and that would lead to the mineral concentration of the drift particles being higher than that of the circulating water. Shofner et al [8] described the ratio of IK to SP measured liquid mass emissions rates as typically on the order of 2 to 3. They attributed this to the following: (1) unscrubbed atmospheric pollution collected by the IK tubes leads to over prediction of apparent drift liquid mass; (2) the mineral concentration is greater in the drops than in the basin water due to evaporation in the fill, especially for small drops; and (3) there are acknowledged uncertainties in the particle-density-distribution measurements of smaller particle sizes (diameters of the order of 20 to 30μm and less).

For these tests, the drift rate computed for the SP test method was approximately 12% higher than the average drift rate produced by the HGBIK method. The distribution in the SP based drift tests both between trace elements and between test runs was comparable to the distribution of the isokinetic based drift test. This good agreement can be attributed to the lack of tracer elements in the ambient air.

The SP technique, does not evaluate drift emissions due to particles that are less than 10 microns in size. The uncertainties in the particle count of the smaller particles, however, must be very large before it would significantly alter the measured liquid mass emission rate. The potential for the SP technique to underestimate the liquid mass emission rate significantly is therefore much less than the IKs potential to overestimate the liquid mass emission rate significantly.

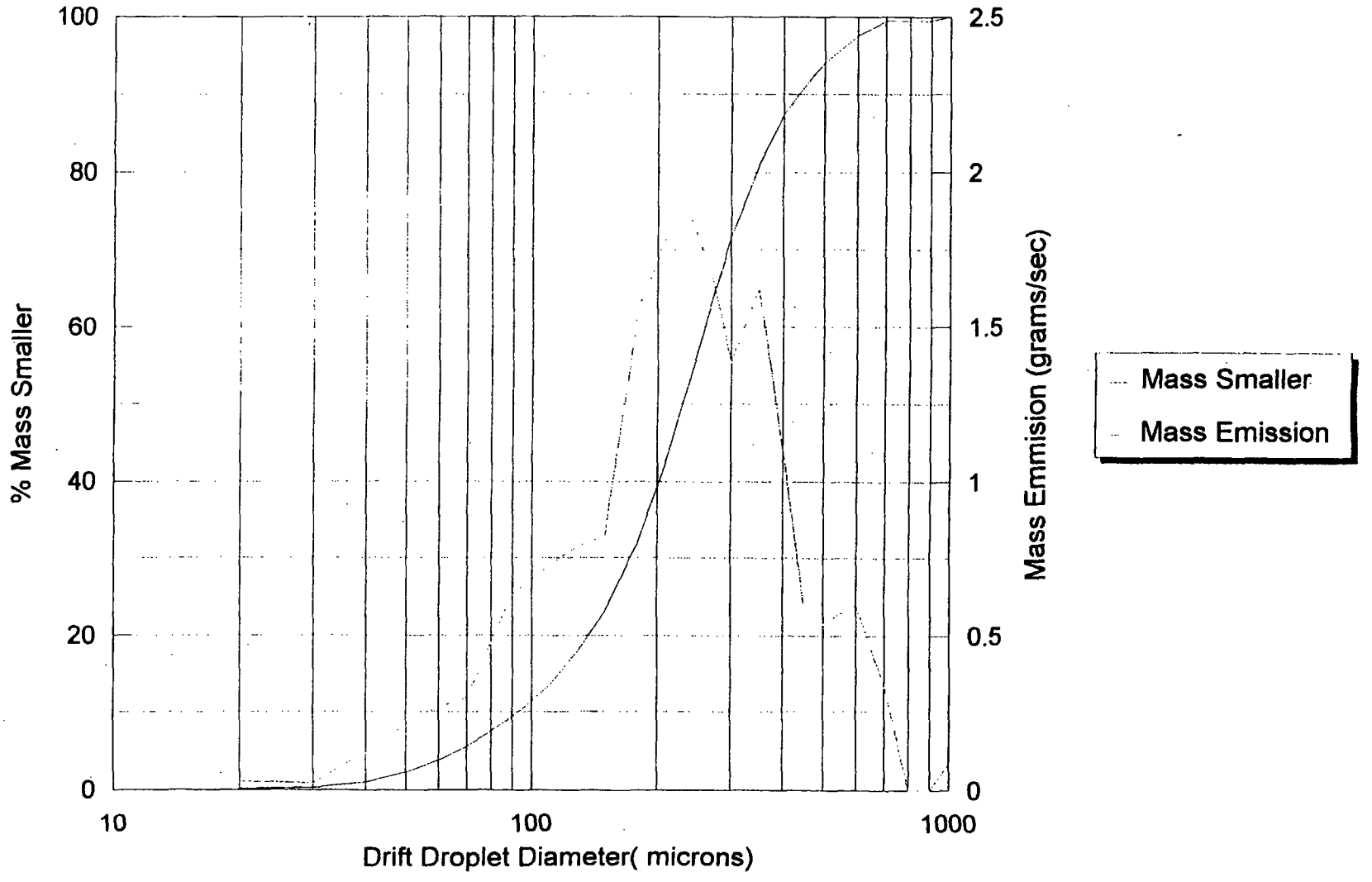
Another note of interest in the present report is that the ratio of minerals captured by the IK to the minerals present in the circulating water is consistent for the three tracer chemicals. It would therefore seem appropriate to calculate the mass emission of any non-volatile chemical using the measured ratio of another such chemical. This would be a valuable technique for determining the efflux of non-volatile chemicals which are present in the circulating water in very small concentrations.

Table 2. Summary Drift Size Distribution for Stacks A and B

Bin	Lower Diameter microns	Upper Diameter microns	Mass Flux µg/m2/sec	Mass Emission g/sec	Mass % Smaller %
1	10	20	1222	0.026	0.15
2	20	30	1034	0.022	0.29
3	30	40	5585	0.121	0.99
4	40	50	9695	0.209	2.22
5	50	60	12350	0.267	3.79
6	60	70	13835	0.299	5.54
7	70	90	29300	0.633	9.25
8	90	110	33650	0.727	13.52
9	110	130	36550	0.789	18.15
10	130	150	38050	0.822	22.97
11	150	180	71800	1.551	32.07
12	180	210	82750	1.787	42.56
13	210	240	85850	1.854	53.43
14	240	270	77400	1.672	63.24
15	270	300	64200	1.387	71.38
16	300	350	75000	1.620	80.88
17	350	400	51100	1.104	87.36
18	400	450	27850	0.602	90.89
19	450	500	24910	0.538	94.04
20	500	600	27610	0.596	97.54
21	600	700	31300	0.338	99.52
22	700	800	0	0.000	99.52
23	800	900	0	0.000	99.52
24	900	1000	7500	0.081	100.00
Total Mass Flux				788500	µg/m²/sec
Mass Mean Diameter				**252**	microns
Mass Emission Rate				**17.05**	gram/sec

Figure 4 Summary Drift Droplet Size Distribution

Cooling Tower Stacks A and B



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***Calculating Realistic PM 10 Emissions from Cooling Towers,* AWMA, Proceedings Florida Conference 2001, Session No. AM-1b**

Calculating Realistic PM_{10} Emissions from Cooling Towers

Abstract No. 216 Session No. AM-1b

Joel Reisman and Gordon Frisbie
Greystone Environmental Consultants, Inc., 650 University Avenue, Suite 100, Sacramento, California 95825

ABSTRACT

Particulate matter less than 10 micrometers in diameter (PM_{10}) emissions from wet cooling towers may be calculated using the methodology presented in EPA's AP-42[1] , which assumes that all total dissolved solids (TDS) emitted in "drift" particles (liquid water entrained in the air stream and carried out of the tower through the induced draft fan stack.) are PM_{10}. However, for wet cooling towers with medium to high TDS levels, this method is overly conservative, and predicts significantly higher PM_{10} emissions than would actually occur, even for towers equipped with very high efficiency drift eliminators (e.g., 0.0006% drift rate). Such over-prediction may result in unrealistically high PM_{10} modeled concentrations and/or the need to purchase expensive Emission Reduction Credits (ERCs) in PM_{10} non-attainment areas. Since these towers have fairly low emission points (10 to 15 m above ground), over-predicting PM_{10} emission rates can easily result in exceeding federal Prevention of Significant Deterioration (PSD) significance levels at a project's fenceline. This paper presents a method for computing realistic PM_{10} emissions from cooling towers with medium to high TDS levels.

INTRODUCTION

Cooling towers are heat exchangers that are used to dissipate large heat loads to the atmosphere. Wet, or evaporative, cooling towers rely on the latent heat of water evaporation to exchange heat between the process and the air passing through the cooling tower. The cooling water may be an integral part of the process or may provide cooling via heat exchangers, for example, steam condensers. Wet cooling towers provide direct contact between the cooling water and air passing through the tower, and as part of normal operation, a very small amount of the circulating water may be entrained in the air stream and be carried out of the tower as "drift" droplets. Because the drift droplets contain the same chemical impurities as the water circulating through the tower, the particulate matter constituent of the drift droplets may be classified as an emission. The magnitude of the drift loss is influenced by the number and size of droplets produced within the tower, which are determined by the tower fill design, tower design, the air and water patterns, and design of the drift eliminators.

AP-42 METHOD OF CALCULATING DRIFT PARTICULATE

EPA's AP-42[1] provides available particulate emission factors for wet cooling towers, however, these values only have an emission factor rating of "E" (the lowest level of confidence acceptable). They are also rather high, compared to typical present-day manufacturers' guaranteed drift rates, which are on the order of 0.0006%. (Drift emissions are typically

expressed as a percentage of the cooling tower water circulation rate). AP-42 states that "a *conservatively high* PM_{10} emission factor can be obtained by (a) multiplying the total liquid drift factor by the TDS fraction in the circulating water, and (b) assuming that once the water evaporates, all remaining solid particles are within the PM_{10} range." (Italics per EPA).

If TDS data for the cooling tower are not available, a source-specific TDS content can be estimated by obtaining the TDS for the make-up water and multiplying it by the cooling tower cycles of concentration. [The cycles of concentration is the ratio of a measured parameter for the cooling tower water (such as conductivity, calcium, chlorides, or phosphate) to that parameter for the make-up water.]

Using AP-42 guidance, the total particulate emissions (PM) (after the pure water has evaporated) can be expressed as:

$$PM = \text{Water Circulation Rate} \times \text{Drift Rate} \times TDS \qquad [1]$$

For example, for a typical power plant wet cooling tower with a water circulation rate of 146,000 gallons per minute (gpm), drift rate of 0.0006%, and TDS of 7,700 parts per million by weight (ppmw):

$$PM = 146{,}000 \text{ gpm} \times 8.34 \text{ lb water/gal} \times 0.0006/100 \times 7{,}700 \text{ lb solids}/10^6 \text{ lb water} \times 60 \text{ min/hr} = \underline{3.38 \text{ lb/hr}}$$

On an annual basis, this is equivalent to almost 15 tons per year (tpy). Even for a state-of-the-art drift eliminator system, this is not a small number, especially if assumed to all be equal to PM_{10}, a regulated criteria pollutant. However, as the following analysis demonstrates, only a very small fraction is actually PM_{10}.

COMPUTING THE PM_{10} FRACTION

Based on a representative drift droplet size distribution and TDS in the water, the amount of solid mass in each drop size can be calculated. That is, for a given initial droplet size, assuming that the mass of dissolved solids condenses to a spherical particle after all the water evaporates, and assuming the density of the TDS is equivalent to a representative salt (e.g., sodium chloride), the diameter of the final solid particle can be calculated. Thus, using the drift droplet size distribution, the percentage of drift mass containing particles small enough to produce PM_{10} can be calculated. This method is conservative as the final particle is assumed to be perfectly spherical; hence as small a particle as can exist.

The droplet size distribution of the drift emitted from the tower is critical to performing the analysis. Brentwood Industries, a drift eliminator manufacturer, was contacted and agreed to provide drift eliminator test data from a test conducted by Environmental Systems Corporation (ESC) at the Electric Power Research Institute (EPRI) test facility in Houston, Texas in 1988 (Aull[2], 1999). The data consist of water droplet size distributions for a drift eliminator that achieved a tested drift rate of 0.0003 percent. As we are using a 0.0006 percent drift rate, it is reasonable to expect that the 0.0003 percent drift rate would produce smaller droplets, therefore,

this size distribution data can be assumed to be conservative for predicting the fraction of PM_{10} in the total cooling tower PM emissions.

In calculating PM_{10} emissions the following assumptions were made:

- Each water droplet was assumed to evaporate shortly after being emitted into ambient air, into a single, solid, spherical particle.
- Drift water droplets have a density (ρ_w) of water; $1.0\ g/cm^3$ or $1.0 * 10^{-6}\ \mu g/\mu m^3$.
- The solid particles were assumed to have the same density (ρ_{TDS}) as sodium chloride, (i.e., 2.2 g/cm^3).

Using the formula for the volume of a sphere, $V = 4\pi r^3/3$, and the density of pure water, $\rho_w = 1.0\ g/cm^3$, the following equations can be used to derive the solid particulate diameter, D_p, as a function of the TDS, the density of the solids, and the initial drift droplet diameter, D_d :

Volume of drift droplet = $(4/3)\pi(D_d/2)^3$ [2]

Mass of solids in drift droplet = (TDS)(ρ_w)(Volume of drift droplet) [3]

substituting,

Mass of solids in drift = (TDS)(ρ_w) $(4/3)\pi(D_d/2)^3$ [4]

Assuming the solids remain and coalesce after the water evaporates, the mass of solids can also be expressed as:

Mass of solids = (ρ_{TDS}) (solid particle volume) = (ρ_{TDS})$(4/3)\pi(D_p/2)^3$ [5]

Equations [4] and [5] are equivalent:

$(\rho_{TDS})(4/3)\pi(D_p/2)^3 = (TDS)(\rho_w)(4/3)\pi(D_d/2)^3$ [6]

Solving for D_p:

$D_p = D_d\ [(TDS)(\rho_w / \rho_{TDS})]^{1/3}$ [7]

Where,

TDS is in units of ppmw
D_p = diameter of solid particle, micrometers (μm)
D_d = diameter of drift droplet, μm

Using formulas [2] – [7] and the particle size distribution test data, Table 1 can be constructed for drift from a wet cooling tower having the same characteristics as our example; 7,700 ppmw TDS and a 0.0006% drift rate. The first and last columns of this table are the particle size distribution derived from test results provided by Brentwood Industries. Using straight-line interpolation for a solid particle size 10 μm in diameter, we conclude that approximately 14.9 percent of the mass emissions are equal to or smaller than PM_{10}. The balance of the solid

particulate are particulate greater than 10 μm. Hence, PM_{10} emissions from this tower would be equal to PM emissions x 0.149, or 3.38 lb/hr x 0.149 = 0.50 lb/hr. The process is repeated in Table 2, with all parameters equal except that the TDS is 11,000 ppmw. The result is that approximately 5.11 percent are smaller at 11,000 ppm. Thus, while total PM emissions are larger by virtue of a higher TDS, overall PM_{10} emissions are actually lower, because more of the solid particles are larger than 10 μm.

Table 1. Resultant Solid Particulate Size Distribution (TDS = 7700 ppmw)

EPRI Droplet Diameter (μm)	Droplet Volume (μm^3) [2][1]	Droplet Mass (μg) [3]	Particle Mass (Solids) (μg) [4]	Solid Particle Volume (μm^3)	Solid Particle Diameter (μm) [7]	EPRI % Mass Smaller
10	524	5.24E-04	4.03E-06	1.83	1.518	0.000
20	4189	4.19E-03	3.23E-05	14.66	3.037	0.196
30	14137	1.41E-02	1.09E-04	49.48	4.555	0.226
40	33510	3.35E-02	2.58E-04	117.29	6.073	0.514
50	65450	6.54E-02	5.04E-04	229.07	7.591	1.816
60	113097	1.13E-01	8.71E-04	395.84	9.110	5.702
70	179594	1.80E-01	1.38E-03	628.58	10.628	21.348
90	381704	3.82E-01	2.94E-03	1335.96	13.665	49.812
110	696910	6.97E-01	5.37E-03	2439.18	16.701	70.509
130	1150347	1.15E+00	8.86E-03	4026.21	19.738	82.023
150	1767146	1.77E+00	1.36E-02	6185.01	22.774	88.012
180	3053628	3.05E+00	2.35E-02	10687.70	27.329	91.032
210	4849048	4.85E+00	3.73E-02	16971.67	31.884	92.468
240	7238229	7.24E+00	5.57E-02	25333.80	36.439	94.091
270	10305995	1.03E+01	7.94E-02	36070.98	40.994	94.689
300	14137167	1.41E+01	1.09E-01	49480.08	45.549	96.288
350	22449298	2.24E+01	1.73E-01	78572.54	53.140	97.011
400	33510322	3.35E+01	2.58E-01	117286.13	60.732	98.340
450	47712938	4.77E+01	3.67E-01	166995.28	68.323	99.071
500	65449847	6.54E+01	5.04E-01	229074.46	75.915	99.071
600	113097336	1.13E+02	8.71E-01	395840.67	91.098	100.000

[1] Bracketed numbers refer to equation number in text.

The percentage of PM_{10}/PM was calculated for cooling tower TDS values from 1000 to 12000 ppmw and the results are plotted in Figure 1. Using these data, Figure 2 presents predicted PM_{10} emission rates for the 146,000 gpm example tower. As shown in this figure, the PM emission rate increases in a straight line as TDS increases, however, the PM_{10} emission rate increases to a maximum at around a TDS of 4000 ppmw, and then begins to decline. The reason is that at higher TDS, the drift droplets contain more solids and therefore, upon evaporation, result in larger solid particles for any given initial droplet size.

CONCLUSION

The emission factors and methodology given in EPA's AP-42[1] Chapter 13.4 *Wet Cooling Towers*, do not account for the droplet size distribution of the drift exiting the tower. This is a critical factor, as more than 85% of the mass of particulate in the drift from most cooling towers will result in solid particles larger than PM_{10} once the water has evaporated. Particles larger than PM_{10} are no longer a regulated air pollutant, because their impact on human health has been shown to be insignificant. Using reasonable, conservative assumptions and a realistic drift

droplet size distribution, a method is now available for calculating realistic PM_{10} emission rates from wet mechanical draft cooling towers equipped with modern, high-efficiency drift eliminators and operating at medium to high levels of TDS in the circulating water.

Table 2. Resultant Solid Particulate Size Distribution (TDS = 11000 ppmw)

EPRI Droplet Diameter (μm)	Droplet Volume (μm^3) [2][1]	Droplet Mass (μg) [3]	Particle Mass (Solids) (μg) [4]	Solid Particle Volume (μm^3)	Solid Particle Diameter (μm) [7]	EPRI % Mass Smaller
10	524	5.24E-04	5.76E-06	2.62	1.710	0.000
20	4189	4.19E-03	4.61E-05	20.94	3.420	0.196
30	14137	1.41E-02	1.56E-04	70.69	5.130	0.226
40	33510	3.35E-02	3.69E-04	167.55	6.840	0.514
50	65450	6.54E-02	7.20E-04	327.25	8.550	1.816
60	113097	1.13E-01	1.24E-03	565.49	10.260	5.702
70	179594	1.80E-01	1.98E-03	897.97	11.970	21.348
90	381704	3.82E-01	4.20E-03	1908.52	15.390	49.812
110	696910	6.97E-01	7.67E-03	3484.55	18.810	70.509
130	1150347	1.15E+00	1.27E-02	5751.73	22.230	82.023
150	1767146	1.77E+00	1.94E-02	8835.73	25.650	88.012
180	3053628	3.05E+00	3.36E-02	15268.14	30.780	91.032
210	4849048	4.85E+00	5.33E-02	24245.24	35.909	92.468
240	7238229	7.24E+00	7.96E-02	36191.15	41.039	94.091
270	10305995	1.03E+01	1.13E-01	51529.97	46.169	94.689
300	14137167	1.41E+01	1.56E-01	70685.83	51.299	96.288
350	22449298	2.24E+01	2.47E-01	112246.49	59.849	97.011
400	33510322	3.35E+01	3.69E-01	167551.61	68.399	98.340
450	47712938	4.77E+01	5.25E-01	238564.69	76.949	99.071
500	65449847	6.54E+01	7.20E-01	327249.23	85.499	99.071
600	113097336	1.13E+02	1.24E+00	565486.68	102.599	100.000

Figure 1: Percentage of Drift PM that Evaporates to PM10

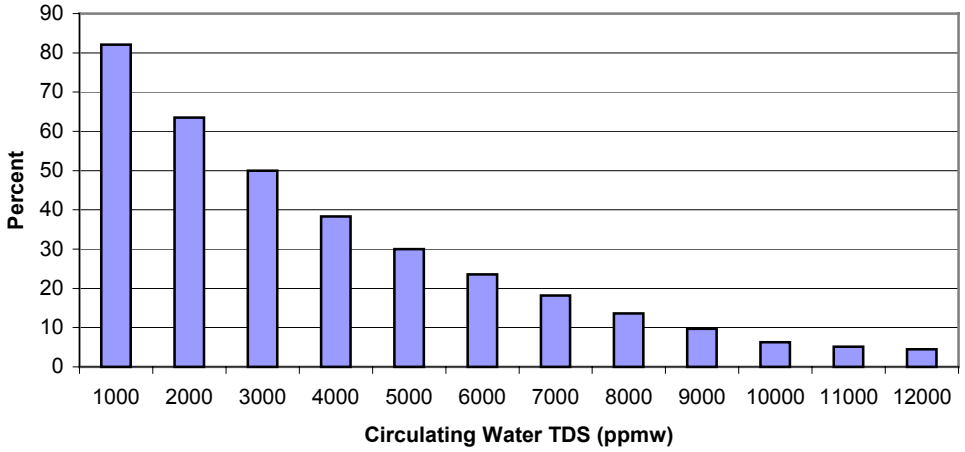
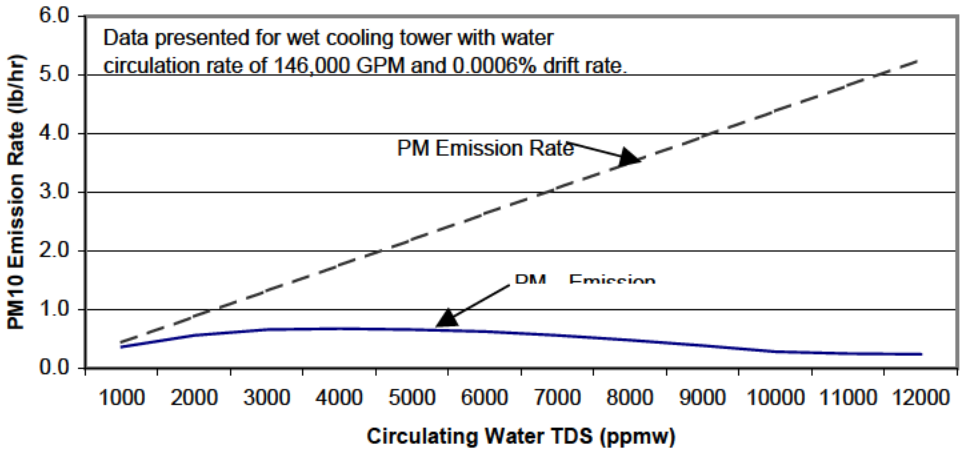


Figure 2: PM_{10} Emission Rate vs. TDS



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KEY WORDS

Drift
Drift eliminators
Cooling tower
PM_{10} emissions
TDS

Nationwide Emission Benefits of a Low Sulfur Diesel Fuel,
Air Improvement Resource, Inc.

Nationwide Emission Benefits of a Low Sulfur Diesel Fuel

March 3, 1999

For: Engine Manufacturers Association

By: Tom Darlington
Dennis Kahlbaum

Air Improvement Resource, Inc.
47298 Sunnybrook Lane
Novi, Michigan
48374

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1.0 Summary

The Environmental Protection Agency (EPA) will release its Tier 2 Notice of Proposed Rulemaking (NPRM) early this year. In addition to lower emission standards for passenger cars and light trucks, sport utility vehicles, and vans, the NPRM is expected to include a proposal to reduce the sulfur level in gasoline by about 90%. A reduction in gasoline sulfur level is needed to reduce criteria pollutants emitted from current and future vehicles and to enable the next generation of vehicle emission control technology.

Along with lower sulfur levels in gasoline, EPA is also beginning to study lower sulfur levels in diesel fuel for both on-road and off-road engines. Sulfur in diesel fuel forms sulfur dioxide (SO_2) and sulfate (SO_4) particulate matter (PM) during combustion. These pollutants contribute to acidic deposition and raise particulate levels including ambient fine PM (i.e. < 2.5 microns) levels. EPA recently established a fine PM air quality standard that regions will have to meet. In addition to these air quality impacts, sulfur in diesel fuel contributes to increased acid levels in the engine, causing engine and emission control system wear. Finally, more stringent NOx standards for light duty diesel vehicles and trucks are being considered in the Tier 2 proposed rule, and more stringent standards for heavy-duty diesel vehicles have already been adopted for 2004 and later engines. Engine makers and aftertreatment suppliers are working on advanced emission control devices to meet more stringent standards, but many of these devices require low sulfur diesel fuel to be commercially available. Therefore, cutting on-road and off-road diesel fuel sulfur levels would reduce ambient SO_2 and fine PM levels, improve engine and aftertreatment system durability, and enable new technology to be commercially viable.

To determine the SO_2 and PM emission inventory impacts of lower sulfur on-road and off-road diesel fuel, the Engine Manufacturers Association (EMA) sponsored this study to evaluate two fuel control options. Current on-road diesel fuel has a fuel sulfur content on average of 300 parts per million (ppm), with off-road diesel 11 times that amount at 3300 ppm. Sulfur control Case A would reduce on-road and off-road sulfur levels to 30 ppm maximum by October 1, 2003. Case B would reduce on-road sulfur levels to the 30 ppm and off-road levels to 500 ppm by July 1, 2002. Case B would include a second phase for off-road diesel, reducing the sulfur level from 500 ppm to 30 ppm maximum by October 1, 2005. EMA's choice of 30 ppm sulfur for modeling purposes is meant to show the emission reductions of this level of control, and does not mean to imply that EMA believes that 30 ppm is sufficient to enable advanced aftertreatment technology.

AIR reviewed the existing EPA and California Air Resources Board (ARB) on-road and off-road models for predicting SO_2 and SO_4 PM emissions from diesel engines. There were many similarities between the models, but the EPA models appear to more completely account for sulfur than the ARB models. Therefore, for this study, AIR used the EPA PART5 model for on-road engines and the EPA NONROAD model for off-road engines to estimate these pollutants. The fractions of light heavy-duty and medium heavy-duty diesel vehicles equipped with catalysts in the PART5 model were updated

with more recent information. AIR obtained on-road diesel vehicle activity information (miles per day by vehicle class) from EPA sources. Off-road activity is already included in the NONROAD model. The PART5 model includes indirect sulfates (i.e., those formed from reaction of SO_2 to sulfates in the atmosphere), but the NONROAD model does not. AIR therefore estimated indirect sulfates for NONROAD engines consistent with the EPA PART5 model methodology. The EPA estimate of indirect sulfates, as explained in the body of the text, is a significant underestimate of the impact that low sulfur diesel fuel will make on nationwide PM concentrations and sulfate deposition. More refined estimates are beyond the scope of this report.

The results of the analysis are shown in Figures 1 and 2, which show SO_2 and SO_4 PM emission reductions by calendar year for the two cases. The reductions in tons per day for each pollutant are shown for calendar years 2002 to 2010, and are shown separately for on-road and off-road engines. There are differences in the cases in the transitional years (2002-2005), but the long-term reductions are the same, and peak at almost 3000 tons per day (tpd) for SO_2, and 1100 tpd for SO_4 PM. Since the off-road current sulfur level is nearly 11 times that of the on-road sulfur level, the majority of the reductions come from off-road diesel. These reductions represent a 95% cut in these pollutants for on-road sources, and a 99% cut for off-road sources.

The 3000 tpd reduction in SO_2 in 2010 amounts to over 1 million tons per year. In 2010, total SO_2 from all sources after the 10 million ton per year acid rain program is completed will be about 15 to 17 million tons per year. Therefore, the 1 million ton per year reduction is very significant, or about 6 or 7 % of the total SO_2 in 2010.

Figure 1
National SO_2 Reductions

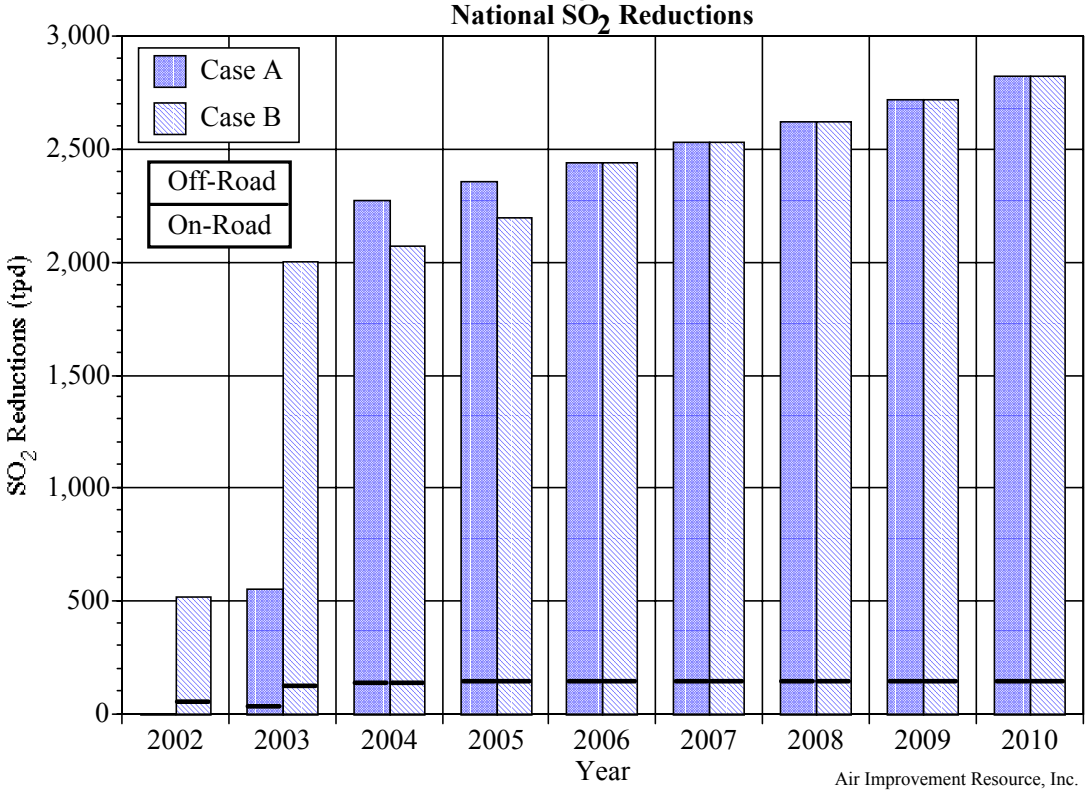
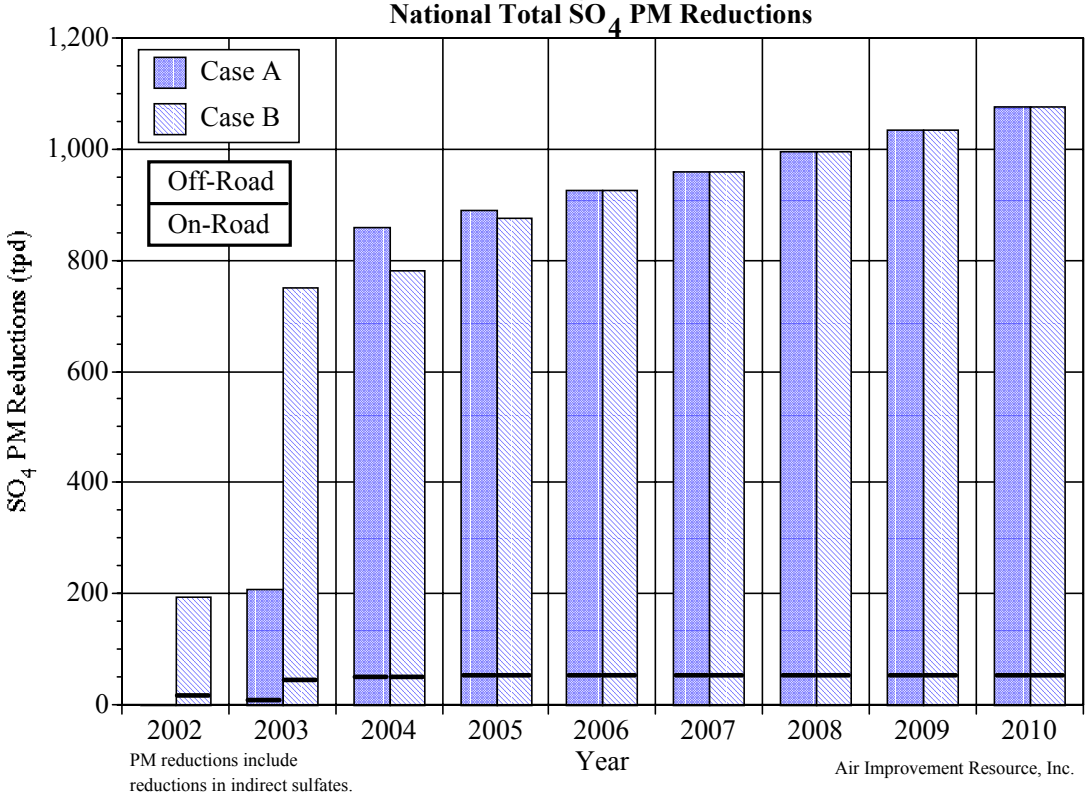


Figure 2
National Total SO_4 PM Reductions



2.0 Introduction

EPA plans to release its Tier 2 NPRM early this year. The NPRM will not only call for lower exhaust emissions standards for cars and light trucks, it will also propose tighter sulfur limits for gasoline. The tighter sulfur limits will have the immediate impact of lowering in-use emissions of ozone-forming pollutants, carbon monoxide and particulate matter. Sulfur control is critical because sulfur forms sulfur dioxide (SO_2) in the engine during combustion, and SO_2 impairs the ability of the catalytic converter to reduce exhaust emissions, especially in all vehicles equipped with catalytic converters, especially in vehicles equipped with advanced emission control technology. Current gasoline sulfur levels in non-California states vary significantly, but the national average is about 340 ppm. (1) EPA is studying a number of scenarios, including reducing this by over 90% to an average of about 30 ppm, and the possibility of eventually phasing in a "sulfur free" fuel. Sulfur levels in gasoline in California are under 30 ppm, because California's Phase 2 reformulated gasoline requirement contains an averaging limit of 30 ppm. California is also studying the possibility of further reducing the sulfur in its gasoline below 30 ppm to essentially a "sulfur free" fuel corresponding to the next level of emission reductions requirements, LEV II.

Sulfur in diesel fuel also affects engine emissions. Sulfur forms SO_2 during combustion, and some of the SO_2 reacts with additional oxygen and water to form sulfate (H_2SO4) particulate matter (PM). This PM is called "direct" PM. SO_2 also forms additional PM by complex reactions in the atmosphere, and this is referred to as "indirect" PM. In 1993, EPA implemented a 500 ppm nationwide cap for the sulfur limit of on-highway diesel fuel. California also implemented the same cap for diesel fuel sold in California. California further controlled total aromatics in diesel fuel to a maximum of 10%, although uit has implemented a mechanism to certify fuels with alternative formulations that achieve equivalent emissions performance. The current national average sulfur level for on-highway diesel fuel is about 300 ppm. (2) Currently, there is no sulfur cap for off-highway diesel fuel, and EPA estimates that off-highway diesel fuel has a sulfur level of almost 3300 ppm, or about *11 times* the on-highway level. (3) The adoption of Stage III/IV standards for 2000/2005 by Europe was accompanied by a phased reduction of sulfur to a 50 ppm cap. This was necessary for advanced diesel aftertreatment technology to function effectively.

Sulfur in diesel fuel also has an effect on exhaust emission aftertreatment expected to be used to meet lower NOx standards. The EPA has adopted stricter NOx standards for heavy-duty diesel engines starting in 2004, and many expect EPA to lower heavy-duty NOx standards further in the future. Many engine manufacturers will utilize exhaust gas recirculation (EGR), in combination with other strategies, to meet the 2004 NOx standards. However, in order for EGR to be effective at reducing NOx emissions, the exhaust gas must be cooled, and in the process of cooling the exhaust gas, sulfuric acid condenses in the EGR system. Thus, with current sulfur fuel, manufacturers must use premium components for EGR systems combined with shorter service intervals that increase overall maintenance costs.

In the longer term for heavy-duty diesel engines, if NOx standards are further tightened, it is unlikely that EGR systems alone will be able to enable engine manufacturers to meet lower standards. The diesel engine and emission control manufacturers are developing new technologies such as adsorption catalysts and other devices to reduce NOx from diesel engines. Like the catalytic converters used for gasoline vehicles, many of these advanced diesel technologies are also adversely impacted by SO_2.

Some oil companies, expecting control of gasoline sulfur levels under the Federal Tier 2 rule, also expect diesel fuel sulfur levels to be eventually reduced as well, and may desire for EPA to reduce gasoline and diesel fuel sulfur levels along a similar timeline. Recognizing this, EPA is requesting input from all parties on an advance notice of proposed rulemaking (ANPRM) on potentially controlling future diesel fuel sulfur levels. California would also like to reduce sulfur levels in diesel fuel.

The advantages of a lower sulfur on-highway and off-highway diesel fuel, then are summarized below:

- Lower SO_2 emissions from diesel engines, and reduced acidic deposition
- Lower directly emitted PM from diesel engines
- Lower indirect PM
- Improved visibility and ambient PM levels
- Increased EGR system life
- Increased engine life and reduced maintenance costs
- Allows for commercial application of advanced technology aftertreatment

Because of the need for lower sulfur on-highway and off-highway diesel fuel, the Engine Manufacturers Association (EMA) contracted with AIR to assess the SO_2 and SO_4 PM emission benefits of low sulfur diesel fuel in the nation, and in California. EMA also contracted with MathPro to perform a study of the costs of lower sulfur diesel fuel. EMA desired to study the emission reductions of two control cases, as shown in Table 1.

Table 1. Diesel Fuel Control Scenarios

Case	On-Road		Off-Road	
	Level	Date	Level	Date
A	30 max	10/1/2003	30 max	10/1/2003
B	30 max	7/1/2002	500 max	10/1/2002
			30 max	10/1/2005

Case A would limit all on- and off-road diesel sulfur to 30 ppm maximum starting on October 1, 2003. Case B would limit on-road diesel sulfur to 30 ppm maximum on July 1, 2002, and would provide for a two-phase reduction for off-road diesel to 500 ppm maximum on October 1, 2002, followed by a further reduction to 30 ppm maximum on October 1, 2005. EMA's choice of 30 ppm sulfur for modeling purposes is meant to show the emission reductions of this level of control, and does not

mean to imply that EMA believes that 30 ppm is sufficient to enable advanced aftertreatment technology.

The remainder of this report is divided into four sections. *Section 3 Review of Methods to Estimate SO_2 and SO_4 Emissions From Diesel Engines* reviews the methods used by the EPA and California Air Resources Board to estimate SO_2 and SO_4 emissions in the various on-road and off-road models. *Section 4 Methods Used in This Analysis* discusses the modeling approach used in this analysis. *Section 5 Results* presents the emission inventories and emissions reductions from the various cases. *Section 6 Conclusions* discusses implications of the analysis and remaining uncertainties.

3.0 Review of Methods Used to Estimate SO_2 and SO_4 From Diesel Engines

EPA and ARB have two models each, which estimate SO_2 and SO_4 emissions from on- and off-highway diesel engines. These models are shown in Table 2.

Table 2. ARB and EPA Models

Source	Model Name	Vehicles Covered
EPA	PART5	On-Highway Vehicles
	NONROAD	Off-Road Vehicles
ARB	MVEI7G	On-Highway Vehicles
	OFFROAD	Off-Road Vehicles

The PART5 model was finalized shortly after MOBILE5 was finalized. EPA currently plans to update this model about a year after MOBILE6 is finalized (MOBILE6 is scheduled to be completed by the end of 1999). MVEI7G is ARB's current model for California; it is being updated at this time. The new model, EMFAC99, will be released sometime this spring. Both of the models for off-road engines are still under development, but both have been available for some time for review by interested parties. AIR has provided both organizations with comments on various parts of these models, but until now AIR has not reviewed in detail the methods used to estimate emissions specifically derived from the sulfur in diesel fuel.

The following sections review how each of these models estimate SO_2 and SO_4 emissions.

3.1 On-Road Models

3.1.1 EPA's PART5 Model

EPA's PART5 model estimates SO_2 and SO_4 emissions for the following diesel vehicle types:

- Light Duty Diesel Vehicles
- Light Duty Diesel Trucks (0-6000 lb GVW)
- 2B Diesel Trucks (6,001-10,000 lb GVW)
- Light-Heavy Duty Diesel Vehicles (10,001-19,500 lb GVW)
- Medium-Heavy Duty Diesel Vehicles (19,501-33,000 lb GVW)
- Heavy-Heavy Duty Diesel Vehicles (33,000+ lb GVW)

SO_2 and SO_4 emission rates are estimated for non-catalyst equipped vehicles with the following expressions:

$$\boldsymbol{SO_2 = (9.072 * Density * Sulfur * (1\text{-}Frac_{SO4}))/Fuel\ Economy} \quad (4)$$

Where

SO_2 is in g/mi
*9.072 is (453.6 g * 2)/100, where 2 is the number of grams of SO_2 formed per gram of S (64/32), and 100 converts sulfur from a wt % to a wt fraction*
Density is the assumed density of diesel fuel, 7.11 lb/gal
Sulfur is the wt percent of sulfur in on-road diesel fuel, assumed to be 0.05%, or 500 ppm
$Frac_{SO4}$ is the fraction of sulfur converted to SO_4 in the exhaust, 2%
Fuel Economy is the fuel economy in mpg for each model of each vehicle type

SO_4 = (31.10 * Density * Sulfur * $Frac_{SO4}$)/Fuel Economy

Where

SO_4 is in g/mi
*31.10 is (453.6 g/lb * 6.857)/100, where 6.857 is EPA's estimate of the g of H_2SO_4 : $7H_2O$ per g of S, and 100 converts sulfur from wt % to a wt fraction*
Other terms are the same as for SO_2

In the above expressions, the PART5 model splits the fuel sulfur into either SO_2 or SO_4 using the assumed fraction of sulfur converted to SO_4 in the exhaust (2%). The expressions use fuel economy in mpg by vehicle type and model year to estimate SO_2 and SO_4 emissions in g/mi. Finally, EPA assumes that direct sulfate is emitted as sulfuric acid with associated water (7 water molecules per molecule of sulfuric acid).

In the above expression, EPA estimates that 6.857 is the ratio of sulfuric acid and 7 waters to sulfur ($[H_2SO_4 + 7H_2O]/S$). EPA estimated this number as the product of two other ratios: SO_4/S (96/32 = 3.0), and $(H_2SO_4 + 7H_20)/H_2SO_4$ (224/98 = 2.2857). Note that EPA uses SO_4 in the numerator of the first ratio and H_2SO_4 in the denominator of the second ratio. H_2SO_4 should have been used in the first ratio; then the 31.10 would be 31.75. This is not considered to be a major difference, so AIR used the EPA equation as is.

For the non-catalyst-equipped vehicle s, all of the above factors are constant except fuel economy, which varies by vehicle type and model year. To estimate fleet SO_2 emission factors, the model combines the model year emission factors with travel fractions in the same manner that MOBILE5 does for HC, CO and NOx.

Direct PM emissions include sulfates, carbon, and a soluble organic fraction (SOF). EPA bases the PART5 PM estimates on total direct PM from its available test data. This data is assumed to have been gathered using a test fuel that matches the sulfur level of in-use fuel (500 ppm). To estimate the emission rates of the different PM types, EPA subtracts the estimated sulfates from total PM, and then splits the remainder (carbon + SOF) using an estimated SOF fraction.

For catalyst-equipped diesel vehicles, EPA assumes that the fraction of sulfur converted to sulfates increases to 3% from 2%. EPA estimates that 90% of the 1995 and later LHDVs, 75% of the 1995 and later MHDVs, and 100% of the 1991 and later buses are equipped with catalysts.

Fuel economy values assumed in the model for diesel vehicles are shown in Figures 3 (LDDV and LDDT) and 4 (HDDVs). The fuel economy values show a significant increase in fuel economy from the 1989 model year to the 1990 model year, which is not expected. The reason for this increase is an artifact of how the EPA referenced the fuel economy values to the MOBILE3 Fuel Consumption Model: EPA used 1975 fuel economy values for 1975-1989 vehicles, and a projection for 1990 for 1990 and later vehicles. (5) The fuel economy values should show more of a constant increase from 1975-1989, which has been acknowledged by the EPA. This has a tendency to overstate PM emissions, until the 1975-1989 vehicles are retired. AIR did not change the fuel economy values, but this should be addressed by the EPA in PART6, and the fuel economy values should probably be based on recent Truck Inventory and Use Surveys (TIUS).

The PART5 model also estimates indirect sulfates, that is, sulfates that are formed in the atmosphere from SO_2. The model uses the following expression:

$$\textit{Indirect } SO_4 = \textit{Indirect } Frac_{SO4} * SO_2 * 1.92$$

Where

Indirect SO_4 is in g/mi
Indirect $Frac_{SO4}$ is the fraction of SO_2 that reacts to form SO_4 in the atmosphere, or 12%
SO_2 is in g/mi (from earlier expression)
1.92 is the g of ammonium sulfate (NH_2SO_4) and ammonium bisulfate (NH_4HSO_4) (50/50) produced per g of SO_2

Figure 3
PART5 Light Duty Fuel Economy

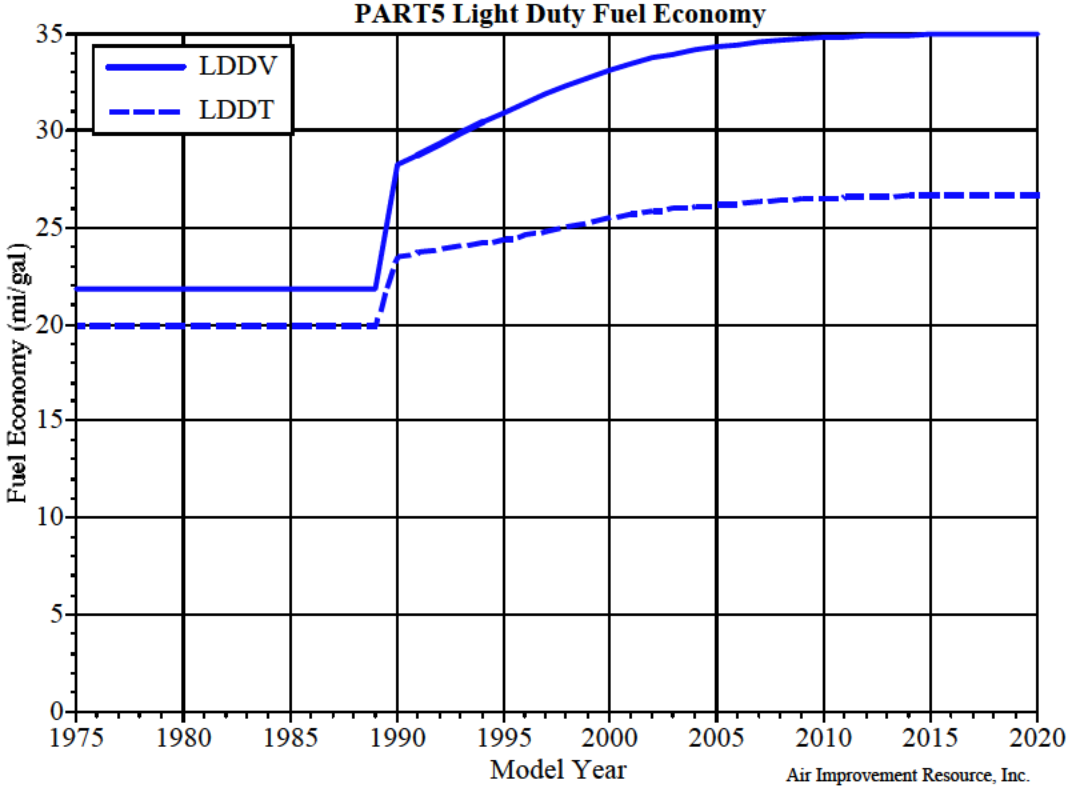
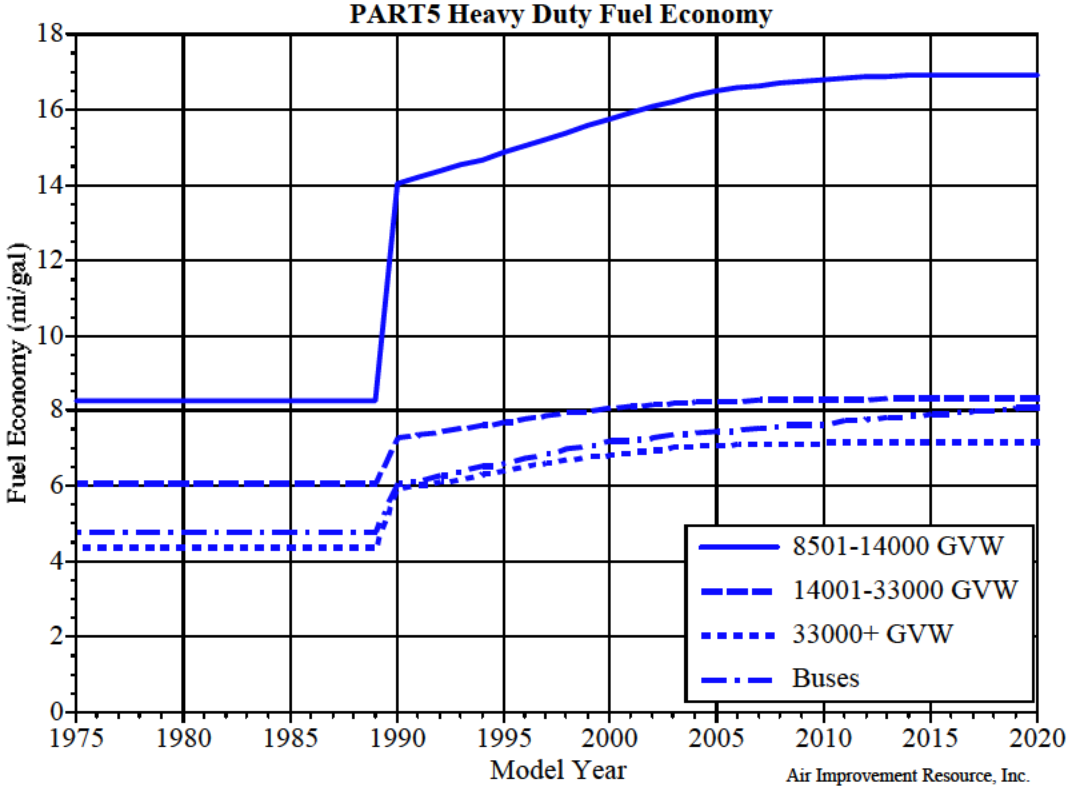


Figure 4
PART5 Heavy Duty Fuel Economy



EPA estimates that 12% of SO_2 is converted in urban areas to sulfate PM.[1] The source of this estimate is an EPA analysis of nationwide SO_4 to SO_2 ambient levels from SO_2 and SO_4 monitors across the U.S. (6) This analysis was performed for the 1990 diesel fuel sulfur rule, which lowered diesel fuel sulfur levels to 500 ppm. EPA assumes that the SO_2 that reacts in the atmosphere forms either ammonium sulfate or ammonium bisulfate. In its analysis, EPA cites reaction rates in California as high as 6% per hour in the spring, summer, and fall, in which all of the SO_2 would be expected to have formed sulfates within about 18 hours. However, to better represent non-California states, EPA developed the 12% figure from ambient sulfate and SO_2 data in 10 non-California cities. The ambient data were year-round, rather than being in the spring or summer when reaction rates are probably significantly higher. Also, EPA's analysis assumes that sulfate and SO_2 deposition in the 10 cities occurs at the same rate (EPA assumes that because of the small size of the sulfate that it disperses like a gas). If SO_4 deposition occurs faster than SO_2 deposition, then the 12% conversion rate is underestimated.

Overall, our concern with the 12% figure is that it could be low, particularly in the spring and summer when meteorological conditions favor secondary PM formation, and human exposure is greater.

3.1.2 ARB's MVEI7G Model

MVEI7G, ARB's model for on-road vehicles, utilizes the EMFAC emission factor models and the BURDEN activity model to produce emissions for California in tons per day. The MVEI7G model estimates all on-highway emission rates (HC, CO, NOx, CO_2, PM, SO_2) for the following vehicle classes:

- Passenger cars
- Light duty trucks (0-6000 lb GVW)
- Medium duty trucks (6-8500 lb GVW)
- Light-heavy-duty trucks (8,500-14,000 lb GVW)
- Medium-heavy-duty trucks (14,000-33,000 lb GVW)
- Heavy-heavy-duty trucks (33,000+ lb GVW)
- Buses

In the MVEI7G model, SO_2 emissions in tons per day are estimated with the following expression:

$$\boldsymbol{SO_2 = (Fuel * Density * Sulfur * Frac_{SO2})/(2*10^9)} \qquad (7)$$

Where

SO_2 is in tons per day

[1] The remaining SO_2 is assumed to be converted into sulfates in nonurban areas, or deposited onto surfaces in urban or nonurban areas without reacting. However, SO_2 and SO_4 that is deposited contribute to acid deposition.

Fuel is fuel consumption in 000s of gal/day
Density is the assumed density of diesel fuel, 7.07 lb/gal
Sulfur is the assumed sulfur content of diesel fuel, or 500 ppm starting in 1993
$Frac_{SO2}$ is the g of SO_2 produced per gram of S (64/32)
2 10^9 converts from ppm to a wt fraction and from lbs to tons*

In the above expression, all of the fuel sulfur is assumed to react to form SO_2. Fuel consumption in gal/day by vehicle class is estimated with fuel economy estimates by vehicle class and activity (miles per day). ARB fuel economy by vehicle class is shown in Figures 5 (LDDVs and LDDTs) and 6 (HDDVs). The above expression is similar to EPA's expression, however, there are three differences in the input data and assumptions:

- ARB assumes that all of the fuel sulfur reacts to form SO_2, where EPA assumes that 98% reacts to form SO_2

Figure 5
ARB Light Duty Fuel Economy

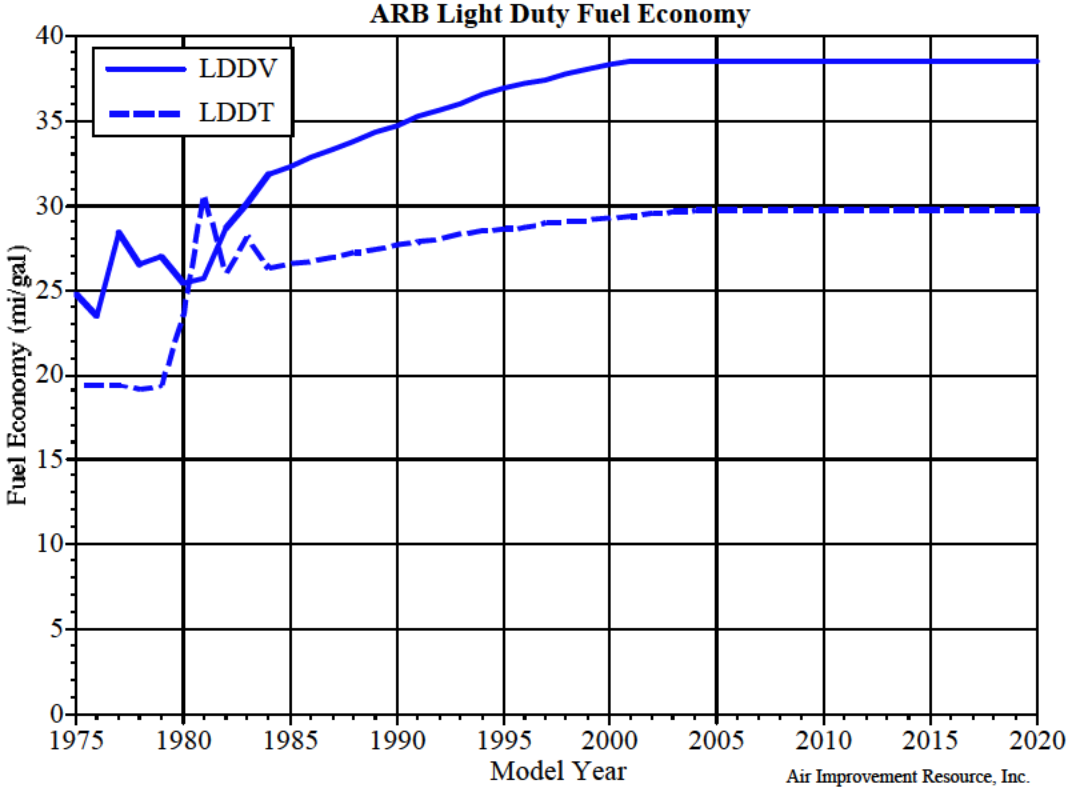


Figure 6
ARB Heavy Duty Fuel Economy

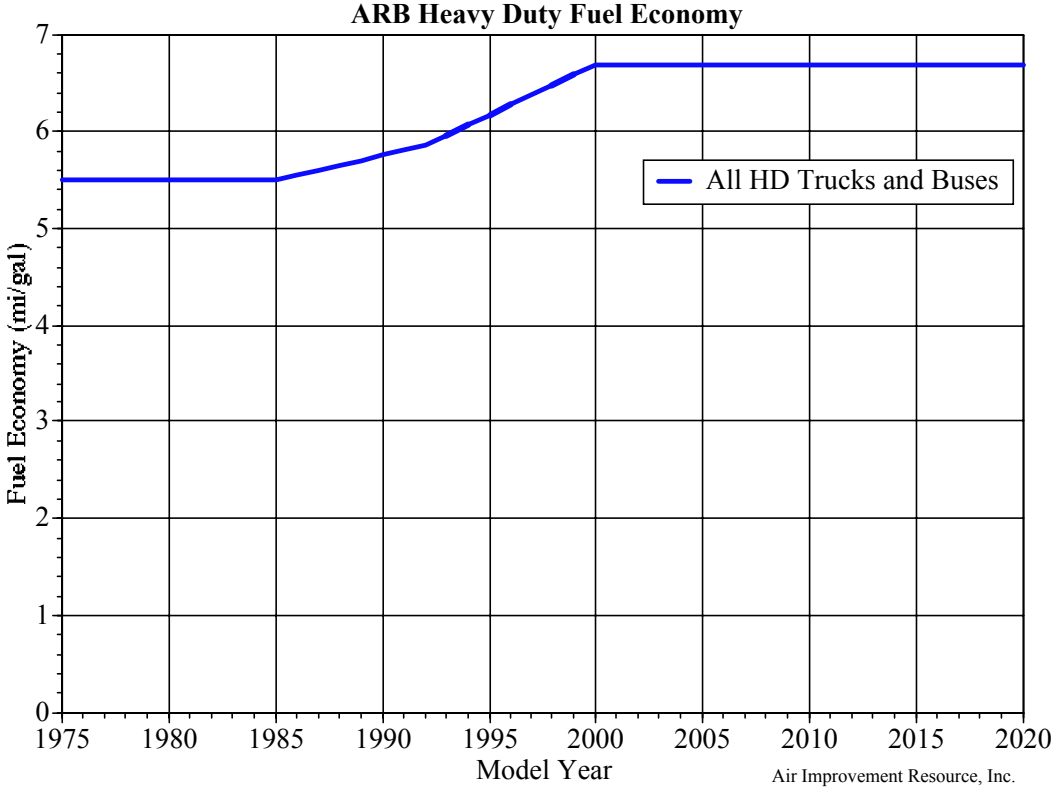


Figure 7
Light Duty Fuel Economy Comparison

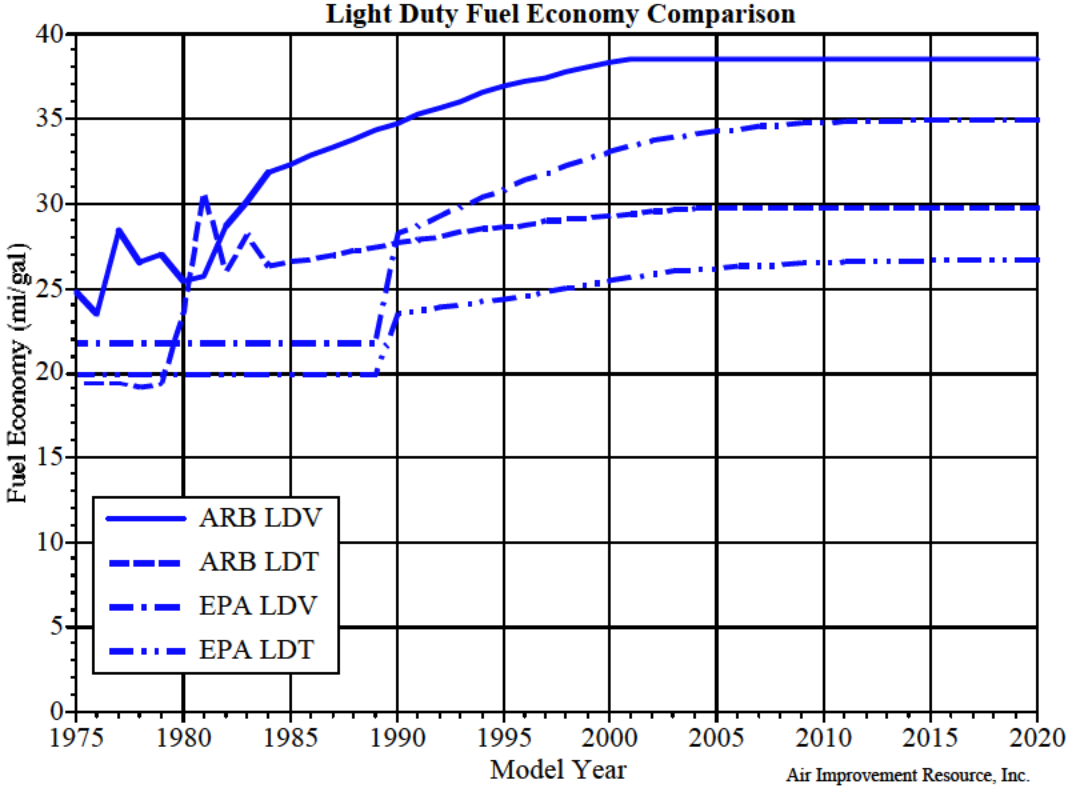
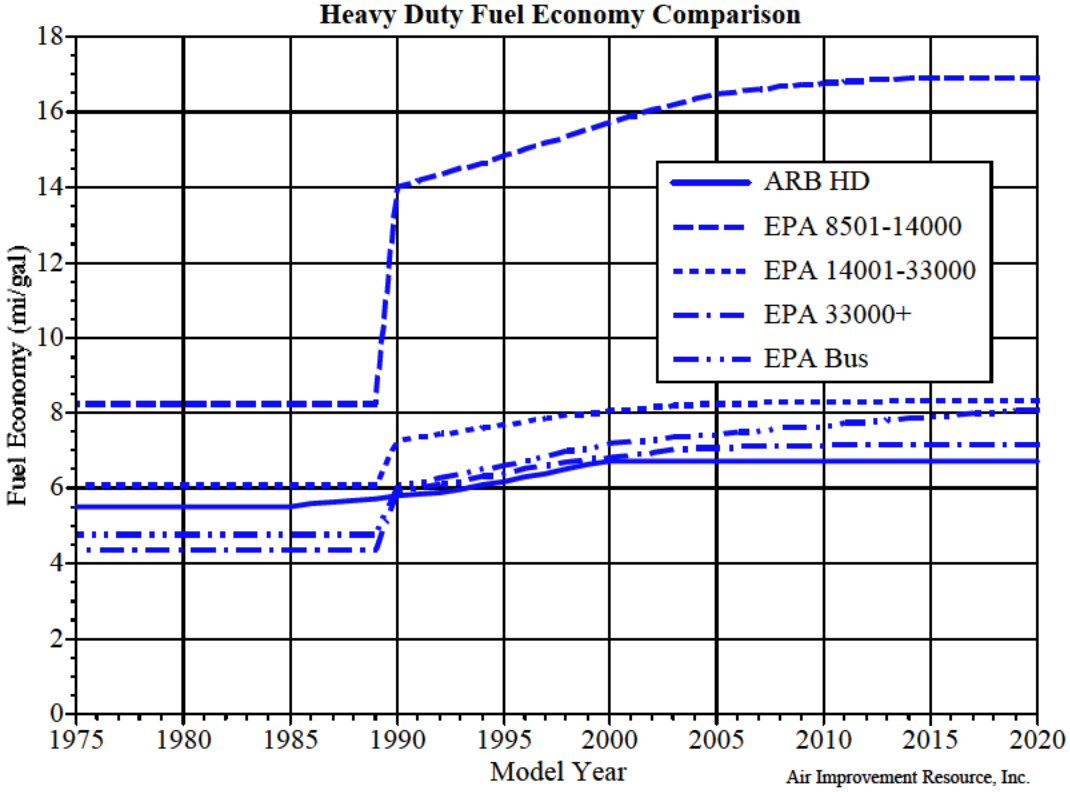


Figure 8
Heavy Duty Fuel Economy Comparison



- There is a small difference in the assumed diesel fuel density (ARB – 7.07 lb/gal, EPA- 7.11 lb/gal)

- There are significant differences in estimated fuel economy by vehicle class, as shown in Figures 7 and 8. For light duty vehicles and light duty trucks, the EPA values are lower than the ARB values. The trends (increasing fuel economy with time) are similar. For the heavy-duty vehicles, ARB uses a single value for all heavy-duty vehicles, while EPA uses separate values by vehicle class. Because of this, it is difficult to compare the heavy-duty vehicle fuel economy estimates.

For sulfate particulate, ARB relies on its PM emission rates from test data. In this sense, ARB is double-counting the sulfur that forms sulfate particulate, because it does not subtract the sulfur that forms sulfate PM when estimating SO_2 emissions.

3.2 Off-Highway Models

3.2.1 EPA's Draft NONROAD Model

EPA's Draft NONROAD model estimates HC, CO, NOx, SO_2, and PM emissions (including sulfates) for the nation, for the following equipment types:

- Agriculture
- Airport Ground Support
- Lawn and Garden
- Light Commercial
- Logging
- Recreation
- Other Oil Field Equipment
- Transport Refrigeration Units

The model does not yet include vessels and rail operations, but the final version is expected to include these equipment types.

For SO_2 emissions, the model uses the following expression:

$$\boldsymbol{SO_2 = (BSFC * (1\text{-}Frac_{SO4}) - HC) * Sulfur * 2} \quad (8)$$

Where

SO_2 is in g/hp-hr
BSFC is the in-use adjusted fuel consumption in lb/hp-hr
453.6 is the conversion factor from g to lb
$Frac_{SO4}$ is the fraction of sulfur converted to sulfate, assumed to be 2.2%
HC is the in-use adjusted HC emissions in g/hp-hr

Sulfur is the wt fraction of sulfur in nonroad diesel fuel, 0.0033%, or 3300 ppm
2 is the g of SO_2 formed per g of S

The equation above includes corrections for the fraction of sulfur that is converted to direct PM and for the fraction of sulfur remaining in the unburned fuel. There are two differences in the above expression and the expression used for on-highway diesel vehicles:

- In the NONROAD model, EPA is assuming that 2.2% of the sulfur is converted to SO_4, where the PART5 model assumes this percentage is 2.0%

- EPA also appears to be correcting for the sulfur in the unburned, or partially burned fuel

It is not clear why the NONROAD model assumes a conversion of 2.2%, while the onroad model PART5 assumes a conversion of 2.0% for noncatalyst-equipped vehicles. Also, EPA assumes that the fraction of sulfur in the unburned, or partially burned fuel is the same as in the raw fuel. First the HC emissions are probably at least partially burned, and there is no evidence that the fraction of sulfur in the partially burned fuel is the same as in the raw fuel. While this assumption and resulting adjustment is questionable, since HC emissions from diesel vehicles are very low, the adjustment has little effect on the overall SO_2 emission rate.

For SO_4 emissions, EPA utilizes test data of a number of engines on different test fuels, but adjusts the total PM to a sulfur level of 3300 ppm. Thus, there appears to be no double counting of sulfur.

Unlike the PART5 model, the NONROAD model does not estimate indirect sulfates. The reasons for this are not clear.

3.2.2 ARB Draft OFFROAD Model

In ARB's OFFROAD model, SO_2 emissions are estimated very similarly to the method ARB uses in its MVEI7G on-road model, except that fuel consumption by equipment type is estimated by multiplying fuel consumption in g/hp-hr by activity in total hp-hr. ARB assumes that all of the diesel fuel sulfur reacts to form SO_2, but the PM emissions ARB uses includes SO_4, so sulfur appears to be double-counted in this model as well. The OFFROAD diesel fuel sulfur level is assumed to be 2800 ppm.

3.3 Comparison of Models

A comparison of some of the input parameters for all four models is shown in Table 3. In the last column, we have indicated that for the EPA models, the sulfate PM is based on the fuel sulfur level and the assumed percent of sulfur converted to SO_4, and that for ARB, the sulfate PM is based on test data, which could have varying sulfur levels.

Table 3. Input Parameter Comparison for the Various Models						
Model	Base Sulfur Level (ppm)	% Sulfur Convert to SO_2	% Sulfur Convert to SO_4	Indirect SO_4 Estimated?	Fuel Density (lb/gal)	Exhaust SO_4 PM Based On
PART5 – EPA	500	98.0	2.0	Yes – 12%	7.11	Amount converted
MVEI7G – ARB	500	100.0	0.0	No	7.07	Test data
NONROAD – EPA	3300	97.8	2.2	No	NA	Amount converted
OFFROAD – ARB	2800	100.0	0.0	No	NA	Test data

NA = not applicable

4.0 Modeling Method Used in This Analysis

4.1 Models Used

Since both of the EPA models seem to effectively split the fuel sulfur into SO_2 and SO_4 without double counting, AIR will use the EPA models to estimate nationwide SO_2 and SO_4 emission inventories. It is recognized, however, that these two models are not exactly consistent with each other, in the following respects:

- The NONROAD model does not yet include indirect sulfates
- There is a difference in the assumed percent of sulfur converted to SO_4. The SO_4 conversion is 2.2% for off-road engines, and 2.0% for on-road engines. The reason for this difference is not clear.
- The NONROAD model corrects for the sulfur in unburned or partially burned HC, while PART5 does not. The models should be made consistent, but the small size of this adjustment probably does not make much difference.

These differences should be corrected when the next version of each model is finalized. Certainly the biggest issue is the omission of estimating indirect sulfate particulate from the NONROAD model, and this analysis will include indirect sulfates for NONROAD vehicles, using the same fraction of SO_2 reacted (12%) as in the PART5 model for onroad vehicles.

It should also be recognized that the NONROAD model is still being developed by EPA, although many parts of the model have receive substantial review and comment. One area that is still undergoing review by the EPA that could impact these estimates is nonroad diesel fuel consumption. Some have commented that the off-road diesel fuel consumption appears to be too high relative to other sources. If true, this could mean that the activity is too high, the populations are too high, or both. EPA is currently reviewing these comments and conducting additional analyses. If the fuel consumption in the model is too high, then the inventories and reductions as estimate from this analysis will also be too high. However, the emission reductions from nonroad sources are still expected to be very significant.

AIR has several other concerns with the EPA models, as follows:

1. The indirect sulfate conversion of 12% in PART5 may be very low. As mentioned earlier in this report, it was estimated by EPA on an annual average basis, and does not represent an episodic condition (late Spring, Summer, early Fall) in which the SO_2 conversion may be significantly higher. EPA's 12% estimate is for urban areas. The SO_2 that does not react in the immediate urban area is transported downwind and reacts in rural areas, contributing to acid deposition, fine PM, and visibility problems in downwind areas.

2. The catalyst fractions in PART5 should be updated. This is discussed further in the next section.

3. The direct sulfate conversion of 3% for current catalyst-equipped vehicles may be low. AIR has examined evidence that the conversion rate may be much higher than 3%. The level of conversion is very sensitive to the catalyst formulation. All of this evidence is on current and past diesel catalyst formulations. It is very likely that future diesel catalyst formulations that must reduce NOx emissions by 50-60% will likely have much higher SO_2 conversions. In this analysis, however, we have used EPA's estimate of 3%.

4.2 Human Exposure and the Source of SO_2

AIR also believes that there could be a significant difference in the level of human exposure to sulfate from diesel engines, versus from tall stack stationary sources. In the case of tall stacks located near urban areas, SO_2 emitted can be blown many miles before it reacts to form sulfate PM. In the case of diesel engines, however, direct sulfate, indirect sulfate, and SO_2 emissions are much closer to ground level, thereby increasing human exposure. This difference is not reflected in the models or inventories.

4.3 Model Modifications

First, for on-road engines, many 2b, light-heavy-duty, and medium heavy-duty vehicles are now equipped with oxidation catalysts. The PART5 model assumes the fraction equipped for these vehicles is zero. In a previous analysis that AIR conducted for the Canadian Vehicle Manufacturers Association (CVMA), AIR estimated that 90% of 1995 and later 2b and light heavy duty vehicles are equipped with oxidation catalysts, and that 75% of 1995 and later medium duty vehicles are equipped with catalysts. (9) As noted earlier, EPA estimates that the fraction of sulfur that is converted to sulfates increases from 2% to 3% with an oxidation catalyst. Therefore, AIR adjusted the fraction of sulfur converted to sulfates in the model for 1995 and later 2bs, LHDDVs, and MHDDVs. The increased sulfate conversion fractions are shown in Table 4.

Table 4. Sulfate Conversion and Catalyst Fractions for Heavy Duty Diesels

Vehicle Type	Sulfate Conversion Fraction		Catalyst Fraction
	1994 and earlier MY	1995 and later MY	1995 and later MY
2b and LHDDV	0.02	0.029	0.9
MHDDV	0.02	0.0275	0.75
HHDDV	0.02	0.02	0

Second, since the NONROAD model currently does not include indirect sulfates, AIR included indirect sulfates to be consistent with the PART5 model. This was accomplished by estimating the SO_2 to indirect SO_4 inventory ratio for the on-road vehicles, and using this ratio with the NONROAD SO_2 inventory to estimate the indirect sulfates from NONROAD sources.

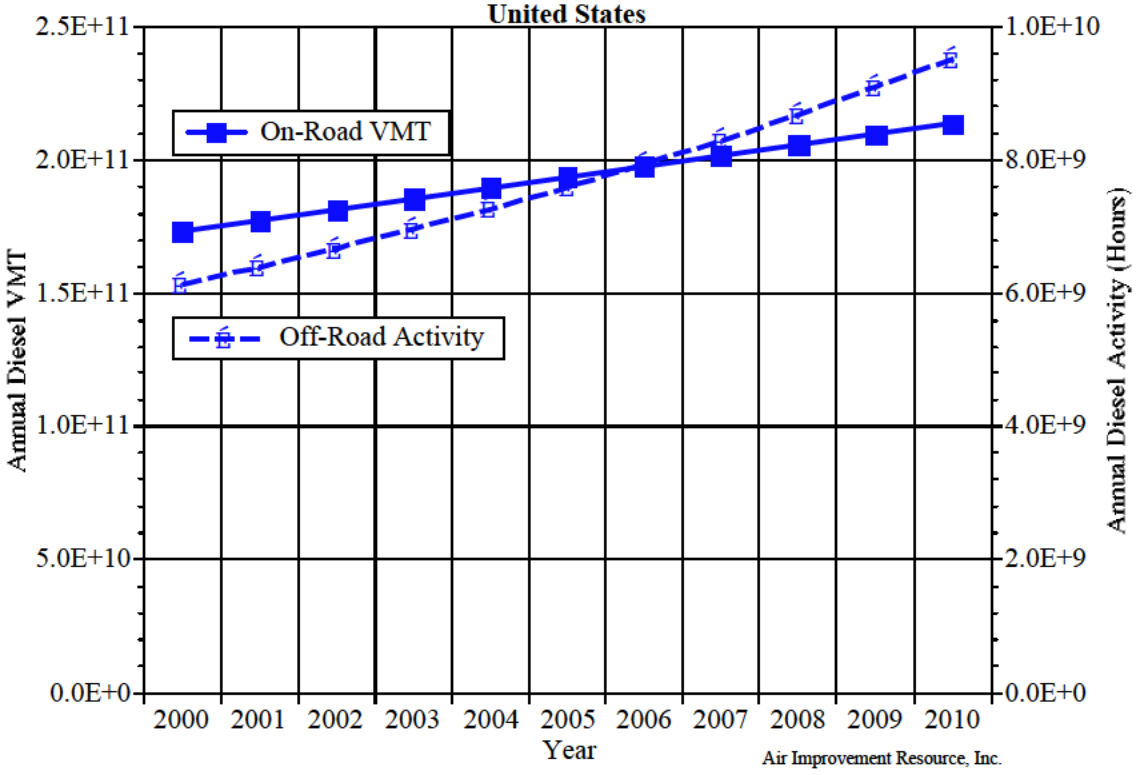
Third, AIR modified both of the models to input diesel fuel sulfur level, to aid in modeling the various control scenarios.

4.4 Activity

The NONROAD model already includes all of the populations and activities, so that it can estimate nationwide inventories in tons directly. However, the PART5 model outputs emissions in g/mi, so we must find a source of diesel vehicle miles traveled (VMT). AIR performed an analysis of the benefits of gasoline sulfur controls for AAMA, in which we obtained projected VMT for the 2007 calendar year by vehicle type and state for all 50 states from the EPA. (10,11) EPA has used this VMT to project nationwide emission inventories from on-highway mobile sources. To obtain VMT by diesel vehicle type for other calendar years, AIR applied a 2% linear growth factor. For years prior to 2007, the VMT values were reduced by 2% per year. For years after 2007, the VMT was increase by 2% per year.

The on-road and off-road total activity for calendar years 2000-2010 is shown in Figure 9.

Figure 9
Diesel On-Road VMT and Off-Road Activity
United States



4.5 Diesel Fuel Scenarios

EMA's diesel fuel control scenarios are shown in Table 5.

Table 5. Diesel Fuel Control Scenarios

Case	On-Road		Off-Road	
	Level	Date	Level	Date
Base	300	NA	3000	NA
A	30 max/15 nom	10/1/2003	30 max/15 nom	10/1/2003
B	30 max/15 nom	7/1/2002	500 max/300 nom	10/1/2002
			30 max/15 nom	10/1/2005

The PART5 model assumes on-road diesel sulfur level is 500 ppm, and the NONROAD model assumes the sulfur level is 3300 ppm. AIR evaluated on-road national sulfur levels using AAMA's fuel surveys, and the population-weighted average was very close to 300 ppm, therefore, 300 ppm was used in PART5 for on-road fuel in the base case. EMA specified a 3000 ppm nominal value for the baseline for off-road diesel fuel, so 3000 ppm was used in the off-road modeling.

Control Case A implements a 30 ppm cap for both on-road and off-road fuel on 10/1/2003. With a 30 ppm cap, AIR believes many refiners would sell fuel below the cap, therefore, we assumed a 15 ppm nominal level for all modeling of a 30 ppm cap. The 10/1/2003 implementation date was modeled by assuming for 3/4s of the year, the fuel sulfur level was at 300 ppm, and for the last quarter, it was at the nominal level.

Control Case B implements the 30 ppm cap for on-road engines 15 months earlier than Case A, but for off-road engines the first phase drops to a 500 ppm cap. The 500 ppm cap is modeled at a nominal value of 300 ppm. This is further reduced to a 30 ppm cap (15 ppm nominal) in 2005.

5.0 Results

5.1 On-Road Results

On-road SO_2, direct SO_4, and indirect SO_4 PM inventories in tons per day for the Base Case (i.e., 300 ppm S) are shown in Table 6. SO_2 ranges from 132 tpd in 2000 to 151 tpd in 2010. Total SO_4 PM is around 50 tpd. It should be recalled that this is only urban PM; urban + rural PM is likely to be much higher due to continued reaction of SO_2 in other areas. Emission reductions from the Base Case for Cases A and B are shown in Table 7, and are shown graphically in Figures 10 and 11. Once the low sulfur requirement is fully phased-in, SO_2 and SO_4 PM are reduced by 95%, or about 140 tpd and 50 tpd, respectively.

Table 6. Base Case SO_2 and SO_4 Inventories From On-Road Diesel Vehicles (tons per day)

Year	SO_2	Direct SO_4 PM	Indirect SO_4 PM	Total SO_4 PM
2000	131.7	9.9	37.9	47.8
2001	134.8	10.3	38.8	49.1
2002	136.6	10.5	39.3	49.6
2003	138.4	10.6	39.8	50.2
2004	140.0	10.8	40.3	51.1
2005	141.8	11.0	40.8	51.9
2006	143.4	11.3	41.3	52.6
2007	145.1	11.5	41.8	53.3
2008	146.8	11.7	42.3	54.0
2009	148.6	11.9	42.8	54.7
2010	150.5	12.0	43.3	55.3

Table 7. On-Road Emission Reductions from Cases A and B (tons per day)								
	Case A				Case B			
Year	SO_2	Direct SO_4 PM	Indirect SO_4 PM	Total SO_4 PM	SO_2	Direct SO_4 PM	Indirect SO_4 PM	Total SO_4 PM
2000	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	64.9	5.0	18.7	23.7
2003	32.9	2.5	9.5	12.0	131.4	10.1	37.9	48.0
2004	133.0	10.3	38.3	48.6	133.0	10.3	38.3	48.6
2005	134.7	10.5	38.8	49.3	134.7	10.5	38.8	49.3
2006	136.2	10.7	39.2	49.9	136.2	10.7	39.2	49.9
2007	137.8	10.9	39.7	50.6	137.8	10.9	39.7	50.6
2008	139.5	11.1	40.2	51.2	139.5	11.1	40.2	51.2
2009	141.2	11.3	40.7	51.9	141.2	11.3	40.7	51.9
2010	143.0	11.4	41.2	52.6	143.0	11.4	41.2	52.6

5.2 Off-Road Results

Off-road SO_2, total PM, and Indirect SO_4 PM in tons per day for the Base Case, Case A, and Case B are shown in Table 8. SO_2 and PM inventories are directly from the model, and the Indirect SO_4 emissions were estimated from SO_2 with the same ratio of SO_2/SO_4 as from on-road mobile sources. The PM emissions include nonsulfate PM as discussed earlier. Emission inventory reductions for the two cases are shown in Table 9, and are shown in Figures 12 and 13.

Table 8. Base Case Nonroad Vehicle SO_2, PM, and Indirect SO_4 Inventories (tpd)			
Year	SO_2	PM	Indirect SO_4
2000	1870	856	538
2001	1935	875	557
2002	2005	897	577
2003	2078	923	598
2004	2155	951	621
2005	2235	982	644
2006	2318	1016	668
2007	2405	1051	693
2008	2496	1089	719
2009	2592	1131	747
2010	2693	1174	776

Table 9. Nonroad SO_2 and PM Emission Reductions (tpd)								
	Case A				Case B			
Year	SO_2	Direct SO_4 PM	Indirect SO_4 PM	Total SO_4 PM	SO_2	Direct SO_4 PM	Indirect SO_4 PM	Total SO_4 PM
2000	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	451	40	130	170
2003	517	46	149	195	1871	167	538	705
2004	2144	193	618	811	1939	174	559	733
2005	2224	201	641	842	2064	187	641	828
2006	2307	210	666	876	2307	210	666	876
2007	2393	220	689	909	2393	220	689	909
2008	2484	230	715	945	2484	230	715	945
2009	2579	241	743	984	2579	241	743	984
2010	2678	252	772	1024	2678	252	772	1024

Table 9 indicates that Case will reduce SO_2 by 2100 tpd in 2004, expanding to 2700 tpd in 2010. Total sulfate PM is reduced by 600 tpd in 2004, expanding to over 1000 tpd in 2010. The reductions for Case B are approximately the same, except that they start one year earlier.

5.3 Total Program Emission Reductions

Total on-highway and off-highway SO_2 and SO_4 PM reductions for the two cases are shown in Table 10. Nationwide SO_2 reductions are almost 3000 tpd and total PM SO_4 reductions are in excess of 1000 tpd.

Table 10. Total Nationwide SO_2 and PM Emission Inventory Reductions (tpd)				
	Case A		Case B	
Year	SO_2	Total PM	SO_2	Total PM
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	516	194
2003	541	207	2002	753
2004	2277	860	2072	782
2005	2359	891	2199	878
2006	2443	926	2443	926
2007	2531	960	2531	960
2008	2624	996	2624	996
2009	2720	1036	2720	1036
2010	2821	1077	2821	1077

Figure 10
On-Road National SO_2 Reductions

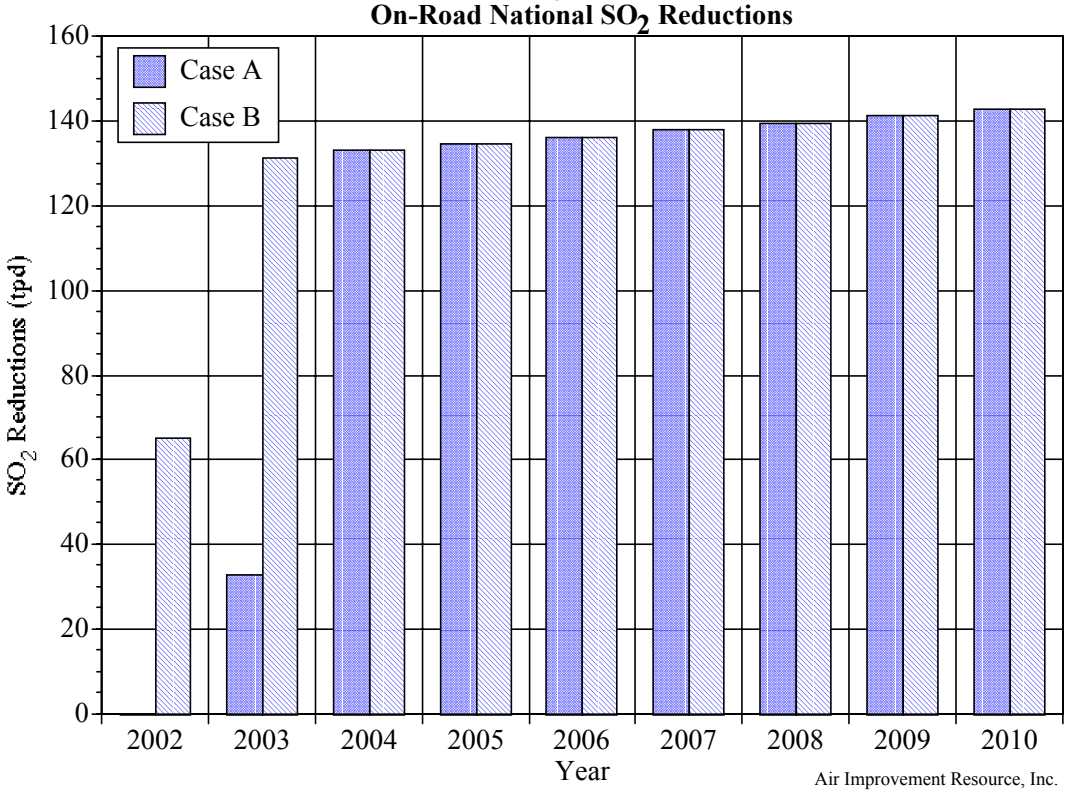


Figure 11
On-Road National Total SO_4 PM Reductions

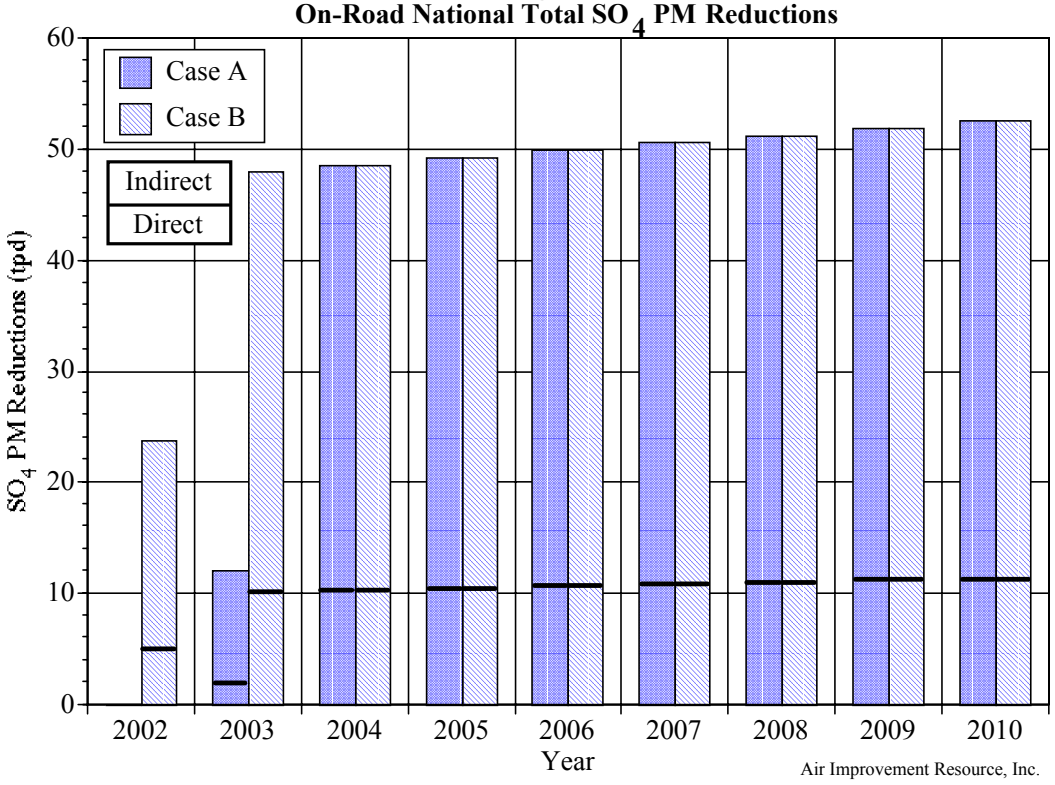


Figure 12
Off-Road National SO_2 Reductions

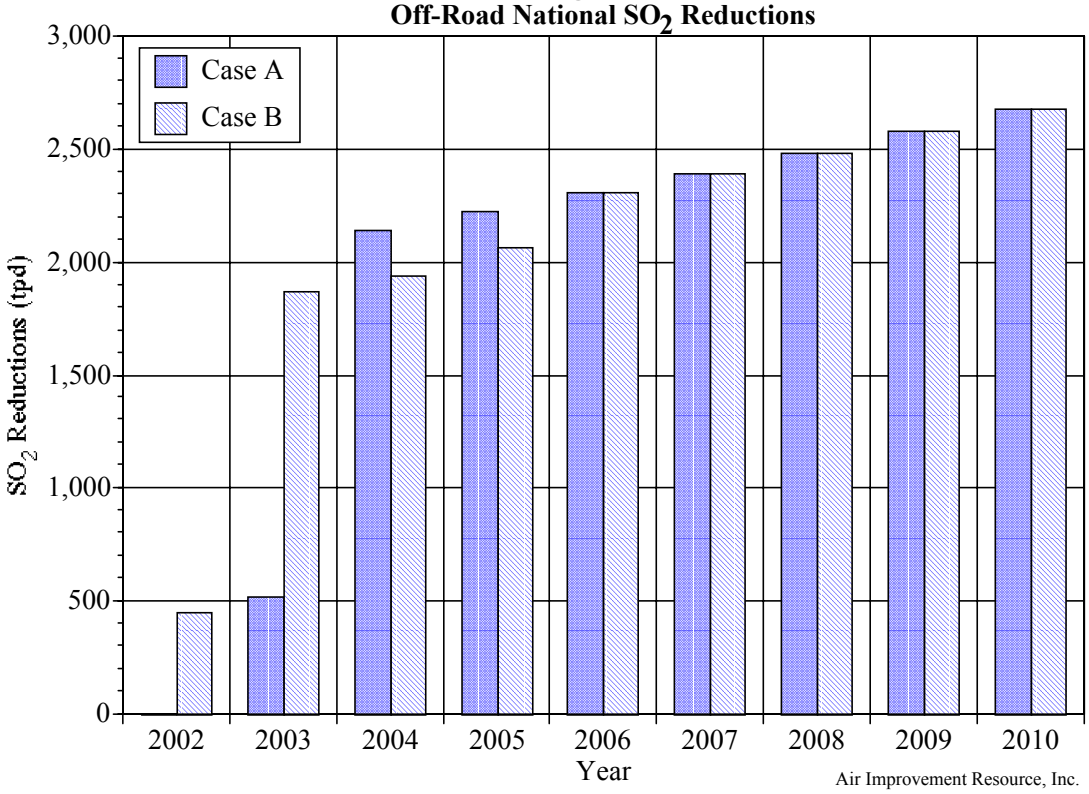
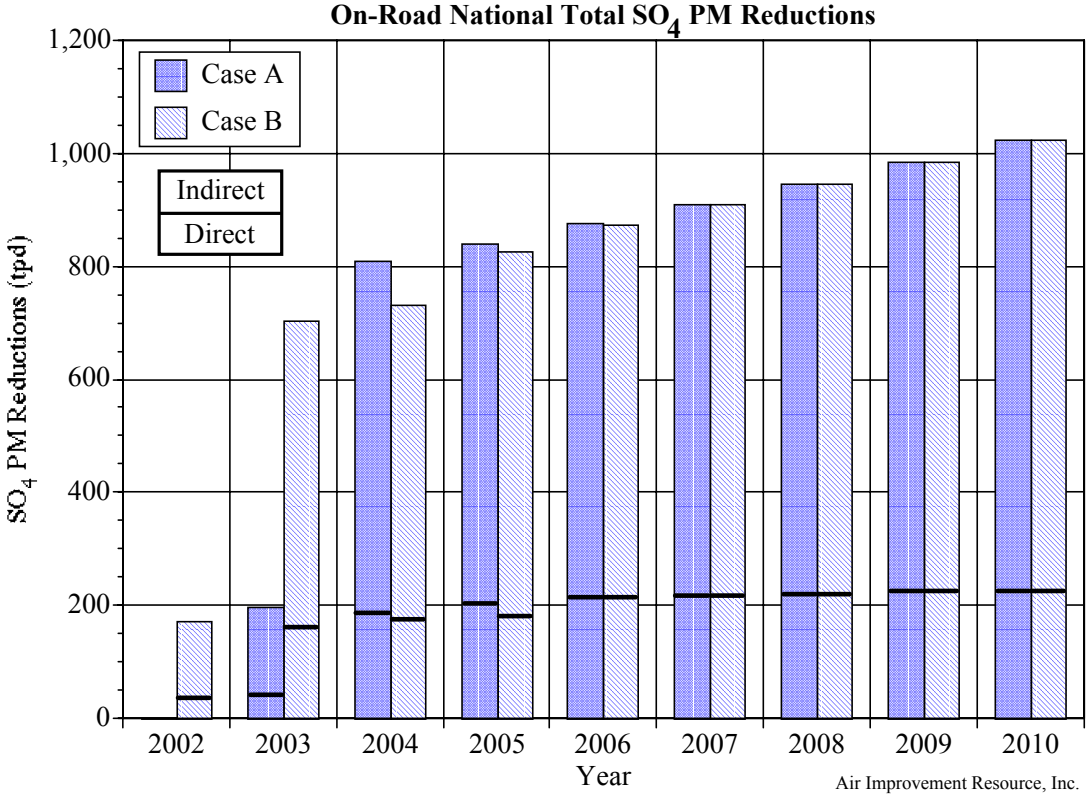


Figure 13
On-Road National Total SO_4 PM Reductions



6.0 Conclusions

This analysis has shown that a low sulfur on-road and off-road diesel specification would result in significant reductions in SO_2 and SO_4 PM emission inventories. The reductions in PM inventories are probably greater than estimated here because of the low assumed reaction of SO_2 to sulfate PM in this analysis. The PM reductions are certainly much greater in the summertime, when meteorological conditions favor much more rapid PM formation. Because sulfur oxides from diesel engines are emitted relatively close to the ground (compared to stationary sources), the reductions in SO_2 and fine sulfate PM inventories should result in lower ambient fine PM levels, improved visibility, and reduced human exposure to these pollutants. Finally, reducing diesel sulfur levels would improve EGR system life in diesel engines, reduce engine wear and maintenance costs, and allow for commercial application of more advanced diesel aftertreatment control devices.

7.0 References

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2. AIR derived this figure from AAMA's 1996 Annual Fuel Survey data.

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11. "Comparison of Emission Benefits of AAMA and API Sulfur Proposals in the U.S.: Summary Tables," AIR for AIAM, December 1998.

IPCC Assessment Report 5 Supplementary Material, Chapter 8SM

8.SM.15 Metric Values for Halocarbons Including Climate–Carbon Feedback for Carbon Dioxide to Support Section 8.7.2

Table 8.SM.16 | GWP and GTP with climate–carbon feedbacks included for halocarbons. The additional effect (delta) and the total effect are given. (Climate–carbon feedbacks in response to the reference gas CO_2 are always included).

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
CFC-11										
Delta	3.04E-12	**122**	6.32E-11	**689**	1.29E-13	**189**	4.32E-13	**701**	6.32E-13	**1156**
Total	1.75E-10	**7020**	4.91E-10	**5352**	4.84E-12	**7078**	3.45E-12	**5589**	1.91E-12	**3491**
CFC-12										
Delta	4.53E-12	**182**	1.20E-10	**1308**	1.94E-13	**283**	7.45E-13	**1208**	1.34E-12	**2459**
Total	2.74E-10	**10,976**	1.06E-09	**11,547**	7.90E-12	**11,549**	7.50E-12	**12,160**	5.96E-12	**10,907**
CFC-13										
Delta	4.40E-12	**177**	1.43E-10	**1558**	1.89E-13	**277**	8.09E-13	**1312**	1.76E-12	**3221**
Total	2.75E-10	**11,040**	1.42E-09	**15,451**	8.18E-12	**11,960**	9.58E-12	**15,530**	1.05E-11	**19,144**
CFC-113										
Delta	2.75E-12	**110**	6.99E-11	**762**	1.17E-13	**171**	4.41E-13	**716**	7.69E-13	**1407**
Total	1.65E-10	**6600**	6.04E-10	**6586**	4.72E-12	**6902**	4.29E-12	**6963**	3.22E-12	**5880**
CFC-114										
Delta	3.18E-12	**127**	9.38E-11	**1023**	1.36E-13	**199**	5.55E-13	**900**	1.11E-12	**2026**
Total	1.96E-10	**7839**	8.82E-10	**9615**	5.74E-12	**8385**	6.12E-12	**9922**	5.79E-12	**10,579**
CFC-115										
Delta	2.37E-12	**95**	7.81E-11	**851**	1.02E-13	**149**	4.39E-13	**712**	9.69E-13	**1772**
Total	1.49E-10	**5954**	7.81E-10	**8516**	4.42E-12	**6463**	5.25E-12	**8517**	5.88E-12	**10,749**
HCFC-21										
Delta	4.72E-13	**19**	2.91E-12	**32**	1.71E-14	**25**	2.16E-14	**35**	2.03E-14	**37**
Total	1.40E-11	**562**	1.65E-11	**179**	1.49E-13	**217**	3.75E-14	**61**	3.14E-14	**57**
HCFC-22										
Delta	2.88E-12	**115**	3.13E-11	**342**	1.18E-13	**172**	2.46E-13	**399**	2.44E-13	**446**
Total	1.35E-10	**5395**	1.93E-10	**2106**	2.99E-12	**4368**	7.59E-13	**1230**	3.87E-13	**708**
HCFC-122										
Delta	1.99E-13	**8**	1.17E-12	**13**	7.06E-15	**10**	8.66E-15	**14**	8.13E-15	15
Total	5.63E-12	**226**	6.60E-12	**72**	5.51E-14	**81**	1.49E-14	**24**	1.26E-14	23
HCFC-122a										
Delta	7.28E-13	**29**	5.00E-12	**54**	2.75E-14	**40**	3.78E-14	**61**	3.54E-14	**65**
Total	2.43E-11	**975**	2.87E-11	**312**	3.19E-13	**466**	6.77E-14	**110**	5.50E-14	**101**
HCFC-123										
Delta	2.61E-13	**10**	1.57E-12	**17**	9.35E-15	**14**	1.16E-14	**19**	1.09E-14	**20**
Total	7.54E-12	**302**	8.85E-12	**96**	7.64E-14	**112**	2.01E-14	**33**	1.69E-14	**31**
HCFC-123a										
Delta	9.98E-13	**40**	7.12E-12	**78**	3.82E-14	**56**	5.42E-14	**88**	5.08E-14	**93**
Total	3.47E-11	**1390**	4.10E-11	**447**	4.89E-13	**715**	9.86E-14	**160**	7.89E-14	**144**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
HCFC-124										
Delta	1.24E-12	**50**	9.96E-12	**109**	4.87E-14	**71**	7.70E-14	**125**	7.24E-14	**132**
Total	4.79E-11	**1920**	5.82E-11	**635**	8.12E-13	**1187**	1.52E-13	**246**	1.13E-13	**206**
HCFC-132c										
Delta	8.93E-13	**36**	6.50E-12	**71**	3.43E-14	**50**	4.96E-14	**80**	4.65E-14	**85**
Total	3.16E-11	**1268**	3.75E-11	**409**	4.61E-13	**674**	9.10E-14	**148**	7.23E-14	**132**
HCFC-141b										
Delta	1.48E-12	**59**	1.43E-11	**156**	5.99E-14	**88**	1.12E-13	**182**	1.08E-13	**197**
Total	6.51E-11	**2608**	8.60E-11	**938**	1.33E-12	**1941**	2.80E-13	**453**	1.69E-13	**309**
HCFC-142b										
Delta	2.53E-12	**101**	3.33E-11	**363**	1.05E-13	**153**	2.56E-13	**415**	2.75E-13	**502**
Total	1.28E-10	**5125**	2.15E-10	**2345**	3.11E-12	**4546**	1.10E-12	**1787**	4.69E-13	**858**
HCFC-225ca										
Delta	4.02E-13	**16**	2.51E-12	**27**	1.47E-14	**21**	1.87E-14	**30**	1.75E-14	**32**
Total	1.21E-11	**485**	1.42E-11	**155**	1.31E-13	**192**	3.25E-14	**53**	2.72E-14	**50**
HCFC-225cb										
Delta	1.23E-12	**49**	9.92E-12	**108**	4.85E-14	**71**	7.67E-14	**124**	7.22E-14	**132**
Total	4.77E-11	**1913**	5.80E-11	**633**	8.09E-13	**1183**	1.51E-13	**245**	1.12E-13	**205**
(E)-1-Chloro-3,3,3-trifluoroprop-1-ene										
Delta	5.31E-15	**<1**	2.97E-14	**<1**	1.82E-16	**<1**	2.17E-16	**<1**	2.04E-16	<1
Total	1.42E-13	**6**	1.66E-13	**2**	1.28E-15	**2**	3.71E-16	**1**	3.16E-16	1
HFC-23										
Delta	4.45E-12	**178**	1.34E-10	**1459**	1.91E-13	**279**	7.85E-13	**1272**	1.59E-12	**2913**
Total	2.75E-10	**11,005**	1.27E-09	**13,856**	8.07E-12	**11,802**	8.78E-12	**14,232**	8.54E-12	**15,622**
HFC-32										
Delta	1.67E-12	**67**	1.29E-11	**141**	6.52E-14	**95**	9.91E-14	**161**	9.31E-14	**170**
Total	6.24E-11	**2502**	7.50E-11	**817**	9.97E-13	**1457**	1.88E-13	**305**	1.45E-13	**265**
HFC-41										
Delta	3.43E-13	**14**	2.27E-12	**25**	1.28E-14	**19**	1.70E-14	**28**	1.60E-14	**29**
Total	1.10E-11	**441**	1.29E-11	**141**	1.34E-13	**195**	3.01E-14	**49**	2.48E-14	**45**
HFC-125										
Delta	2.83E-12	**113**	4.79E-11	**522**	1.19E-13	**174**	3.49E-13	**566**	4.37E-13	**798**
Total	1.55E-10	**6207**	3.39E-10	**3691**	4.08E-12	**5971**	2.19E-12	**3543**	9.66E-13	**1766**
HFC-134										
Delta	2.06E-12	**82**	2.03E-11	**221**	8.31E-14	**122**	1.59E-13	**258**	1.54E-13	**282**
Total	9.14E-11	**3663**	1.23E-10	**1337**	1.90E-12	**2778**	4.13E-13	**670**	2.41E-13	**441**
HFC-134a										
Delta	1.97E-12	**79**	2.27E-11	**248**	8.07E-14	**118**	1.78E-13	**288**	1.80E-13	**329**
Total	9.45E-11	**3789**	1.42E-10	**1549**	2.17E-12	**3171**	6.11E-13	**991**	2.90E-13	**530**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
HFC-143										
Delta	9.18E-13	**37**	6.35E-12	**69**	3.48E-14	**51**	4.81E-14	**78**	4.51E-14	**82**
Total	3.09E-11	**1239**	3.64E-11	**397**	4.10E-13	**600**	8.63E-14	**140**	7.00E-14	**128**
HFC-143a										
Delta	3.05E-12	**122**	6.45E-11	**703**	1.29E-13	**189**	4.38E-13	**710**	6.50E-13	**1189**
Total	1.76E-10	**7064**	5.05E-10	**5508**	4.89E-12	**7146**	3.56E-12	**5771**	2.02E-12	**3693**
HFC-152										
Delta	5.73E-14	**2**	3.27E-13	**4**	.1.99E-15	**3**	2.40E-15	**4**	2.25E-15	**4**
Total	1.56E-12	**63**	1.83E-12	**20**	1.45E-14	**21**	4.10E-15	**7**	3.49E-15	**6**
HFC-152a										
Delta	4.46E-13	**18**	2.71E-12	**30**	1.61E-14	**23**	2.01E-14	**33**	1.89E-14	35
Total	1.31E-11	**524**	1.53E-11	**167**	1.35E-13	**198**	3.49E-14	**57**	2.93E-14	54
HFC-161										
Delta	1.29E-14	**1**	7.26E-14	**1**	4.44E-16	**1**	5.30E-16	**1**	4.99E-16	**1**
Total	3.46E-13	**14**	4.06E-13	**4**	3.14E-15	**5**	9.06E-16	**1**	7.72E-16	**1**
HFC-227ca										
Delta	2.36E-12	**95**	3.99E-11	**435**	9.91E-14	**145**	2.91E-13	**472**	3.64E-13	**665**
Total	1.29E-10	**5175**	2.82E-10	**3077**	3.41E-12	**4978**	1.82E-12	**2954**	8.05E-13	**1472**
HFC-227ea										
Delta	2.40E-12	**96**	4.69E-11	**512**	1.01E-13	**148**	3.27E-13	**531**	4.56E-13	**835**
Total	1.36E-10	**5454**	3.54E-10	**3860**	3.72E-12	**5431**	2.45E-12	**3967**	1.25E-12	**2294**
HFC-236cb										
Delta	1.85E-12	**74**	2.12E-11	**231**	7.59E-14	**111**	1.66E-13	**269**	1.67E-13	**305**
Total	8.86E-11	**3550**	1.32E-10	**1438**	2.02E-12	**2953**	5.58E-13	**904**	2.68E-13	**490**
HFC-236ea										
Delta	2.28E-12	**92**	2.39E-11	**261**	9.30E-14	**136**	1.88E-13	**305**	1.84E-13	**337**
Total	1.05E-10	**4203**	1.46E-10	**1596**	2.27E-12	**3322**	5.41E-13	**878**	2.91E-13	**532**
HFC-236fa										
Delta	2.84E-12	**114**	8.64E-11	**942**	1.22E-13	**178**	5.05E-13	**818**	1.03E-12	**1890**
Total	1.76E-10	**7054**	8.25E-10	**8998**	5.18E-12	**7575**	5.69E-12	**9220**	5.61E-12	**10,267**
HFC-245ca										
Delta	1.62E-12	**65**	1.35E-11	**147**	6.39E-14	**93**	1.04E-13	**169**	9.85E-14	**180**
Total	6.42E-11	**2575**	7.91E-11	**863**	1.14E-12	**1663**	2.13E-13	**345**	1.53E-13	**281**
HFC-245cb										
Delta	2.94E-12	**118**	6.20E-11	**676**	1.24E-13	**182**	4.21E-13	**683**	6.25E-13	**1144**
Total	1.70E-10	**6795**	4.86E-10	**5298**	4.70E-12	**6875**	3.42E-12	**5552**	1.94E-12	**3553**
HFC-245ea										
Delta	6.73E-13	**27**	4.57E-12	**50**	2.54E-14	**37**	3.45E-14	**56**	3.23E-14	**59**
Total	2.22E-11	**890**	2.61E-11	**285**	2.84E-13	**415**	6.14E-14	**100**	5.02E-14	**92**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
HFC-245eb										
Delta	8.37E-13	**34**	5.64E-12	**61**	3.15E-14	**46**	4.25E-14	**69**	3.99E-14	73
Total	2.74E-11	**1099**	3.23E-11	**352**	3.46E-13	**506**	7.56E-14	**123**	6.19E-14	113
HFC-245fa										
Delta	1.79E-12	**72**	1.59E-11	**174**	7.14E-14	**104**	1.24E-13	**202**	1.18E-13	**216**
Total	7.46E-11	**2992**	9.47E-11	**1032**	1.42E-12	**2079**	2.76E-13	**447**	1.84E-13	**337**
HFC-263fb										
Delta	2.50E-13	**10**	1.49E-12	**16**	8.93E-15	**13**	1.10E-14	**18**	1.04E-14	**19**
Total	7.18E-12	**288**	8.42E-12	**92**	7.20E-14	**105**	1.91E-14	**31**	1.61E-14	**29**
HFC-272ca										
Delta	4.31E-13	**17**	2.82E-12	**31**	1.60E-14	**23**	2.11E-14	**34**	1.98E-14	**36**
Total	1.36E-11	**547**	1.60E-11	**175**	1.62E-13	**236**	3.72E-14	**60**	3.07E-14	**56**
HFC-329p										
Delta	2.09E-12	**84**	3.55E-11	**387**	8.79E-14	**128**	2.59E-13	**420**	3.24E-13	**593**
Total	1.15E-10	**4594**	2.52E-10	**2742**	3.03E-12	**4423**	1.63E-12	**2638**	7.21E-13	**1318**
HFC-365mfc										
Delta	1.57E-12	**63**	1.48E-11	**161**	6.33E-14	**93**	1.16E-13	**188**	1.11E-13	**203**
Total	6.79E-11	**2724**	8.86E-11	**966**	1.36E-12	**1986**	2.77E-13	**450**	1.73E-13	**317**
HFC-43-10mee										
Delta	2.20E-12	**88**	2.80E-11	**305**	9.09E-14	**133**	2.16E-13	**351**	2.28E-13	**417**
Total	1.10E-10	**4403**	1.79E-10	**1952**	2.63E-12	**3851**	8.78E-13	**1424**	3.82E-13	**698**
HFC-1132a										
Delta	1.51E-16	**<1**	8.44E-16	**<1**	5.18E-18	**<1**	6.16E-18	**<1**	5.79E-18	**<1**
Total	4.04E-15	**<1**	4.73E-15	**<1**	3.61E-17	**<1**	1.05E-17	**<1**	8.98E-18	**<1**
HFC-1141										
Delta	6.04E-17	**<1**	3.38E-16	**<1**	2.07E-18	**<1**	2.47E-18	**<1**	2.32E-18	**<1**
Total	1.62E-15	**<1**	1.90E-15	**<1**	1.44E-17	**<1**	4.21E-18	**<1**	3.60E-18	**<1**
(Z)-HFC-1225ye										
Delta	8.31E-16	**<1**	4.65E-15	**<1**	2.85E-17	**<1**	3.39E-17	**<1**	3.19E-17	**<1**
Total	2.22E-14	**1**	2.60E-14	**<1**	1.99E-16	**<1**	5.80E-17	**<1**	4.95E-17	**<1**
(E)-HFC-1225ye										
Delta	2.81E-16	**<1**	1.57E-15	**<1**	9.64E-18	**<1**	1.15E-17	**<1**	1.08E-17	<1
Total	7.52E-15	**<1**	8.81E-15	**<1**	6.72E-17	**<1**	1.96E-17	**<1**	1.67E-17	<1
(Z)-HFC-1234ze										
Delta	1.01E-15	**<1**	5.68E-15	**<1**	3.48E-17	**<1**	4.14E-17	**<1**	3.90E-17	**<1**
Total	2.71E-14	**1**	3.18E-14	**<1**	2.43E-16	**<1**	7.08E-17	**<1**	6.04E-17	**<1**
HFC-1234yf										
Delta	1.25E-15	**<1**	7.02E-15	**<1**	4.31E-17	**<1**	5.12E-17	**<1**	4.82E-17	**<1**
Total	3.35E-14	**1**	3.93E-14	**<1**	3.00E-16	**<1**	8.75E-17	**<1**	7.47E-17	**<1**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
(E)-HFC-1234ze										
Delta	3.40E-15	<1	1.90E-14	<1	1.17E-16	<1	1.39E-16	<1	1.30E-16	<1
Total	9.07E-14	4	1.06E-13	1	8.14E-16	1	2.37E-16	<1	2.02E-16	<1
(Z)-HFC-1336										
Delta	5.98E-15	<1	3.35E-14	<1	2.06E-16	<1	2.45E-16	<1	2.30E-16	<1
Total	1.60E-13	6	1.87E-13	2	1.44E-15	2	4.18E-16	1	3.56E-16	1
HFC-1243zf										
Delta	5.31E-16	<1	2.97E-15	<1	1.82E-17	<1	2.17E-17	<1	2.04E-17	<1
Total	1.42E-14	1	1.66E-14	<1	1.27E-16	<1	3.70E-17	<1	3.16E-17	<1
HFC-1345zfc										
Delta	4.49E-16	<1	2.51E-15	<1	1.54E-17	<1	1.83E-17	<1	1.72E-17	<1
Total	1.20E-14	<1	1.41E-14	<1	1.07E-16	<1	3.13E-17	<1	2.67E-17	<1
3,3,4,4,5,5,6,6,6-Nonafluorohex-1-ene										
Delta	4.84E-16	<1	2.71E-15	<1	1.66E-17	<1	1.98E-17	<1	1.86E-17	<1
Total	1.29E-14	1	1.52E-14	<1	1.16E-16	<1	3.38E-17	<1	2.88E-17	<1
3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooct-1-ene										
Delta	3.84E-16	<1	2.15E-15	<1	1.32E-17	<1	1.57E-17	<1	1.47E-17	<1
Total	1.03E-14	<1	1.20E-14	<1	9.19E-17	<1	2.68E-17	<1	2.29E-17	<1
3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodec-1-ene										
Delta	3.31E-16	<1	1.85E-15	<1	1.14E-17	<1	1.35E-17	<1	1.27E-17	<1
Total	8.86E-15	<1	1.04E-14	<1	7.92E-17	<1	2.31E-17	<1	1.97E-17	<1
Methyl chloroform										
Delta	4.02E-13	16	3.05E-12	33	1.56E-14	23	2.34E-14	38	2.20E-14	40
Total	1.48E-11	594	1.77E-11	193	2.32E-13	339	4.42E-14	72	3.42E-14	63
Carbon tetrachloride										
Delta	1.64E-12	66	2.66E-11	290	6.86E-14	100	1.96E-13	318	2.39E-13	436
Total	8.86E-11	3550	1.85E-10	2019	2.31E-12	3378	1.16E-12	1887	5.01E-13	915
Methyl chloride										
Delta	4.09E-14	2	2.42E-13	3	1.45E-15	2	1.78E-15	3	1.67E-15	3
Total	1.16E-12	46	1.36E-12	15	1.14E-14	17	3.07E-15	5	2.59E-15	5
Methylene chloride										
Delta	3.12E-14	1	1.78E-13	2	1.08E-15	2	1.30E-15	2	1.22E-15	2
Total	8.49E-13	34	9.95E-13	11	7.86E-15	11	2.23E-15	4	1.90E-15	3
Chloroform										
Delta	5.73E-14	2	3.27E-13	4	1.99E-15	3	2.40E-15	4	2.25E-15	4
Total	1.56E-12	63	1.83E-12	20	1.45E-14	21	4.10E-15	7	3.49E-15	6
1,2-Dichloroethane										
Delta	3.18E-15	<1	1.79E-14	<1	1.10E-16	<1	1.31E-16	<1	1.23E-16	<1
Total	8.56E-14	3	1.00E-13	1	7.77E-16	1	2.24E-16	<1	1.91E-16	<1

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
Methyl bromide										
Delta	8.01E-15	<1	4.68E-14	1	2.82E-16	<1	3.44E-16	1	3.23E-16	1
Total	2.24E-13	9	2.63E-13	3	2.16E-15	3	5.91E-16	1	5.01E-16	1
Methylene bromide										
Delta	3.56E-15	<1	2.02E-14	<1	1.23E-16	<1	1.48E-16	<1	1.39E-16	<1
Total	9.66E-14	4	1.13E-13	1	8.90E-16	1	2.54E-16	<1	2.16E-16	<1
Halon-1201										
Delta	9.29E-13	37	7.16E-12	78	3.62E-14	53	5.50E-14	89	5.17E-14	95
Total	3.47E-11	1390	4.16E-11	454	5.54E-13	809	1.05E-13	170	8.04E-14	147
Halon-1202										
Delta	6.76E-13	27	4.50E-12	49	2.53E-14	37	3.38E-14	55	3.17E-14	58
Total	2.18E-11	875	2.57E-11	280	2.69E-13	393	5.99E-14	97	4.92E-14	90
Halon-1211										
Delta	2.34E-12	94	2.97E-11	324	9.67E-14	141	2.30E-13	373	2.42E-13	442
Total	1.17E-10	4684	1.90E-10	2070	2.80E-12	4091	9.28E-13	1504	4.04E-13	739
Halon-1301										
Delta	3.35E-12	134	7.91E-11	862	1.43E-13	208	5.15E-13	835	8.40E-13	1536
Total	1.98E-10	7935	6.56E-10	7154	5.61E-12	8194	4.68E-12	7581	3.12E-12	5703
Halon-2301										
Delta	4.89E-13	20	3.36E-12	37	1.85E-14	27	2.54E-14	41	2.38E-14	44
Total	1.63E-11	655	1.93E-11	210	2.14E-13	313	4.55E-14	74	3.70E-14	68
Halon-2311/Halothane										
Delta	1.38E-13	6	8.15E-13	9	4.90E-15	7	6.01E-15	10	5.64E-15	10
Total	3.91E-12	157	4.59E-12	50	3.84E-14	56	1.04E-14	17	8.75E-15	16
Halon-2401										
Delta	5.38E-13	22	3.58E-12	39	2.01E-14	29	2.69E-14	44	2.52E-14	46
Total	1.74E-11	696	2.04E-11	223	2.14E-13	312	4.77E-14	77	3.92E-14	72
Halon-2402										
Delta	1.68E-12	68	2.40E-11	262	7.01E-14	102	1.82E-13	296	2.04E-13	373
Total	8.76E-11	3511	1.59E-10	1734	2.19E-12	3207	8.90E-13	1443	3.70E-13	676
Nitrogen trifluoride										
Delta	5.19E-12	208	1.66E-10	1815	2.23E-13	326	9.48E-13	1537	2.04E-12	3733
Total	3.24E-10	12,987,000	1.64E-09	17,885	9.61E-12	14,049	1.11E-11	18,041	1.20E-11	21,852
Sulphur hexafluoride										
Delta	7.06E-12	283	2.37E-10	2580	3.03E-13	444	1.32E-12	2139	2.96E-12	5416
Total	4.44E-10	17,783	2.39E-09	26,087	1.32E-11	19,348	1.60E-11	25,934	1.84E-11	33,631
(Trifluoromethyl)sulphur pentafluoride										
Delta	5.46E-12	219	1.78E-10	1946	2.35E-13	343	1.01E-12	1633	2.21E-12	4039
Total	3.42E-10	13,698	1.78E-09	19,396	1.02E-11	14,855	1.20E-11	19,443	1.33E-11	24,271

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
Sulphuryl fluoride										
Delta	3.08E-12	**124**	5.84E-11	**637**	1.30E-13	**190**	4.12E-13	**668**	5.60E-13	**1024**
Total	1.74E-10	**6965**	4.34E-10	**4732**	4.71E-12	**6885**	2.96E-12	**4805**	1.46E-12	**2671**
PFC-14										
Delta	1.96E-12	**79**	6.64E-11	**724**	8.44E-14	**123**	3.69E-13	**598**	8.34E-13	1524
Total	1.24E-10	**4954**	6.74E-10	**7349**	3.69E-12	**5396**	4.49E-12	**7286**	5.23E-12	9563
PFC-116										
Delta	3.31E-12	**133**	1.12E-10	**1216**	1.42E-13	**208**	6.20E-13	**1006**	1.40E-12	**2560**
Total	2.08E-10	**8344**	1.13E-09	**12,340**	6.21E-12	**9085**	7.55E-12	**12,243**	8.76E-12	**16,016**
PFC-c216										
Delta	2.76E-12	**111**	9.26E-11	**1010**	1.19E-13	**174**	5.16E-13	**837**	1.16E-12	**2119**
Total	1.74E-10	**6964**	9.36E-10	**10,208**	5.18E-12	**7576**	6.26E-12	**10,149**	7.19E-12	**13,151**
PFC-218										
Delta	2.68E-12	**107**	8.97E-11	**978**	1.15E-13	**168**	5.00E-13	**812**	1.12E-12	**2051**
Total	1.68E-10	**6752**	9.06E-10	**9878**	5.02E-12	**7344**	6.06E-12	**9826**	6.95E-12	**12,705**
PFC-318										
Delta	2.87E-12	**115**	9.61E-11	**1048**	1.23E-13	**180**	5.36E-13	**869**	1.20E-12	**2199**
Total	1.80E-10	**7221**	9.71E-10	**10,592**	5.37E-12	**7856**	6.49E-12	**10,530**	7.47E-12	**13,655**
PFC-31-10										
Delta	2.77E-12	**111**	9.27E-11	**1011**	1.19E-13	**174**	5.17E-13	**839**	1.16E-12	**2121**
Total	1.74E-10	**6981**	9.37E-10	**10,213**	5.19E-12	**7594**	6.27E-12	**10,160**	7.18E-12	**13,137**
Perfluorocyclopentene										
Delta	6.63E-15	**<1**	3.72E-14	**<1**	2.28E-16	**<1**	2.71E-16	**<1**	2.55E-16	**<1**
Total	1.77E-13	**7**	2.08E-13	**2**	1.60E-15	**2**	4.63E-16	**1**	3.95E-16	**1**
PFC-41-12										
Delta	2.56E-12	**103**	8.59E-11	**937**	1.10E-13	**161**	4.79E-13	**776**	1.08E-12	**1968**
Total	1.61E-10	**6448**	8.70E-10	**9484**	4.80E-12	**7017**	5.81E-12	**9422**	6.70E-12	**12,253**
PFC-51-14										
Delta	2.38E-12	**95**	7.97E-11	**869**	1.02E-13	**149**	4.44E-13	**720**	9.97E-13	**1823**
Total	1.49E-10	**5988**	8.05E-10	**8780**	4.46E-12	**6514**	5.38E-12	**8730**	6.19E-12	**11,316**
PFC-61-16										
Delta	2.35E-12	**94**	7.88E-11	**859**	1.01E-13	**148**	4.39E-13	**712**	9.86E-13	**1802**
Total	1.48E-10	**5922**	7.96E-10	**8681**	4.41E-12	**6443**	5.32E-12	**8631**	6.12E-12	**11,183**
PFC-71-18										
Delta	2.29E-12	**92**	7.67E-11	**837**	9.84E-14	**144**	4.28E-13	**694**	9.60E-13	1756
Total	1.44E-10	**5769**	7.76E-10	**8456**	4.29E-12	**6276**	5.19E-12	**8408**	5.96E-12	10,894
PFC-91-18										
Delta	2.18E-12	**87**	7.26E-11	**791**	9.35E-14	**137**	4.05E-13	**658**	9.06E-13	**1657**
Total	1.37E-10	**5476**	7.32E-10	**7977**	4.07E-12	**5954**	4.90E-12	**7943**	5.59E-12	**10,222**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
Perfluorodecalin(cis)										
Delta	2.19E-12	**88**	7.31E-11	**797**	9.42E-14	**138**	4.08E-13	**662**	9.13E-13	**1669**
Total	1.38E-10	**5515**	7.37E-10	**8033**	4.10E-12	**5997**	4.93E-12	**8000**	5.63E-12	**10,295**
Perfluorodecalin(trans)										
Delta	1.90E-12	**76**	6.35E-11	**692**	8.18E-14	**120**	3.55E-13	**575**	7.93E-13	**1450**
Total	1.20E-10	**4792**	6.40E-10	**6980**	3.56E-12	**5211**	4.29E-12	**6951**	4.89E-12	**8946**
PFC-1114										
Delta	1.03E-17	**<1**	5.78E-17	**<1**	3.55E-19	**<1**	4.22E-19	**<1**	3.96E-19	**<1**
Total	2.77E-16	**<1**	3.24E-16	**<1**	2.47E-18	**<1**	7.21E-19	**<1**	6.15E-19	**<1**
PFC-1216										
Delta	2.49E-16	**<1**	1.40E-15	**<1**	8.56E-18	**<1**	1.02E-17	**<1**	9.57E-18	**<1**
Total	6.67E-15	**<1**	7.82E-15	**<1**	5.97E-17	**<1**	1.74E-17	**<1**	1.48E-17	**<1**
Perfluorobuta-1,3-diene										
Delta	1.27E-17	**<1**	7.11E-17	**<1**	4.36E-19	**<1**	5.19E-19	**<1**	4.88E-19	**<1**
Total	3.40E-16	**<1**	3.99E-16	**<1**	3.04E-18	**<1**	8.86E-19	**<1**	7.57E-19	**<1**
Perfluorobut-1-ene										
Delta	3.25E-16	**<1**	1.82E-15	**<1**	1.11E-17	**<1**	1.33E-17	**<1**	1.25E-17	**<1**
Total	8.69E-15	**<1**	1.02E-14	**<1**	7.77E-17	**<1**	2.26E-17	**<1**	1.93E-17	**<1**
Perfluorobut-2-ene										
Delta	6.28E-15	**<1**	3.52E-14	**<1**	2.16E-16	**<1**	2.57E-16	**<1**	2.42E-16	**<1**
Total	1.68E-13	**7**	1.97E-13	**2**	1.51E-15	**2**	4.39E-16	**1**	3.74E-16	**1**
HFE-125										
Delta	5.18E-12	**208**	1.42E-10	**1549**	2.21E-13	**324**	8.68E-13	**1408**	1.62E-12	**2961**
Total	3.15E-10	**12,617**	1.28E-09	**13,951**	9.13E-12	**13,349**	9.01E-12	**14,615**	7.59E-12	**13,871**
HFE-134 (HG-00)										
Delta	5.51E-12	**221**	8.69E-11	**947**	2.31E-13	**337**	6.46E-13	**1047**	7.69E-13	1406
Total	2.96E-10	**11,857**	5.97E-10	**6512**	7.65E-12	**11,183**	3.67E-12	**5945**	1.55E-12	2837
HFE-143a										
Delta	1.33E-12	**53**	1.00E-11	**109**	5.16E-14	**75**	7.67E-14	**124**	7.19E-14	**132**
Total	4.86E-11	**1947**	5.80E-11	**632**	7.47E-13	**1091**	1.43E-13	**232**	1.12E-13	**205**
HFE-227ea										
Delta	3.88E-12	**156**	8.49E-11	**926**	1.65E-13	**241**	5.70E-13	**924**	8.70E-13	**1590**
Total	2.26E-10	**9058**	6.77E-10	**7377**	6.31E-12	**9224**	4.79E-12	**7773**	2.85E-12	**5217**
HCFE-235ca2 (enflurane)										
Delta	1.54E-12	**62**	1.12E-11	**122**	5.92E-14	**87**	8.55E-14	**139**	8.01E-14	**147**
Total	5.45E-11	**2185**	6.47E-11	**705**	7.95E-13	**1162**	1.57E-13	**254**	1.25E-13	**228**
HCFE-235da2 (isoflurane)										
Delta	1.37E-12	**55**	9.51E-12	**104**	5.21E-14	**76**	7.20E-14	**117**	6.75E-14	**123**
Total	4.63E-11	**1854**	5.45E-11	**595**	6.14E-13	**898**	1.29E-13	**209**	1.05E-13	**192**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
HFE-236ca										
Delta	4.72E-12	**189**	6.86E-11	**748**	1.97E-13	**287**	5.19E-13	**842**	5.87E-13	**1074**
Total	2.47E-10	**9901**	4.58E-10	**4990**	6.23E-12	**9105**	2.62E-12	**4241**	1.09E-12	**1985**
HFE-236ea2 (desflurane)										
Delta	3.10E-12	**124**	3.22E-11	**351**	1.26E-13	**184**	2.53E-13	**410**	2.48E-13	**453**
Total	1.42E-10	**5678**	1.97E-10	**2143**	3.05E-12	**4463**	7.17E-13	**1163**	3.90E-13	**713**
HFE-236fa										
Delta	2.07E-12	**83**	1.82E-11	**199**	8.24E-14	**120**	1.42E-13	**230**	1.35E-13	**247**
Total	8.56E-11	**3431**	1.08E-10	**1177**	1.61E-12	**2358**	3.10E-13	**503**	2.10E-13	**384**
HFE-245cb2										
Delta	1.65E-12	**66**	1.25E-11	**136**	6.41E-14	**94**	9.58E-14	**155**	8.99E-14	**164**
Total	6.06E-11	**2430**	7.25E-11	**790**	9.41E-13	**1376**	1.80E-13	**292**	1.40E-13	**256**
HFE-245fa1										
Delta	1.86E-12	**74**	1.55E-11	**169**	7.34E-14	**107**	1.21E-13	**196**	1.14E-13	**208**
Total	7.41E-11	**2970**	9.15E-11	**997**	1.32E-12	**1932**	2.48E-13	**402**	1.77E-13	**324**
HFE-245fa2										
Delta	1.97E-12	**79**	1.54E-11	**168**	7.69E-14	**112**	1.19E-13	**193**	1.12E-13	204
Total	7.45E-11	**2987**	8.99E-11	**981**	1.22E-12	**1786**	2.29E-13	**372**	1.74E-13	318
2,2,3,3,3-Pentafluoropropan-1-ol										
Delta	6.60E-14	**3**	3.75E-13	**4**	2.29E-15	**3**	2.75E-15	**4**	2.58E-15	**5**
Total	1.79E-12	**72**	2.10E-12	**23**	1.65E-14	**24**	4.70E-15	**8**	4.00E-15	**7**
HFE-254cb1										
Delta	9.07E-13	**36**	5.88E-12	**64**	3.36E-14	**49**	4.41E-14	**71**	4.13E-14	**76**
Total	2.85E-11	**1141**	3.35E-11	**365**	3.33E-13	**487**	7.74E-14	**126**	6.41E-14	**117**
HFE-263fb2										
Delta	4.72E-15	**<1**	2.65E-14	**<1**	1.62E-16	**<1**	1.93E-16	**<1**	1.82E-16	**<1**
Total	1.26E-13	**5**	1.48E-13	**2**	1.13E-15	**2**	3.30E-16	**1**	2.81E-16	**1**
HFE-263m1										
Delta	1.03E-13	**4**	5.87E-13	**6**	3.57E-15	**5**	4.30E-15	**7**	4.04E-15	**7**
Total	2.80E-12	**112**	3.29E-12	**36**	2.61E-14	**38**	7.37E-15	**12**	6.26E-15	**11**
3,3,3-Trifluoropropan-1-ol										
Delta	1.39E-15	**<1**	7.77E-15	**<1**	4.77E-17	**<1**	5.67E-17	**<1**	5.33E-17	**<1**
Total	3.71E-14	**1**	4.35E-14	**<1**	3.32E-16	**<1**	9.69E-17	**<1**	8.27E-17	**<1**
HFE-329mcc2										
Delta	3.22E-12	**129**	4.88E-11	**532**	1.35E-13	**197**	3.66E-13	**593**	4.24E-13	**776**
Total	1.71E-10	**6847**	3.30E-10	**3598**	4.36E-12	**6379**	1.96E-12	**3175**	8.17E-13	**1494**
HFE-338mmz1										
Delta	2.87E-12	**115**	4.22E-11	**460**	1.20E-13	**175**	3.19E-13	**517**	3.63E-13	**663**
Total	1.51E-10	**6053**	2.83E-10	**3081**	3.82E-12	**5584**	1.63E-12	**2644**	6.77E-13	**1238**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
HFE-338mcf2										
Delta	1.96E-12	**79**	1.73E-11	**189**	7.82E-14	**114**	1.35E-13	**219**	1.28E-13	**234**
Total	8.13E-11	**3258**	1.03E-10	**1118**	1.53E-12	**2239**	2.95E-13	**478**	2.00E-13	**365**
Sevoflurane (HFE-347mmz1)										
Delta	6.66E-13	**27**	4.24E-12	**46**	2.45E-14	**36**	3.17E-14	**51**	2.97E-14	**54**
Total	2.05E-11	**821**	2.41E-11	**262**	2.31E-13	**337**	5.54E-14	**90**	4.61E-14	**84**
HFE-347mcc3 (HFE-7000)										
Delta	1.33E-12	**53**	1.01E-11	**110**	5.17E-14	**76**	7.77E-14	**126**	7.29E-14	133
Total	4.91E-11	**1968**	5.88E-11	**641**	7.69E-13	**1125**	1.46E-13	**237**	1.13E-13	207
HFE-347mcf2										
Delta	1.91E-12	**77**	1.60E-11	**175**	7.57E-14	**111**	1.24E-13	**202**	1.18E-13	**215**
Total	7.64E-11	**3063**	9.43E-11	**1028**	1.36E-12	**1993**	2.55E-13	**414**	1.83E-13	**335**
HFE-347pcf2										
Delta	2.08E-12	**83**	1.68E-11	**183**	8.17E-14	**119**	1.30E-13	**211**	1.22E-13	**224**
Total	8.07E-11	**3236**	9.83E-11	**1072**	1.38E-12	**2015**	2.57E-13	**417**	1.90E-13	**348**
HFE-347mmy1										
Delta	1.00E-12	**40**	7.02E-12	**77**	3.82E-14	**56**	5.33E-14	**86**	4.99E-14	**91**
Total	3.42E-11	**1370**	4.04E-11	**440**	4.65E-13	**680**	9.61E-14	**156**	7.76E-14	**142**
HFE-356mec3										
Delta	1.06E-12	**42**	7.47E-12	**81**	4.04E-14	**59**	5.67E-14	**92**	5.32E-14	**97**
Total	3.64E-11	**1457**	4.29E-11	**468**	5.01E-13	**732**	1.03E-13	**166**	8.26E-14	**151**
HFE-356mff2										
Delta	5.90E-14	**2**	3.34E-13	**4**	2.04E-15	**3**	2.45E-15	**4**	2.30E-15	**4**
Total	1.60E-12	**64**	1.87E-12	**20**	1.46E-14	**21**	4.18E-15	**7**	3.56E-15	**7**
HFE-356pcf2										
Delta	1.72E-12	**69**	1.36E-11	**149**	6.72E-14	**98**	1.05E-13	**171**	9.89E-14	**181**
Total	6.57E-11	**2633**	7.96E-11	**867**	1.10E-12	**1601**	2.05E-13	**332**	1.54E-13	**281**
HFE-356pcf3										
Delta	1.25E-12	**50**	8.64E-12	**94**	4.74E-14	**69**	6.54E-14	**106**	6.13E-14	**112**
Total	4.20E-11	**1685**	4.96E-11	**540**	5.58E-13	**816**	1.17E-13	**190**	9.52E-14	**174**
HFE-356pcc3										
Delta	1.13E-12	**45**	7.97E-12	**87**	4.31E-14	**63**	6.05E-14	**98**	5.67E-14	**104**
Total	3.88E-11	**1555**	4.58E-11	**500**	5.34E-13	**781**	1.09E-13	**177**	8.81E-14	**161**
HFE-356mmz1										
Delta	4.79E-14	**2**	2.71E-13	**3**	1.66E-15	**2**	1.98E-15	**3**	1.86E-15	**3**
Total	1.29E-12	**52**	1.52E-12	**17**	1.18E-14	**17**	3.39E-15	**5**	2.89E-15	**5**
HFE-365mcf3										
Delta	3.31E-15	**<1**	1.85E-14	**<1**	1.14E-16	**<1**	1.35E-16	**<1**	1.27E-16	<1
Total	8.84E-14	**4**	1.04E-13	**1**	7.93E-16	**1**	2.31E-16	**<1**	1.97E-16	<1

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
HFE-365mcf2										
Delta	2.01E-13	**8**	1.16E-12	**13**	7.05E-15	**10**	8.53E-15	**14**	8.01E-15	**15**
Total	5.56E-12	**223**	6.52E-12	**71**	5.24E-14	**77**	1.46E-14	**24**	1.24E-14	**23**
HFE-374pc2										
Delta	1.57E-12	**63**	1.20E-11	**130**	6.11E-14	**89**	9.18E-14	**149**	8.62E-14	**158**
Total	5.80E-11	**2326**	6.95E-11	**758**	9.09E-13	**1329**	1.73E-13	**281**	1.34E-13	**245**
4,4,4-TrIfluorobutan-1-ol										
Delta	6.72E-17	**<1**	3.76E-16	**<1**	2.31E-18	**<1**	2.74E-18	**<1**	2.58E-18	**<1**
Total	1.80E-15	**<1**	2.11E-15	**<1**	1.61E-17	**<1**	4.68E-18	**<1**	4.00E-18	**<1**
2,2,3,3,4,4,5,5-Octafluorocyclopentanol										
Delta	4.52E-14	**2**	2.56E-13	**3**	1.57E-15	**2**	1.88E-15	**3**	1.76E-15	**3**
Total	1.22E-12	**49**	1.44E-12	**16**	1.12E-14	**16**	3.21E-15	**5**	2.73E-15	**5**
HFE-43-10pccc124 (H-Galden 1040x, HG-11)										
Delta	4.23E-12	**170**	4.92E-11	**536**	1.74E-13	**254**	3.84E-13	**623**	3.90E-13	**713**
Total	2.04E-10	**8176**	3.07E-10	**3353**	4.69E-12	**6854**	1.33E-12	**2156**	6.28E-13	**1149**
HFE-449s1 (HFE-7100)										
Delta	1.08E-12	**43**	8.05E-12	**88**	4.17E-14	**61**	6.17E-14	**100**	5.79E-14	**106**
Total	3.91E-11	**1568**	4.66E-11	**509**	5.95E-13	**870**	1.15E-13	**186**	8.99E-14	**164**
n-HFE-7100										
Delta	1.24E-12	**50**	9.29E-12	**101**	4.82E-14	**70**	7.12E-14	**115**	6.68E-14	**122**
Total	4.52E-11	**1810**	5.38E-11	**587**	6.87E-13	**1004**	1.33E-13	**215**	1.04E-13	**190**
I-HFE-7100										
Delta	1.04E-12	**42**	7.79E-12	**85**	4.04E-14	**59**	5.96E-14	**97**	5.60E-14	**102**
Total	3.78E-11	**1517**	4.51E-11	**492**	5.76E-13	**842**	1.11E-13	**180**	8.70E-14	**159**
HFE-569sf2 (HFE-7200)										
Delta	1.93E-13	**8**	1.13E-12	**12**	6.81E-15	**10**	8.31E-15	**13**	7.80E-15	**14**
Total	5.40E-12	**217**	6.34E-12	**69**	5.20E-14	**76**	1.43E-14	**23**	1.21E-14	**22**
n-HFE-7200										
Delta	2.20E-13	**9**	1.28E-12	**14**	7.74E-15	**11**	9.44E-15	**15**	8.86E-15	16
Total	6.14E-12	**246**	7.21E-12	**79**	5.91E-14	**86**	1.62E-14	**26**	1.37E-14	25
I-HFE-7200										
Delta	1.51E-13	**6**	8.80E-13	**10**	5.31E-15	**8**	6.47E-15	**10**	6.08E-15	**11**
Total	4.21E-12	**169**	4.94E-12	**54**	4.05E-14	**59**	1.11E-14	**18**	9.42E-15	**17**
HFE-236ca12 (HG-10)										
Delta	5.21E-12	**209**	8.31E-11	**907**	2.18E-13	**319**	6.16E-13	**999**	7.39E-13	**1352**
Total	2.81E-10	**11,248**	5.74E-10	**6260**	7.28E-12	**10,646**	3.56E-12	**5769**	1.51E-12	**2769**
HFE-338pcc13 (HG-01)										
Delta	4.50E-12	**181**	5.11E-11	**557**	1.85E-13	**270**	4.00E-13	**648**	4.02E-13	**736**
Total	2.15E-10	**8607**	3.18E-10	**3466**	4.88E-12	**7129**	1.33E-12	**2153**	6.44E-13	**1178**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
1,1,1,3,3,3-Hexafluoropropan-2-ol										
Delta	5.73E-13	**23**	3.57E-12	**39**	2.09E-14	**31**	2.66E-14	**43**	2.50E-14	**46**
Total	1.72E-11	**691**	2.02E-11	**221**	1.87E-13	**274**	4.64E-14	**75**	3.87E-14	**71**
HG-02										
Delta	4.22E-12	**169**	4.79E-11	**523**	1.73E-13	**253**	3.75E-13	**608**	3.77E-13	**690**
Total	2.01E-10	**8072**	2.98E-10	**3250**	4.57E-12	**6686**	1.25E-12	**2019**	6.04E-13	**1105**
HG-03										
Delta	4.42E-12	**177**	5.01E-11	**547**	1.81E-13	**265**	3.92E-13	**636**	3.95E-13	**722**
Total	2.11E-10	**8443**	3.12E-10	**3400**	4.78E-12	**6993**	1.30E-12	**2112**	6.32E-13	**1155**
HG-20										
Delta	5.16E-12	**207**	8.24E-11	**898**	2.16E-13	**316**	6.10E-13	**990**	7.32E-13	**1339**
Total	2.78E-10	**11,143**	5.69E-10	**6201**	7.21E-12	**10,546**	3.52E-12	**5715**	1.50E-12	**2743**
HG-21										
Delta	5.84E-12	**234**	6.79E-11	**740**	2.40E-13	**351**	5.30E-13	**860**	5.38E-13	**984**
Total	2.82E-10	**11,285**	4.24E-10	**4628**	6.47E-12	**9461**	1.84E-12	**2976**	8.67E-13	**1586**
HG-30										
Delta	7.14E-12	**286**	1.14E-10	**1242**	2.99E-13	**437**	8.44E-13	**1369**	1.01E-12	**1852**
Total	3.84E-10	**15,408**	7.86E-10	**8575**	9.98E-12	**14,583**	4.87E-12	**7903**	2.07E-12	**3793**
1-Ethoxy-1,1,2,2,3,3,3-heptafluoropropane										
Delta	2.07E-13	**8**	1.20E-12	**13**	7.28E-15	**11**	8.86E-15	**14**	8.32E-15	15
Total	5.77E-12	**231**	6.77E-12	**74**	5.52E-14	**81**	1.52E-14	**25**	1.29E-14	24
Fluoroxene										
Delta	1.93E-16	**<1**	1.08E-15	**<1**	6.62E-18	**<1**	7.88E-18	**<1**	7.41E-18	**<1**
Total	5.16E-15	**<1**	6.05E-15	**<1**	4.61E-17	**<1**	1.35E-17	**<1**	1.15E-17	**<1**
1,1,2,2-Tetrafluoro-1-(fluoromethoxy)ethane										
Delta	2.01E-12	**80**	1.64E-11	**179**	7.91E-14	**116**	1.27E-13	**206**	1.20E-13	**219**
Total	7.88E-11	**3157**	9.64E-11	**1051**	1.37E-12	**1996**	2.55E-13	**413**	1.87E-13	**341**
2-Ethoxy-3,3,4,4,5-pentafluorotetrahydro-2,5-bis[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]-furan										
Delta	1.86E-13	**7**	1.10E-12	**12**	6.61E-15	**10**	8.12E-15	**13**	7.62E-15	**14**
Total	5.28E-12	**212**	6.19E-12	**68**	5.19E-14	**76**	1.40E-14	**23**	1.18E-14	**22**
Fluoro(methoxy)methane										
Delta	4.44E-14	**2**	2.51E-13	**3**	1.53E-15	**2**	1.83E-15	**3**	1.72E-15	**3**
Total	1.20E-12	**48**	1.40E-12	**15**	1.09E-14	**16**	3.13E-15	**5**	2.67E-15	**5**
Difluoro(methoxy)methane										
Delta	4.79E-13	**19**	2.85E-12	**31**	1.70E-14	**25**	2.10E-14	**34**	1.97E-14	**36**
Total	1.37E-11	**547**	1.60E-11	**175**	1.36E-13	**198**	3.62E-14	**59**	3.06E-14	**56**
Fluoro(fluoromethoxy)methane										
Delta	4.40E-13	**18**	2.59E-12	**28**	1.56E-14	**23**	1.91E-14	**31**	1.79E-14	**33**
Total	1.24E-11	**497**	1.45E-11	**159**	1.21E-13	**176**	3.28E-14	**53**	2.77E-14	**51**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
Difluoro(fluoromethoxy)methane										
Delta	1.75E-12	**70**	1.20E-11	**131**	6.63E-14	**97**	9.05E-14	**147**	8.48E-14	**155**
Total	5.82E-11	**2335**	6.86E-11	**748**	7.55E-13	**1103**	1.62E-13	**262**	1.32E-13	**241**
Trifluoro(fluoromethoxy)methane										
Delta	1.97E-12	**79**	1.44E-11	**157**	7.58E-14	**111**	1.10E-13	**179**	1.03E-13	**189**
Total	7.02E-11	**2812**	8.33E-11	**909**	1.03E-12	**1512**	2.03E-13	**329**	1.61E-13	**294**
HG′-01										
Delta	6.94E-13	**28**	4.36E-12	**48**	2.54E-14	**37**	3.25E-14	**53**	3.05E-14	**56**
Total	2.10E-11	**843**	2.47E-11	**269**	2.31E-13	**338**	5.66E-14	**92**	4.72E-14	**86**
HG′-02										
Delta	7.38E-13	**30**	4.64E-12	**51**	2.70E-14	**39**	3.46E-14	**56**	3.24E-14	59
Total	2.24E-11	**897**	2.63E-11	**287**	2.46E-13	**360**	6.03E-14	**98**	5.03E-14	92
HG′-03										
Delta	6.91E-13	**28**	4.34E-12	**47**	2.53E-14	**37**	3.23E-14	**52**	3.03E-14	**55**
Total	2.09E-11	**840**	2.46E-11	**268**	2.30E-13	**336**	5.64E-14	**91**	4.70E-14	**86**
HFE-329me3										
Delta	3.20E-12	**128**	6.34E-11	**691**	1.35E-13	**198**	4.40E-13	**714**	6.20E-13	**1133**
Total	1.82E-10	**7299**	4.81E-10	**5241**	4.98E-12	**7286**	3.33E-12	**5406**	1.73E-12	**3173**
3,3,4,4, 5,5,6,6,7,7,7-Undecafluoroheptan-1-ol										
Delta	1.52E-15	**<1**	8.51E-15	**<1**	5.22E-17	**<1**	6.21E-17	**<1**	5.84E-17	**<1**
Total	4.06E-14	**2**	4.76E-14	**1**	3.64E-16	**1**	1.06E-16	**<1**	9.04E-17	**<1**
3,3,4,4,5,5,6,6,7,7,8,8,9,9, 9-Pentadecafluorononan-1-ol										
Delta	1.17E-15	**<1**	6.53E-15	**<1**	4.01E-17	**<1**	4.77E-17	**<1**	4.48E-17	**<1**
Total	3.12E-14	**1**	3.65E-14	**<1**	2.80E-16	**<1**	8.14E-17	**<1**	6.95E-17	**<1**
3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Nonadecafluoroundecan-1-ol										
Delta	6.69E-16	**<1**	3.75E-15	**<1**	2.30E-17	**<1**	2.73E-17	**<1**	2.57E-17	**<1**
Total	1.79E-14	**1**	2.10E-14	**<1**	1.60E-16	**<1**	4.67E-17	**<1**	3.98E-17	**<1**
2-Chloro-1,1,2-trifluoro-1-methoxyethane										
Delta	3.99E-13	**16**	2.41E-12	**26**	1.43E-14	**21**	1.79E-14	**29**	1.68E-14	**31**
Total	1.16E-11	**465**	1.36E-11	**149**	1.19E-13	**174**	3.09E-14	**50**	2.60E-14	**48**
PFPMIE (perfluoropolymethylisopropyl ether)										
Delta	3.04E-12	**122**	9.93E-11	**1083**	1.30E-13	**191**	5.60E-13	**908**	1.23E-12	**2247**
Total	1.90E-10	**7619**	9.89E-10	**10,789**	5.65E-12	**8263**	6.67E-12	**10,815**	7.38E-12	**13,501**
HFE-216										
Delta	7.45E-16	**<1**	4.17E-15	**<1**	2.56E-17	**<1**	3.04E-17	**<1**	2.86E-17	**<1**
Total	1.99E-14	**1**	2.34E-14	**<1**	1.78E-16	**<1**	5.20E-17	**<1**	4.44E-17	**<1**
Trifluoromethyl formate										
Delta	1.65E-12	**66**	1.14E-11	**124**	6.24E-14	**91**	8.62E-14	**140**	8.08E-14	**148**
Total	5.54E-11	**2220**	6.53E-11	**712**	7.36E-13	**1075**	1.55E-13	**251**	1.25E-13	229

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
Perfluoroethyl formate										
Delta	1.62E-12	**65**	1.12E-11	**122**	6.16E-14	**90**	8.50E-14	**138**	7.97E-14	**146**
Total	5.46E-11	**2190**	6.44E-11	**703**	7.26E-13	**1061**	1.53E-13	**247**	1.24E-13	**226**
Perfluoropropyl formate										
Delta	1.13E-12	**45**	7.34E-12	**80**	4.18E-14	**61**	5.51E-14	**89**	5.16E-14	**94**
Total	3.56E-11	**1427**	4.18E-11	**456**	4.22E-13	**616**	9.70E-14	**157**	8.01E-14	**147**
Perfluorobutyl formate										
Delta	1.14E-12	**46**	7.62E-12	**83**	4.27E-14	**62**	5.74E-14	**93**	5.38E-14	**98**
Total	3.70E-11	**1485**	4.36E-11	**475**	4.62E-13	**675**	1.02E-13	**165**	8.36E-14	**153**
2,2,2-Trifluoroethyl formate										
Delta	1.16E-13	**5**	6.66E-13	**7**	4.06E-15	**6**	4.88E-15	**8**	4.59E-15	**8**
Total	3.18E-12	**128**	3.73E-12	**41**	2.96E-14	**43**	8.36E-15	**14**	7.11E-15	**13**
3,3,3-Trifluoropropyl formate										
Delta	6.12E-14	**2**	3.47E-13	**4**	2.12E-15	**3**	2.54E-15	**4**	2.39E-15	**4**
Total	1.66E-12	**66**	1.94E-12	**21**	1.52E-14	**22**	4.34E-15	**7**	3.70E-15	7
1,2,2,2-Tetrafluoroethyl formate										
Delta	1.35E-12	**54**	9.12E-12	**99**	5.07E-14	**74**	6.89E-14	**112**	6.45E-14	**118**
Total	4.44E-11	**1778**	5.22E-11	**569**	5.67E-13	**829**	1.23E-13	**199**	1.00E-13	**183**
1,1,1,3,3,3-Hexafluoropropan-2-yl formate										
Delta	9.53E-13	**38**	6.46E-12	**70**	3.59E-14	**52**	4.88E-14	**79**	4.57E-14	**84**
Total	3.14E-11	**1259**	3.70E-11	**403**	4.02E-13	**587**	8.69E-14	**141**	7.10E-14	**130**
Perfluorobutyl acetate										
Delta	5.90E-15	**<1**	3.31E-14	**<1**	2.03E-16	**<1**	2.41E-16	**<1**	2.27E-16	**<1**
Total	1.58E-13	**6**	1.85E-13	**2**	1.42E-15	**2**	4.12E-16	**1**	3.52E-16	**1**
Perfluoropropyl acetate										
Delta	6.17E-15	**<1**	3.46E-14	**<1**	2.12E-16	**<1**	2.52E-16	**<1**	2.37E-16	**<1**
Total	1.65E-13	**7**	1.93E-13	**2**	1.48E-15	**2**	4.31E-16	**1**	3.67E-16	**1**
Perfluoroethyl acetate										
Delta	7.34E-15	**<1**	4.11E-14	**<1**	2.52E-16	**<1**	3.00E-16	**<1**	2.82E-16	**1**
Total	1.96E-13	**8**	2.30E-13	**3**	1.76E-15	**3**	5.12E-16	**1**	4.37E-16	1
Trifluoromethyl acetate										
Delta	7.39E-15	**<1**	4.14E-14	**<1**	2.54E-16	**<1**	3.02E-16	**<1**	2.84E-16	**1**
Total	1.97E-13	**8**	2.32E-13	**3**	1.77E-15	**3**	5.16E-16	**1**	4.40E-16	**1**
Methyl carbonofluoridate										
Delta	3.02E-13	**12**	1.88E-12	**20**	1.10E-14	**16**	1.40E-14	**23**	1.31E-14	**24**
Total	9.05E-12	**363**	1.06E-11	**116**	9.70E-14	**142**	2.43E-14	**39**	2.03E-14	**37**
1,1-Difluoroethyl carbonofluoridate										
Delta	9.41E-14	**4**	5.35E-13	**6**	3.26E-15	**5**	3.92E-15	**6**	3.68E-15	**7**
Total	2.55E-12	**102**	2.99E-12	**33**	2.35E-14	**34**	6.70E-15	**11**	5.70E-15	**10**

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Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
1,1-Difluoroethyl 2,2,2-trifluoroacetate										
Delta	1.08E-13	**4**	6.15E-13	**7**	3.75E-15	**5**	4.50E-15	**7**	4.23E-15	**8**
Total	2.94E-12	**118**	3.44E-12	**38**	2.70E-14	**40**	7.70E-15	**12**	6.55E-15	**12**
Ethyl 2,2,2-trifluoroacetate										
Delta	4.88E-15	**<1**	2.74E-14	**<1**	1.68E-16	**<1**	2.00E-16	**<1**	1.88E-16	**<1**
Total	1.31E-13	**5**	1.53E-13	**2**	1.17E-15	**2**	3.41E-16	**1**	2.91E-16	1
2,2,2-Trifluoroethyl 2,2,2-trifluoroacetate										
Delta	2.43E-14	**1**	1.37E-13	**1**	8.37E-16	**1**	9.98E-16	**2**	9.38E-16	**2**
Total	6.52E-13	**26**	7.64E-13	**8**	5.90E-15	**9**	1.70E-15	**3**	1.45E-15	**3**
Methyl 2,2,2-trifluoroacetate										
Delta	1.80E-13	**7**	1.04E-12	**11**	6.32E-15	**9**	7.65E-15	**12**	7.18E-15	**13**
Total	4.98E-12	**200**	5.84E-12	**64**	4.71E-14	**69**	1.31E-14	**21**	1.11E-14	**20**
Methyl 2,2-difluoroacetate										
Delta	1.16E-14	**0**	6.54E-14	**1**	4.01E-16	**1**	4.77E-16	**1**	4.49E-16	**1**
Total	3.12E-13	**12**	3.66E-13	**4**	2.81E-15	**4**	8.15E-16	**1**	6.95E-16	**1**
Difluoromethyl 2,2,2-trifluoroacetate										
Delta	9.52E-14	**4**	5.40E-13	**6**	3.30E-15	**5**	3.95E-15	**6**	3.71E-15	**7**
Total	2.58E-12	**103**	3.02E-12	**33**	2.37E-14	**35**	6.76E-15	**11**	5.75E-15	**11**
2,2,3,3,4,4,4-Heptafluorobutan-1-ol										
Delta	1.17E-13	**5**	6.72E-13	**7**	4.08E-15	**6**	4.93E-15	**8**	4.63E-15	**8**
Total	3.21E-12	**129**	3.77E-12	**41**	3.02E-14	**44**	8.45E-15	**14**	7.18E-15	13
1,1,2-Trifluoro-2-(trifluoromethoxy)-ethane										
Delta	2.27E-12	**91**	2.26E-11	**246**	9.20E-14	**134**	1.77E-13	**287**	1.72E-13	**314**
Total	1.01E-10	**4063**	1.37E-10	**1489**	2.12E-12	**3096**	4.65E-13	**754**	2.69E-13	**492**
1-Ethoxy-1,1,2,3,3,3-hexafluoropropane										
Delta	8.16E-14	**3**	4.66E-13	**5**	2.84E-15	**4**	3.41E-15	**6**	3.20E-15	**6**
Total	2.22E-12	**89**	2.61E-12	**28**	2.06E-14	**30**	5.84E-15	**9**	4.96E-15	**9**
1,1,1,2,2,3,3-Heptafluoro-3-(1,2,2,2-tetrafluoroethoxy)-propane										
Delta	3.40E-12	**136**	8.11E-11	**884**	1.45E-13	**212**	5.26E-13	**853**	8.65E-13	**1582**
Total	2.01E-10	**8075**	6.76E-10	**7371**	5.71E-12	**8353**	4.82E-12	**7812**	3.26E-12	**5960**
2,2,3,3-Tetrafluoro-1-propanol										
Delta	4.58E-14	**2**	2.59E-13	**3**	1.59E-15	**2**	1.90E-15	**3**	1.78E-15	**3**
Total	1.24E-12	**50**	1.45E-12	**16**	1.13E-14	**17**	3.24E-15	**5**	2.76E-15	**5**
2,2,3,4,4,4-Hexafluoro-1-butanol										
Delta	6.00E-14	**2**	3.40E-13	**4**	2.07E-15	**3**	2.48E-15	**4**	2.33E-15	**4**
Total	1.62E-12	**65**	1.90E-12	**21**	1.48E-14	**22**	4.25E-15	**7**	3.62E-15	7
2,2,3,3,4,4,4-Heptafluoro-1-butanol										
Delta	5.72E-14	**2**	3.25E-13	**4**	1.98E-15	**3**	2.38E-15	**4**	2.23E-15	**4**
Total	1.55E-12	**62**	1.82E-12	**20**	1.43E-14	**21**	4.07E-15	**7**	3.46E-15	**6**

(continued on next page)

Table 8.SM.16 (continued)

Acronym, Common Name or Chemical Name	AGWP 20-year (W m^{-2} yr kg^{-1})	GWP 20-year	AGWP 100-year (W m^{-2} yr kg^{-1})	GWP 100-year	AGTP 20-year (K kg^{-1})	GTP 20-year	AGTP 50-year (K kg^{-1})	GTP 50-year	AGTP 100-year (K kg^{-1})	GTP 100-year
1,1,2,2-Tetrafluoro-3-methoxy-propane										
Delta	1.87E-15	<1	1.05E-14	<1	6.43E-17	<1	7.65E-17	<1	7.19E-17	<1
Total	5.00E-14	2	5.86E-14	1	4.48E-16	1	1.31E-16	<1	1.11E-16	<1
Perfluoro-2-methyl-3-pentanone										
Delta	3.55E-16	<1	1.99E-15	<1	1.22E-17	<1	1.45E-17	<1	1.36E-17	<1
Total	9.49E-15	<1	1.11E-14	<1	8.49E-17	<1	2.48E-17	<1	2.11E-17	<1
3,3,3-Trifluoro-propanal										
Delta	3.83E-17	<1	2.14E-16	<1	1.31E-18	<1	1.56E-18	<1	1.47E-18	<1
Total	1.02E-15	<1	1.20E-15	<1	9.15E-18	<1	2.67E-18	<1	2.28E-18	<1
2-Fluoroethanol										
Delta	3.14E-15	<1	1.76E-14	<1	1.08E-16	<1	1.28E-16	<1	1.21E-16	<1
Total	8.39E-14	3	9.83E-14	1	7.53E-16	1	2.19E-16	<1	1.87E-16	<1
2,2-Difluoroethanol										
Delta	1.08E-14	<1	6.05E-14	1	3.71E-16	1	4.42E-16	1	4.15E-16	1
Total	2.88E-13	12	3.38E-13	4	2.60E-15	4	7.54E-16	1	6.43E-16	1
2,2,2-Trifluoroethanol										
Delta	7.01E-14	3	3.98E-13	4	2.43E-15	4	2.91E-15	5	2.74E-15	5
Total	1.90E-12	76	2.23E-12	24	1.75E-14	26	4.98E-15	8	4.24E-15	8
1,1′-Oxybis[2-(difluoromethoxy)-1,1,2,2-tetrafluoroethane										
Delta	4.65E-12	186	7.57E-11	825	1.95E-13	285	5.58E-13	905	6.78E-13	1240
Total	2.52E-10	10,096	5.27E-10	5741	6.57E-12	9609	3.31E-12	5367	1.42E-12	2603
1,1,3,3,4,4,6,6,7,7,9,9,10,10,12,12-hexadecafluoro-2,5,8,11-Tetraoxadodecane										
Delta	4.25E-12	170	6.91E-11	754	1.78E-13	260	5.10E-13	827	6.20E-13	1133
Total	2.30E-10	9223	4.81E-10	5245	6.00E-12	8778	3.02E-12	4903	1.30E-12	2378
1,1,3,3,4,4,6,6,7,7,9,9,10,10,12,12,13,13,15,15-Eicosafluoro-2,5,8,11,14-Pentaoxapentadecane										
Delta	3.43E-12	138	5.59E-11	609	1.44E-13	211	4.12E-13	668	5.01E-13	916
Total	1.86E-10	7456	3.89E-10	4240	4.85E-12	7095	2.44E-12	3963	1.05E-12	1923

8.SM.16 Metric Values to Support Figure 8.32 and Figure 8.33

Table 8.SM.17 | Metric values used for Figures 8.32 and 8.33.

Species	GWP_{10}	GWP_{20}	GWP_{50}	GWP_{100}	GTP_{10}	GTP_{20}	GTP_{50}	GTP_{100}
CO_2	1	1	1	1	1	1	1	1
CH_4	104.2	83.9	48.4	28.5	99.9	67.5	14.1	4.3
N_2O	246.6	263.7	275.6	264.8	253.5	276.9	281.8	234.2
BC	4349.2	2421.1	1139.3	658.6	2398.2	702.8	110.0	90.7
OC	–438.5	–244.1	–114.9	–66.4	–241.8	–70.9	–11.1	–9.1
SO_2	–253.5	–141.1	–66.4	–38.4	–139.6	–40.9	–6.4	–5.3
NOx	134.2	16.7	–15.6	–10.8	2.8	–86.3	–27.4	–2.8
CO	8.6	5.9	3.2	1.9	6.8	3.7	0.7	0.3

8.SM.17 Metric Values for Sectors to Support Section 8.7.2

Table 8.SM.18 | GWPs and GTPs for NO_X, BC, OC and SO_2 from various sectors (metrics for SO_2 are given on SO_2 basis, while for NO_X they are given on a nitrogen basis). For the reference gas CO_2, RE and IRF from AR4 are used in the calculations. The GWP_{100} and GTP_{100} values can be scaled by 0.94 and 0.92, respectively, to account for updated values for the reference gas CO_2. For 20 years the changes are negligible. ari is aerosol–radiation interaction.

Sector and emission region (if sub-global)	GWP		GTP	
	H = 20	H = 100	H = 20	H = 100
Aviation				
NO_X[a]	92 to 338	–21 to 67	–396 to –121	–5.8 to 7.9
NO_X[b]	120 to 470	–2.1 to 71	–590 to –200	–9.5 to 7.6
NO_X[h]	415	75	–239	8.6
Shipping				
NO_X[b]	–76 to –31	–36 to –25	–190 to –130	–6.1 to –4.2
NO_X[c]	–107	–73	–135	
SO_2[b]	–150 to –37	–43 to –11	–44 to –11	–6.1 to –1.5
SO_2, Arctic[e]	–47	–13		
OC, Arctic[e]	–151	–43		
BC ari, Arctic[e]	2037	579		
BC on snow, Arctic[e]	764	217		
Energy Related				
BC ari + albedo[g]	2,800 ± 1,800	790 ± 530		
OC Energy related[g]	–110 (–40,–210)	–30 (–12, –60)		
Industry/Power BC, Asia[f]	3,260	910		
Household BC, Asia[f]	2,680	750		
Transport BC, Asia[f]	2,640	740		
Transport BC, North America[f]	3,900	1,090		
Household OC, Asia[f]	–260	–72		
Transport OC, Asia[f]	–180	–50		
Industry/Power SO_2, Asia[f]	–106 (ari)	–30 (ari)		
Industry/Power SO_2, North America[f]	–215 (ari)	–60 (ari)		
Coal-fired power, NO_X[d]	20			
Coal-fired power, SO_2[d]	–189 (ari)	–53 (ari)		
Petroleum Production				
BC ari, Arctic	2,369	673		
BC on snow, Arctic[e]	4,104	1,166		
SO_2, Arctic[e]	–64	–18		
OC, Arctic[e]	–152	–43		
Open Biomass				
BC ari + albedo[g]	3,100 ± 1,300	880 ± 370		
OC[g]	–180 (–70, –360)	–53 (–20, –100)		

Notes:

[a] Myhre et al. (2011)
[b] Fuglestvedt et al. (2010)
[c] Collins et al. (2010)
[d] Shindell and Faluvegi (2010)
[e] Ødemark et al. (2012)
[f] Shindell et al. (2008)
[g] Bond et al. (2011)
[h] Köhler et al. (2013)

8.SM.18 Further Information on Temperature Impact from Various Sectors to Support Section 8.7.2

Table 8.SM.19 | Information about emissions and metric values used in calculations of temperature impacts of sectors.

Species	Global Emissions (Gg)	AGTP Values Based on	GTP_{20}	GTP_{100}
CO_2	**3.69E+07**	Joos et al. (2013) and AR5	1	1
CH_4	**3.64E+05**	Updated by AR5	67	4.3
N_2O	**1.07E+04**	Updated by AR5	277	234
HCFC-141b	**7.68E-01**	Updated by AR5	1853	111
HCF-142b	**6.18E+00**	Updated by AR5	4393	356
HFC-23	**1.75E+01**	Updated by AR5	11524	12709
HFC-32	**2.36E+00**	Updated by AR5	1362	94
HFC-125	**3.00E+01**	Updated by AR5	5797	967
HFC-134a	**1.63E+02**	Updated by AR5	3053	201
HFC-143a	**3.25E+01**	Updated by AR5	6957	2505
HFC-152a	**2.79E+01**	Updated by AR5	174	19
HFC-227ea	**7.18E+00**	Updated by AR5	5283	1500
HFC-236fa	**1.59E-01**	Updated by AR5	7397	8377
HFC-245fa	**4.11E+00**	Updated by AR5	1974	121
HFC-365mfc	**1.73E+00**	Updated by AR5	1893	114
HFC-43-10mee	**2.69E-01**	Updated by AR5	3718	281
SF_6	**6.50E+00**	Updated by AR5	18904	28215
NF_3	**1.75E-01**	Updated by AR5	13723	18119
PFC-14	**1.12E+01**	Updated by AR5	5272	8038
PFC-116	**2.43E+00**	Updated by AR5	8877	13456
PFC-218	**4.13E-01**	Updated by AR5	7176	10654
PFC-318	**2.49E-02**	Updated by AR5	7676	11456
PFC-3-1-10	**1.96E-02**	Updated by AR5	7419	11016
PFC-4-1-12	**9.58E-06**	Updated by AR5	6856	10284
PFC-5-1-14	**3.78E-01**	Updated by AR5	6365	9493
BC	5.31E+03	Bond et al. (2013) aerosol radiation interaction and albedo effect included in metric values	703	91
OC	1.36E+04	Fuglestvedt et al. (2010)	–71	–9.1
SO_2	**1.27E+05** (in SO_2)	Fuglestvedt et al. (2010)	–41	–5.3
Contrails and CIC		Updated by AR5	0.75	0.10
Aircraft NO_x		Stevenson et al. (2004), as given by Fuglestvedt et al. (2010)	–204	6.7
Shipping NO_x		Fuglestvedt et al. (2008), as given by Fuglestvedt et al. (2010)	–162	–4.0
Surface NO_x	**3.72E+04** (includes shipping and air, in N)	The global run in Wild et al. (2001), as given by Fuglestvedt et al. (2010)	–86	–2.8
CO	**8.93E+05**	Derwent et al. (2001), as given by Fuglestvedt et al. (2010)	3.7	0.27
VOC	**1.60E+05**	Collins et al. (2002) , as given Fuglestvedt et al. (2010)	7.4	0.61
NH_3	**4.93E+04**	Shindell et al. (2009)	–23	–3.0
ACI		$(-0.45)/(-0.4)*SO_2$, updated by AR5	–46	–5.9

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7.SM.6 Tables of Greenhouse Gas Lifetimes, Radiative Efficiencies and Metrics

Table 7.SM.7 | Greenhouse gas lifetimes, radiative efficiencies, global warming potentials (GWPs), global temperature potentials (GTPs) and cumulative global temperature potentials (CGTPs). GWPs given for 20-year, 100-year and 500-year time horizons. GTPs and CGTPs given for 50-year and 100-year time horizons. Note CGTP has units of years and is applied to a change in emissions rate rather than a change in emissions amount. Also shown are absolute values of GWPs and GTPs (AGWPs and AGTPs), in units of picowatt years per square metre per kilogram (1 pW = 10^{-12} W) or picokelvin per kilogram (1 pK = 10^{-12} K). Radiative efficiencies for CH_4 and N_2O given in this table do not include chemical adjustments (values including chemical adjustments are given in Table 7.15). For SF6 the assessed lifetime from Section 2.2.4.3 is used, all other lifetimes are taken from Hodnebrog et al. (2020).

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
Carbon dioxide	CO_2		1.33×10^{-5}	0.0243	1	0.0895	1	0.314	1	0.000428	1	0.000395	1		
Methane[1]	CH_4	11.8	0.000388	1.98	81.2	2.49	27.9	2.5	7.95	0.00473	11	0.00212	5.38	2730	3320
Nitrous oxide	N_2O	109	0.0032	6.65	273	24.5	273	40.7	130	0.124	290	0.0919	233		
Chlorofluorocarbons															
CFC-11	CCl_3F	52	0.291	203	8320	557	6230	657	2090	2.72	6350	1.40	3540		
CFC-12	CCl_2F_2	102	0.358	310	12700	1120	12500	1790	5700	5.67	13300	4.10	10400		
CFC-13	$CClF_3$	640	0.278	301	12400	1450	16200	5500	17500	7.26	17000	7.4	18800		
CFC-112	CCl_2FCCl_2F	63.6	0.282	137	5620	413	4620	525	1670	2.06	4810	1.19	3020		
CFC-112a	CCl_3CClF_2	52	0.246	115	4740	317	3550	374	1190	1.55	3620	0.795	2010		
CFC-113	CCl_2FCClF_2	93	0.301	167	6860	583	6520	890	2830	2.96	6910	2.06	5210		
CFC-113a	CCl_3CF_3	55	0.241	124	5110	351	3930	422	1350	1.73	4030	0.917	2320		
CFC-114	$CClF_2CClF_2$	189	0.314	201	8260	844	9430	1930	6150	4.28	9990	3.71	9410		
CFC-114a	CCl_2FCF_3	105	0.297	183	7510	664	7420	1080	3450	3.37	7880	2.46	6240		
CFC-115	$CClF_2CF_3$	540	0.246	180	7410	859	9600	3100	9880	4.3	10100	4.33	11000		
E-R316c	trans cyc (-$CClFCF_2CF_2CClF$-)	75	0.27	117	4810	379	4230	518	1650	1.91	4450	1.2	3040		
Z-R316c	cis cyc (-$CClFCF_2CF_2CClF$-)	114	0.3	136	5590	507	5660	865	2760	2.57	6020	1.94	4910		
CFC 1112	$CClF=CClF$	0.019	0.013	0.0111	0.454	0.0113	0.126	0.0113	0.036	1.18×10^{-5}	0.028	8.96×10^{-6}	0.023	12.9	15.3
CFC 1112a	$CCl_2=CF_2$	0.006	0.007	0.00184	0.076	0.00188	0.021	0.00188	0.006	1.97×10^{-6}	0.005	1.49×10^{-6}	0.004	2.16	2.55
Hydrofluorochlorocarbons															
HCFC-21	$CHCl_2F$	1.7	0.145	14	575	14.3	160	14.3	45.6	0.0152	35.5	0.0114	29	16300	19400
HCFC-22	$CHClF_2$	11.9	0.214	139	5690	175	1960	176	560	0.336	785	0.15	379	192000	234000
HCFC-31	CH_2ClF	1.2	0.068	6.96	286	7.11	79.4	7.11	22.6	0.00752	17.6	0.00567	14.4	8130	9630

1 The methane metrics in this supplementary table are presented without accounting for the carbon content of the methane to enable users to undertake separate carbon budgeting. Examples of budgeting for "fossil" and "non-fossil" methane are provided in the Chapter 7 Table 7.15.

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
HCFC-121	$CHCl_2CCl_2F$	1.11	0.146	5.11	210	5.22	58.3	5.22	16.6	0.00552	12.9	0.00416	10.5	5970	7070
HCFC-122	$CHCl_2CClF_2$	0.9	0.159	4.94	203	5.05	56.4	5.05	16.1	0.00533	12.5	0.00403	10.2	5780	6850
HCFC-122a	$CHClFCCl_2F$	3.1	0.201	21.4	879	21.9	245	21.9	69.9	0.0236	55.3	0.0177	44.7	25000	29600
HCFC-123	$CHCl_2CF_3$	1.3	0.16	7.92	325	8.09	90.4	8.09	25.8	0.00857	20	0.00646	16.4	9260	11000
HCFC-123a	$CHClFCClF_2$	4	0.227	34.3	1410	35.3	395	35.3	113	0.0385	90	0.0285	72.3	40200	47700
HCFC-124	$CHClFCF_3$	5.9	0.207	50.3	2070	53.4	597	53.4	170	0.0612	143	0.0435	110	60500	71900
HCFC-124a	CHF_2CClF_2	17	0.25	124	5110	185	2070	186	592	0.521	1220	0.177	448	192000	244000
HCFC-132	$CHClFCHClF$	1.73	0.143	10.7	440	11	122	11	34.9	0.0116	27.2	0.00876	22.2	12500	14800
HCFC-132a	$CHCl_2CHF_2$	1.12	0.127	6.17	253	6.3	70.4	6.3	20.1	0.00666	15.6	0.00503	12.7	7210	8540
HCFC-132c	CH_2FCCl_2F	4.1	0.169	29.6	1220	30.6	342	30.6	97.6	0.0334	78.1	0.0247	62.7	34800	41300
HCFC-133a	CH_2ClCF_3	4.6	0.15	33.4	1370	34.7	388	34.7	111	0.0382	89.3	0.0281	71.3	39400	46800
HCFC-141	$CH_2ClCHClF$	1.14	0.072	4.08	168	4.17	46.6	4.17	13.3	0.00441	10.3	0.00333	8.43	4770	5650
HCFC-141b	CH_3CCl_2F	9.4	0.161	65.9	2710	77	860	77	246	0.115	269	0.064	162	85800	103000
HCFC-142b	CH_3CClF_2	18	0.193	134	5510	205	2300	207	658	0.611	1430	0.203	514	211000	271000
HCFC-225ca	$CHCl_2CF_2CF_3$	1.9	0.219	12	491	12.2	137	12.2	39	0.013	30.4	0.00979	24.8	14000	16600
HCFC-225cb	$CHClFCF_2CClF_2$	5.9	0.293	47.8	1960	50.8	568	50.8	162	0.0582	136	0.0414	105	57500	68300
HCFO-1233zd(E)	(E)-$CF_3CH{=}CHCl$	0.116	0.065	0.34	14	0.347	3.88	0.347	1.11	0.000364	0.851	0.000276	0.7	398	471
HCFO-1233zd(Z)	(Z)-$CF_3CH{=}CHCl$	0.036	0.025	0.0398	1.64	0.0406	0.454	0.0406	0.129	4.25×10^{-5}	0.099	3.23×10^{-5}	0.082	46.6	55.2
(e)-1-chloro-2-fluoroethene	(E/Z)-$CHCl{=}CHF$	0.005	0.001	0.00032	0.013	0.000327	0.004	0.000327	0.001	3.42×10^{-7}	0.001	2.6×10^{-6}	0.001	0.375	0.444
Hydrofluorocarbons															
HFC-23	CHF_3	228	0.191	301	12400	1310	14600	3300	10500	6.6	15400	5.95	15100		
HFC-32	CH_2F_2	5.4	0.111	65.5	2690	69	771	69	220	0.0775	181	0.0561	142	78200	92900
HFC-41	CH_3F	2.8	0.025	11.8	485	12.1	135	12.1	38.6	0.013	30.4	0.00972	24.6	13800	16400
HFC-125	CHF_2CF_3	30	0.234	164	6740	335	3740	349	1110	1.41	3300	0.512	1300		
HFC-134	CHF_2CHF_2	10	0.194	95	3900	113	1260	113	361	0.18	420	0.0944	239	126000	151500
HFC-134a	CH_2FCF_3	14	0.167	101	4140	137	1530	137	436	0.314	733	0.121	306	147000	181000
HFC-143	CH_2FCHF_2	3.6	0.128	31.7	1300	32.6	364	32.6	104	0.0353	82.6	0.0263	66.6	37100	44000
HFC-143a	CH_3CF_3	51	0.168	191	7840	520	5810	609	1940	2.53	5910	1.28	3250		
HFC-152	CH_2FCH_2F	0.471	0.045	1.89	77.6	1.93	21.5	1.93	6.14	0.00203	4.74	0.00153	3.89	2210	2610
HFC-152a	CH_3CHF_2	1.6	0.102	14.4	591	14.7	164	14.7	46.8	0.0156	36.5	0.0118	29.8	16800	19900

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
HFC-161	CH_3CH_2F	0.219	0.016	0.424	17.4	0.433	4.84	0.433	1.38	0.000454	1.06	0.000344	0.872	497	588
HFC-227ca	$CF_3CF_2CHF_2$	30	0.264	131	5370	267	2980	278	885	1.12	2620	0.407	1030		
HFC-227ea	CF_3CHFCF_3	36	0.273	142	5850	322	3600	345	1100	1.45	3400	0.588	1490		
HFC-236cb	$CH_2FCF_2CF_3$	13.4	0.231	91.2	3750	121	1350	121	387	0.265	620	0.106	268	131000	161000
HFC-236ea	CHF_2CHFCF_3	11.4	0.3	108	4420	134	1500	134	428	0.245	572	0.114	288	147000	179000
HFC-236fa	$CF_3CH_2CF_3$	213	0.251	181	7450	777	8690	1900	6040	3.93	9200	3.5	8870		
HFC-245ca	$CH_2FCF_2CHF_2$	6.6	0.24	65.3	2680	70.5	787	70.5	225	0.0836	196	0.0576	146	79600	94700
HFC-245cb	$CF_3CF_2CH_3$	39.9	0.251	170	6970	407	4550	445	1420	1.89	4410	0.817	2070		
HFC-245ea	$CHF_2CHFCHF_2$	3.2	0.16	22.2	912	22.8	255	22.8	72.6	0.0246	57.4	0.0183	46.5	26000	30800
HFC-245eb	CH2FCHFCF3	3.2	0.204	28.3	1160	29	325	29.1	92.6	0.0313	73.2	0.0234	59.2	33100	39200
HFC-245fa	$CHF_2CH_2CF_3$	7.9	0.245	77.1	3170	86.1	962	86.1	274	0.112	262	0.0708	180	96700	115000
HFC-263fb	$CH_3CH_2CF_3$	1.1	0.1	6.55	269	6.69	74.8	6.69	21.3	0.00707	16.5	0.00534	13.5	7660	9070
HFC-272ca	$CH_3CF_2CH_3$	9	0.08	46.4	1910	53.6	599	53.6	171	0.0771	180	0.0444	113	59900	71800
HFC-329p	$CHF_2CF_2CF_2CF_3$	32	0.313	122	5010	259	2890	272	866	1.12	2610	0.421	1070		
HFC-365mfc	$CH_3CF_2CH_2CF_3$	8.9	0.228	71.1	2920	81.7	914	81.8	261	0.117	272	0.0677	172	91400	109000
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	17	0.357	96.3	3960	143	1600	144	458	0.403	943	0.137	347	149000	189000
HFO-1123	$CHF=CF_2$	0.004	0.002	0.000414	0.017	0.000423	0.005	0.000423	0.001	4.42×10^{-7}	0.001	3.36×10^{-7}	0.001	0.485	0.574
HFO-1132a	$CH_2=CF_2$	0.013	0.004	0.0046	0.189	0.00469	0.052	0.00469	0.015	4.91×10^{-6}	0.011	3.73×10^{-6}	0.009	5.39	6.37
HFO-1141	$CH_2=CHF$	0.007	0.002	0.00213	0.088	0.00217	0.024	0.00218	0.007	2.28×10^{-6}	0.005	1.73×10^{-6}	0.004	2.5	2.95
HFO-1225ye(Z)	(Z)-$CF_3CF=CHF$	0.027	0.025	0.0302	1.24	0.0308	0.344	0.0308	0.098	3.23×10^{-5}	0.075	2.45×10^{-5}	0.062	35.3	41.8
HFO-1225ye(E)	(E)-$CF_3CF=CHF$	0.016	0.015	0.0104	0.426	0.0106	0.118	0.0106	0.034	1.11×10^{-5}	0.026	8.41×10^{-6}	0.021	12.1	14.4
HFO-1234ze(Z)	(Z)-$CF_3CH=CHF$	0.027	0.02	0.0276	1.13	0.0282	0.315	0.0282	0.09	2.95×10^{-5}	0.069	2.24×10^{-5}	0.057	32.3	38.2
HFO-1234ze(E)	(E)-$CF_3CH=CHF$	0.052	0.045	0.12	4.94	0.123	1.37	0.123	0.391	0.000129	0.3	9.75×10^{-5}	0.247	141	167
HFO-1234yf	$CF_3CF=CH_2$	0.033	0.026	0.044	1.81	0.0449	0.501	0.0449	0.143	4.7×10^{-5}	0.11	3.57×10^{-5}	0.09	51.5	60.9
HFO-1336mzz(E)	(E)-$CF_3CH=CHCF_3$	0.334	0.132	1.57	64.3	1.6	17.9	1.6	5.09	0.00168	3.92	0.00127	3.22	1830	2170
HFO-1336mzz(Z)	(Z)-$CF_3CH=CHCF_3$	0.074	0.069	0.182	7.48	0.186	2.08	0.186	0.592	0.000195	0.455	0.000148	0.374	213	252
HFO-1243zf	$CF_3CH=CH_2$	0.025	0.015	0.0229	0.94	0.0234	0.261	0.0234	0.074	2.45×10^{-5}	0.057	1.86×10^{-5}	0.047	26.8	31.7
HFO-1345zfc	$CF_3CF_2CH=CH_2$	0.025	0.016	0.016	0.656	0.0163	0.182	0.0163	0.052	1.71×10^{-5}	0.04	1.29×10^{-5}	0.033	18.7	22.1
3,3,4,4,5,5,6,6,6-nonafluorohex-1-ene	n-$C_4F_9CH=CH_2$	0.025	0.03	0.0179	0.734	0.0182	0.204	0.0182	0.058	1.91×10^{-5}	0.045	1.45×10^{-5}	0.037	20.9	24.7

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
3,3,4,4,5,5,6,6,7,7,8,8,8-trideca-fluorooct-1-ene	n-$C_6F_{13}CH=CH_2$	0.025	0.034	0.0142	0.584	0.0145	0.162	0.0145	0.046	1.52×10^{-5}	0.036	1.15×10^{-5}	0.029	16.6	19.7
3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadeca-fluorodec-1-ene	n-$C_8F_{17}CH=CH_2$	0.025	0.038	0.0124	0.508	0.0126	0.141	0.0126	0.04	1.32×10^{-5}	0.031	0.00001	0.025	14.5	17.1
3,3,3-trifluoro-2-(trifluoromethyl) prop-1-ene	$(CF_3)_2C=CH_2$	0.028	0.033	0.0331	1.36	0.0337	0.377	0.0337	0.107	3.53×10^{-5}	0.083	2.68×10^{-5}	0.068	38.7	45.8
1,1,2,2,3,3-hexa-fluorocyclo-pentane	cyc (-$CF_2CF_2CF_2CH_2CH_2$-)	1.6	0.2	10.5	431	10.7	120	10.7	34.2	0.0114	26.6	0.00857	21.7	12300	14500
1,1,2,2,3,3,4-hep-tafluorocyclo-pentane	cyc (-$CF_2CF_2CF_2CHFCH_2$-)	2.8	0.243	20.2	830	20.7	231	20.7	66	0.0222	52	0.0166	42.1	23600	28000
1,3,3,4,4,5,5-heptafluoro-cyclopentene	cyc (-$CF_2CF_2CF_2CF=CH$-)	0.61	0.215	3.95	162	4.03	45.1	4.03	12.8	0.00424	9.92	0.00321	8.14	4620	5470
(4s,5s)-1,1,2,2,3,3,4,5-octafluoro-cyclopentane	trans-cyc (-$CF_2CF_2CF_2CHFCHF$-)	3.2	0.259	22.5	925	23.1	258	23.1	73.6	0.0249	58.2	0.0186	47.1	26300	31200
HFO-1438ezy(E)	(E)-$(CF_3)_2CFCH=CHF$	0.334	0.079	0.721	29.6	0.736	8.22	0.736	2.34	0.000773	1.81	0.000585	1.48	843	998
HFO-1447fz	$CF_3(CF_2)_2CH=CH_2$	0.025	0.028	0.0206	0.847	0.021	0.235	0.021	0.067	2.2×10^{-5}	0.051	1.67×10^{-5}	0.042	24.1	28.6
1,3,3,4,4-penta-fluorocyclo-butene	cyc (-$CH=CFCF_2CF_2$-)	0.74	0.27	8.1	333	8.27	92.4	8.27	26.4	0.00872	20.4	0.00659	16.7	9470	11200
3,3,4,4-tetra-fluorocyclo-butene	cyc (-$CH=CHCF_2CF_2$-)	0.23	0.21	2.24	92.1	2.29	25.6	2.29	7.29	0.0024	5.61	0.00182	4.61	2620	3100
Chlorocarbons and Hydrochlorocarbons															
Methyl chloroform	CH_3CCl_3	5	0.065	13.8	567	14.4	161	14.4	46	0.016	37.5	0.0117	29.7	16400	19400
Carbon tetrachloride	CCl_4	32	0.166	92.7	3810	196	2200	206	658	0.849	1990	0.32	810		
Methyl chloride	CH_3Cl	0.9	0.005	0.485	19.9	0.495	5.54	0.496	1.58	0.000523	1.22	0.000395	1	567	672
Methylene chloride	CH_2Cl_2	0.493	0.029	0.978	40.2	0.998	11.2	0.998	3.18	0.00105	2.46	0.000795	2.01	1140	1350
Chloroform	$CHCl_3$	0.501	0.074	1.81	74.2	1.84	20.6	1.84	5.87	0.00194	4.53	0.00147	3.72	2110	2500

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
Chloroethane	CH_3CH_2Cl	0.132	0.004	0.0422	1.73	0.043	0.481	0.043	0.137	4.51×10^{-5}	0.105	3.42×10^{-5}	0.087	49.4	58.4
1,2-dichloro-ethane	CH_2ClCH_2Cl	0.225	0.009	0.114	4.68	0.116	1.3	0.116	0.371	0.000122	0.285	9.25×10^{-5}	0.234	133	158
1,1,2-trichloro-ethene	$CHCl=CCl_2$	0.015	0.006	0.00385	0.158	0.00393	0.044	0.00393	0.013	4.11×10^{-6}	0.01	3.12×10^{-5}	0.008	4.51	5.34
1,1,2,2-tetra-chloroethene	$CCl_2=CCl_2$	0.301	0.052	0.556	22.8	0.567	6.34	0.567	1.81	0.000596	1.39	0.000451	1.14	651	770
2-chloropropane	$CH_3CHClCH_3$	0.06	0.004	0.0158	0.651	0.0162	0.181	0.0162	0.052	1.69×10^{-5}	0.04	1.28×10^{-6}	0.033	18.5	21.9
1-chlorobutane	$CH_3(CH_2)_2CH_2Cl$	0.012	0.001	0.000595	0.024	0.000607	0.007	0.000607	0.002	6.35×10^{-7}	0.001	4.82×10^{-7}	0.001	0.697	0.824
Bromocarbons, Hydrobromocarbons and Halons															
Methyl bromide	CH_3Br	0.8	0.004	0.213	8.74	0.217	2.43	0.217	0.692	0.000229	0.535	0.000173	0.438	249	294
Methylene bromide	CH_2Br_2	0.411	0.01	0.133	5.45	0.135	1.51	0.135	0.431	0.000142	0.333	0.000108	0.273	155	184
Halon-1201	$CHBrF_2$	4.9	0.152	32.5	1340	34	380	34	108	0.0376	88	0.0275	69.8	38500	45800
Halon-1202	CBr_2F_2	2.5	0.272	18.9	775	19.3	216	19.3	61.5	0.0207	48.4	0.0155	39.3	22000	26100
Halon-1211	$CBrClF_2$	16	0.3	120	4920	173	1930	173	552	0.458	1070	0.16	406	182000	229000
Halon-1301	$CBrF_3$	72	0.299	202	8320	644	7200	864	2750	3.23	7560	2	5060		
Halon-2301	CH_2BrCF_3	3.2	0.135	15.5	635	15.9	177	15.9	50.6	0.0171	40	0.0128	32.4	18100	21400
Halon-2311	$CHBrClCF_3$	1	0.133	3.94	162	4.03	45	4.03	12.8	0.00425	9.95	0.00321	8.14	4610	5460
Halon-2401	$CHBrFCF_3$	2.9	0.189	17.6	723	18	201	18	57.5	0.0194	45.3	0.0145	36.7	20600	24400
Halon-2402	$CBrF_2CBrF_2$	28	0.312	99	4070	194	2170	201	639	0.791	1850	0.277	702		
Tribromomethane	$CHBr_3$	0.156	0.006	0.0219	0.901	0.0224	0.25	0.0224	0.071	2.35×10^{-5}	0.055	0.0000178	0.045	25.7	30.4
Halon-1011	CH_2BrCl	0.452	0.02	0.415	17.1	0.424	4.74	0.424	1.35	0.000446	1.04	0.000337	0.855	486	575
Bromoethane	CH_3CH_2Br	0.137	0.006	0.0427	1.75	0.0436	0.487	0.0436	0.139	4.57×10^{-5}	0.107	3.46×10^{-5}	0.088	50	59.1
1,2-dibromo-ethane	CH_2BrCH_2Br	0.244	0.012	0.0894	3.67	0.0913	1.02	0.0913	0.291	9.58×10^{-5}	0.224	7.26×10^{-5}	0.184	105	124
1-bromopropane	$CH_3CH_2CH_2Br$	0.041	0.002	0.00457	0.188	0.00466	0.052	0.00466	0.015	4.88×10^{-6}	0.011	3.71×10^{-6}	0.009	5.35	6.33
2-bromopropane	$CH_3CHBrCH_3$	0.055	0.004	0.011	0.453	0.0112	0.126	0.0112	0.036	1.18×10^{-5}	0.028	8.93×10^{-6}	0.023	12.9	15.3
Fully Fluorinated Species															

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
Nitrogen trifluoride	NF_3	569	0.204	326	13400	1560	17400	5720	18200	7.81	18200	7.89	20000		
Pentadecafluoro-triethylamine	$N(C_2F_5)_3$	1000	0.61	188	7700	923	10300	3860	12300	4.61	10800	4.81	12200		
Perfluorotripro-pylamine	$N(CF_2CF_2CF_3)_3$	1000	0.75	164	6750	808	9030	3380	10800	4.03	9430	4.21	10700		
Heptacosafluoro-tributylamine	$N(CF_2CF_2CF_2CF_3)_3$	1000	0.907	154	6340	759	8490	3170	10100	3.79	8860	3.96	10000		
Perfluorotri-pentylamine	$N(CF_2CF_2CF_2CF_2CF_3)_3$	1000	0.95	132	5420	650	7260	2720	8650	3.24	7580	3.39	8580		
Heptafluoroiso-butyronitrile	$(CF_3)_2CFCN$	34.5	0.248	111	4580	246	2750	262	835	1.09	2560	0.431	1090		
Sulphur hexafluoride	SF_6	1000	0.567	442	18200	2180	24300	9100	29000	10.9	25400	11.4	28800		
Trifluromethyl-sulfur pentafluoride	SF_5CF_3	800	0.585	339	13900	1660	18500	6610	21100	8.27	19300	8.54	21600		
Sulfuryl fluoride	SO_2F_2	36	0.211	183	7510	414	4630	444	1410	1.87	4360	0.756	1920		
PFC-14	CF_4	50000	0.099	129	5300	660	7380	3320	10600	3.28	7660	3.57	9050		
PFC-116	C_2F_6	10000	0.261	218	8940	1110	12400	5500	17500	5.51	12900	5.99	15200		
PFC-218	C_3F_8	2600	0.27	165	6770	831	9290	3890	12400	4.13	9660	4.44	11200		
Hexafluoro-cyclobutene	cyc (-CF=CFCF$_2$CF$_2$-)	1.02	0.3	11	453	11.3	126	11.3	35.9	0.0119	27.8	0.00898	22.8	12900	15300
PFC-C-318	cyc (-$CF_2CF_2CF_2CF_2$-)	3200	0.314	180	7400	912	10200	4330	13800	4.53	10600	4.88	12400		
PFC-31-10	n-C_4F_{10}	2600	0.369	178	7300	897	10000	4200	13400	4.46	10400	4.79	12100		
Octafluoro-cyclopentene	cyc (-CF=CFCF$_2$CF$_2$CF$_2$-)	1.1	0.246	6.84	281	6.99	78.1	6.99	22.3	0.00739	17.3	0.00557	14.1	8000	9470
PFC-41-12	n-C_5F_{12}	4100	0.408	163	6680	825	9220	3970	12700	4.1	9580	4.43	11200		
PFC-51-14	n-C_6F_{14}	3100	0.449	153	6260	771	8620	3660	11600	3.83	8960	4.12	10500		
PFC-61-16	n-C_7F_{16}	3000	0.503	149	6120	752	8410	3560	11300	3.74	8740	4.02	10200		
PFC-71-18	n-C_8F_{18}	3000	0.558	146	6010	739	8260	3500	11100	3.67	8590	3.95	10000		
PFC-91-18	$C_{10}F_{18}$	2000	0.537	133	5480	669	7480	3070	9780	3.33	7790	3.56	9010		

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
1,1,2,2,3,3,4,4,4a,5,5,6,6,7,7,8,8,8a-octadecafluoronaphthalene	Z-$C_{10}F_{18}$	2000	0.56	139	5710	698	7800	3200	10200	3.47	8120	3.71	9400		
1,1,2,2,3,3,4,4,4a,5,5,6,6,7,7,8,8,8a-octadecafluoronaphthalene	E-$C_{10}F_{18}$	2000	0.512	127	5220	637	7120	2920	9310	3.17	7420	3.39	8580		
PFC-1114	$CF_2=CF_2$	0.003	0.002	0.000347	0.014	0.000354	0.004	0.000354	0.001	3.71×10^{-7}	0.001	2.81×10^{-7}	0.001	0.406	0.481
PFC-1216	$CF_3CF=CF_2$	0.015	0.013	0.00788	0.324	0.00804	0.09	0.00804	0.026	8.42×10^{-6}	0.02	6.39×10^{-6}	0.016	9.23	10.9
1,1,2,3,4,4-hexafluorobuta-1,3-diene	$CF_2=CFCF=CF_2$	0.003	0.003	0.000347	0.014	0.000354	0.004	0.000354	0.001	3.71×10^{-7}	0.001	2.82×10^{-7}	0.001	0.407	0.481
Octafluoro-1-butene	$CF_3CF_2CF=CF_2$	0.016	0.019	0.00891	0.366	0.00909	0.102	0.00909	0.029	9.52×10^{-6}	0.022	7.22×10^{-5}	0.018	10.4	12.3
Octafluoro-2-buene	$CF_3CF=CFCF_3$	0.085	0.07	0.173	7.1	0.176	1.97	0.176	0.562	0.000185	0.432	0.00014	0.355	202	239
Halogenated Alcohols, Ethers, Furans, Aldehydes and Ketones															
HFE-125	CHF_2OCF_3	135	0.417	328	13500	1280	14300	2410	7680	6.5	15200	5.17	13100		
HFE-134	CHF_2OCHF_2	26.9	0.449	310	12700	593	6630	610	1940	2.37	5530	0.814	2060		
HFE-143a	CH_3OCF_3	4.9	0.189	52.8	2170	55.1	616	55.1	176	0.0611	143	0.0447	113	62600	74300
HFE-227ea	$CF_3CHFOCF_3$	54.8	0.459	238	9800	673	7520	808	2570	3.3	7720	1.75	4440		
HCFE-235ca2	CHF_2OCF_2CHFCl	4.42	0.409	56.4	2320	58.5	654	58.5	186	0.0642	150	0.0473	120	66500	78900
HCFE-235da2	$CHF_2OCHClCF_3$	3.5	0.426	46.9	1930	48.2	539	48.2	154	0.0522	122	0.0388	98.4	54900	65100
HFE-236ea2	$CHF_2OCHFCF_3$	14.1	0.464	171	7020	232	2590	233	741	0.537	1260	0.206	521	249000	308000
HFE-236fa	$CF_3CH_2OCF_3$	7.5	0.371	89.4	3670	98.7	1100	98.8	315	0.125	291	0.0811	205	111000	133000
HFE-245cb2	$CF_3CF_2OCH_3$	5	0.336	64	2630	66.9	747	66.9	213	0.0743	174	0.0542	137	75900	90100
HFE-245fa1	$CHF_2CH_2OCF_3$	6.7	0.314	77.2	3170	83.6	934	83.6	266	0.0998	233	0.0683	173	94300	112000
HFE-245fa2	$CHF_2OCH_2CF_3$	5.5	0.36	74.5	3060	78.6	878	78.6	251	0.0886	207	0.0639	162	89000	106000
2,2,3,3,3-pentafluoropropan-1-ol	$CF_3CF_2CH_2OH$	0.471	0.164	3.01	123	3.07	34.3	3.07	9.78	0.00323	7.54	0.00244	6.19	3520	4160
HFE-254cb1	$CH_3OCF_2CHF_2$	2.5	0.26	28.7	1180	29.3	328	29.3	93.5	0.0314	73.4	0.0235	59.6	33500	39700
HFE-263mf	$CF_3CH_2OCH_3$	0.077	0.046	0.181	7.43	0.184	2.06	0.185	0.588	0.000193	0.452	0.000147	0.371	212	250

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
HFE-263m1	$CF_3OCH_2CH_3$	0.397	0.126	2.56	105	2.61	29.2	2.61	8.32	0.00274	6.42	0.00208	5.27	2990	3540
3,3,3-trifluoro-propan-1-ol	$CF_3CH_2CH_2OH$	0.041	0.026	0.0544	2.23	0.0555	0.62	0.0555	0.177	5.81×10^{-5}	0.136	4.41×10^{-5}	0.112	63.7	75.3
HFE-329mcc2	$CHF_2CF_2OCF_2CF_3$	25	0.545	184	7550	337	3770	345	1100	1.29	3020	0.432	1090		
HFE-338mmz1	$(CF_3)_2CHOCHF_2$	22.3	0.452	158	6500	272	3040	276	880	0.967	2260	0.314	797		
HFE-338mcf2	$CF_3CH_2OCF_2CF_3$	7.5	0.454	84.2	3460	93	1040	93.1	297	0.117	274	0.0764	194	105000	125000
HFE-347mmz1	$(CF_3)_2CHOCH_2F$	1.9	0.308	17.1	702	17.5	195	17.5	55.7	0.0186	43.5	0.014	35.4	20000	23600
HFE-347mcc3	$CH_3OCF_2CF_2CF_3$	5.1	0.339	49.2	2020	51.5	576	51.6	164	0.0574	134	0.0418	106	58500	69400
HFE-347mcf2	$CHF_2CH_2OCF_2CF_3$	6.7	0.431	79.6	3270	86.2	963	86.2	275	0.103	241	0.0705	179	97300	116000
HFE-347pcf2	$CHF_2CF_2OCH_2CF_3$	6.1	0.482	82.1	3370	87.6	980	87.7	279	0.101	237	0.0715	181	99100	118000
HFE-347mmy1	$(CF_3)_2CFOCH_3$	3.7	0.318	34.1	1400	35.1	392	35.1	112	0.0381	89	0.0283	71.8	40000	47400
HFE-356mec3	$CH_3OCF_2CHFCF_3$	2.5	0.288	23.1	949	23.6	264	23.6	75.3	0.0253	59.2	0.019	48	27000	32000
HFE-356mff2	$CF_3CH_2OCH_2CF_3$	0.351	0.19	2.14	88	2.19	24.4	2.19	6.97	0.0023	5.37	0.00174	4.41	2510	2970
HFE-356pcf2	$CHF_2CH_2OCF_2CHF_2$	6	0.378	69.8	2870	74.4	831	74.4	237	0.0856	200	0.0606	154	84100	100000
HFE-356pcf3	$CHF_2OCH_2CF_2CHF_2$	3.5	0.378	42.1	1730	43.3	484	43.3	138	0.0469	110	0.0349	88.4	49300	58500
HFE-356pcc3	$CH_3OCF_2CF_2CHF_2$	2.5	0.303	24.2	995	24.8	277	24.8	79	0.0266	62.1	0.0199	50.4	28300	33500
HFE-356mmz1	$(CF_3)_2CHOCH_3$	0.178	0.125	0.713	29.3	0.728	8.13	0.728	2.32	0.000763	1.78	0.000579	1.47	835	988
HFE-365mcf3	$CF_3CF_2CH_2OCH_3$	0.069	0.058	0.141	5.77	0.143	1.6	0.143	0.457	0.00015	0.351	0.000114	0.289	164	195
HFE-374pc2	$CHF_2CF_2OCH_2CH_3$	0.208	0.132	1.1	45	1.12	12.5	1.12	3.56	0.00117	2.74	0.000889	2.25	1280	1520
4,4,4-trifluoro-butan-1-ol	$CF_3(CH_2)_2CH_2OH$	0.015	0.006	0.00433	0.178	0.00442	0.049	0.00442	0.014	4.63×10^{-5}	0.011	3.51×10^{-5}	0.009	5.08	6.01
2,2,3,3,4,4,5,5-octafluorocyclo-pentan-1-ol	cyc (-$(CF_2)_4$CH(OH)-)	0.301	0.156	1.2	49.1	1.22	13.6	1.22	3.89	0.00128	3	0.000971	2.46	1400	1660
HFE-43-10pccc124	$CHF_2OCF_2OCF_2$ CF_2OCHF_2	14.1	1.03	212	8720	288	3220	289	920	0.667	1560	0.255	647	309000	383000
HFE-449s1	$C_4F_9OCH_3$	4.8	0.36	39.5	1620	41.2	460	41.2	131	0.0455	106	0.0334	84.6	46700	55500
n-HFE-7100	$CF_3CF_2CF_2CF_2OCH_3$	4.8	0.425	46.7	1920	48.6	544	48.7	155	0.0538	126	0.0394	99.9	55200	65600
i-HFE-7100	$(CF_3)_2CFCF_2OCH_3$	4.8	0.341	37.5	1540	39.1	437	39.1	124	0.0432	101	0.0317	80.2	44300	52600
HFE-569sf2	$C_4F_9OC_2H_5$	0.8	0.301	5.32	219	5.43	60.7	5.43	17.3	0.00573	13.4	0.00433	11	6220	7370
i-HFE-7200	$(CF_3)_2CFCF_2O$ CH_2CH_3	0.63	0.216	3.01	124	3.07	34.3	3.07	9.78	0.00323	7.56	0.00245	6.2	3520	4160

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
HFE-7300	$(CF_3)_2CFCFOC_2H_5CF_2CF_2CF_3$	5.24	0.48	34.5	1420	36.2	405	36.2	115	0.0405	94.7	0.0294	74.6	41100	48800
HFE-7500	$n\text{-}C_3F_7CFOC_2H_5CF(CF_3)_2$	0.3	0.27	1.14	47	1.17	13	1.17	3.72	0.00123	2.86	0.000928	2.35	1340	1580
HFE-236ca12	$CHF_2OCF_2OCHF_2$	26.5	0.648	285	11700	542	6060	557	1770	2.15	5020	0.733	1860		
HFE-338pcc13	$CHF_2OCF_2CF_2OCHF_2$	13.4	0.87	223	9180	297	3320	297	948	0.649	1520	0.259	657	321000	395000
1,1,1,3,3,3-hexa-fluoropropan-2-ol	$(CF_3)_2CHOH$	1.9	0.274	18.1	742	18.5	206	18.5	58.8	0.0197	46	0.0148	37.4	21100	25000
HG-02	$CHF_2(OCF_2CF_2)_2OCHF_2$	26.9	1.15	268	11000	513	5730	528	1680	2.05	4780	0.704	1780		
HG-03	$CHF_2(OCF_2CF_2)_3OCHF_2$	26.9	1.43	250	10300	479	5350	492	1570	1.91	4470	0.657	1660		
Fluroxene	$CF_3CH_2OCH{=}CH_2$	0.01	0.011	0.00505	0.207	0.00515	0.058	0.00515	0.016	5.39×10^{-5}	0.013	4.09×10^{-6}	0.01	5.91	6.99
2-ethoxy-3,3,4,4,5-pentafluoro-tetrahydro-2,5-bis[1,2,2,2-tetra-fluoro-1-(trifluoromethyl) ethyl]-furan	$C_{12}H_5F_{19}O_2$	0.81	0.489	4.27	175	4.36	48.7	4.36	13.9	0.0046	10.7	0.00347	8.8	4990	5910
Difluoro (methoxy) methane	CH_3OCHF_2	1.1	0.153	11.9	491	12.2	136	12.2	38.9	0.0129	30.1	0.00973	24.7	14000	16500
HG′-01	$CH_3OCF_2CF_2OCH_3$	1.7	0.289	17.7	727	18.1	202	18.1	57.7	0.0192	45	0.0145	36.7	20700	24500
HG′-02	$CH_3O(CF_2CF_2O)_2CH_3$	1.7	0.562	20	823	20.5	229	20.5	65.3	0.0218	50.9	0.0164	41.5	23400	27700
HG′-03	$CH_3O(CF_2CF_2O)_3CH_3$	1.7	0.762	19.2	789	19.6	219	19.6	62.5	0.0209	48.8	0.0157	39.8	22400	26600
HFE-329me3	$CF_3CFHCF_2OCF_3$	33.6	0.489	180	7410	393	4390	416	1330	1.73	4040	0.671	1700		
3,3,4,4,5,5,6,6,7,7,7-undeca-fluoroheptan-1-ol	$CF_3(CF_2)_4CH_2CH_2OH$	0.047	0.054	0.0468	1.92	0.0477	0.533	0.0477	0.152	5×10^{-5}	0.117	3.79×10^{-5}	0.096	54.8	64.8
3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-pentadecafluoro-nonan-1-ol	$CF_3(CF_2)_6CH_2CH_2OH$	0.047	0.06	0.0394	1.62	0.0401	0.449	0.0402	0.128	4.21×10^{-5}	0.098	3.19×10^{-5}	0.081	46.1	54.5

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-nonadecafluoroundecan-1-ol	$CF_3(CF_2)_8CH_2CH_2OH$	0.047	0.045	0.024	0.985	0.0245	0.273	0.0245	0.078	2.56×10^{-5}	0.06	1.94×10^{-5}	0.049	28.1	33.2
2-chloro-1,1,2-trifluoro-1-methoxyethane	CH_3OCF_2CHClF	1.43	0.211	11.9	488	12.1	136	12.1	38.7	0.0129	30.1	0.0097	24.6	13900	16400
PFPMIE	$CF_3OCFCF_3CF_2OCF_2OCF_3$	800	0.64	189	7750	920	10300	3680	11700	4.59	10700	4.75	12000		
HFE-216	$CF_3OCF{=}CF_2$	0.004	0.006	0.000909	0.037	0.000927	0.01	0.000928	0.003	9.71×10^{-7}	0.002	7.37×10^{-7}	0.002	1.06	1.26
Perfluoroethyl formate	CF_3CF_2OCHO	3.6	0.408	51.9	2130	53.4	597	53.4	170	0.0579	135	0.0431	109	60800	72100
2,2,2-trifluoroethyl formate	CF_3CH_2OCHO	0.548	0.192	4.8	197	4.9	54.8	4.9	15.6	0.00516	12.1	0.0039	9.89	5620	6650
Formic acid;1,1,1,3,3,3-hexafluoropropan-2-ol	$(CF_3)_2CHOCHO$	3.1	0.255	23.5	964	24.1	269	24.1	76.7	0.0259	60.6	0.0194	49	27400	32500
Ethenyl 2,2,2-trifluoroacetate	$CF_3COOCH{=}CH_2$	0.004	0.004	0.000705	0.029	0.000719	0.008	0.000719	0.002	7.52×10^{-7}	0.002	5.71×10^{-7}	0.001	0.825	0.976
Ethyl 2,2,2-trifluoroacetate	$CF_3COOCH_2CH_3$	0.06	0.056	0.139	5.7	0.142	1.58	0.142	0.451	0.000148	0.347	0.000112	0.285	162	192
Prop-2-enyl 2,2,2-trifluoroacetate	$CF_3COOCH_2CH{=}CH_2$	0.003	0.005	0.000636	0.026	0.000648	0.007	0.000649	0.002	6.79×10^{-7}	0.002	5.15×10^{-7}	0.001	0.745	0.881
Methyl 2,2,2-trifluoroacetate	CF_3COOCH_3	1	0.158	7.21	296	7.36	82.3	7.36	23.5	0.00778	18.2	0.00587	14.9	8430	9980
2,2,3,3,4,4,4-heptafluorobutan-1-ol	$CF_3CF_2CF_2CH_2OH$	0.55	0.199	3.2	131	3.26	36.5	3.26	10.4	0.00343	8.03	0.0026	6.58	3740	4430
1,1,2-trifluoro-2-(trifluoromethoxy)ethane	$CHF_2CHFOCF_3$	9	0.353	97.6	4010	113	1260	113	359	0.162	379	0.0933	236	126000	151000
1-ethoxy-1,1,2,3,3,3-hexafluoropropane	$CF_3CHFCF_2OCH_2CH_3$	0.403	0.193	2.32	95.2	2.37	26.4	2.37	7.54	0.00249	5.81	0.00188	4.77	2710	3210

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
1,1,1,2,2,3,3-heptafluoro-3-(1,2,2,2-tetrafluoroethoxy) propane	$CF_3CF_2CF_2OCHFCF_3$	59.4	0.591	202	8320	593	6630	733	2340	2.94	6860	1.63	4140		
2,2,3,3-tetrafluoropropan-1-ol	$CHF_2CF_2CH_2OH$	0.255	0.112	1.27	52	1.29	14.4	1.29	4.12	0.00136	3.17	0.00103	2.6	1480	1750
2,2,3,4,4,4-hexafluorobutan-1-ol	$CF_3CHFCF_2CH_2OH$	0.367	0.227	2.67	110	2.73	30.5	2.73	8.69	0.00287	6.7	0.00217	5.5	3130	3700
1,1,2,2-tetrafluoro-3-methoxypropane	$CHF_2CF_2CH_2OCH_3$	0.071	0.052	0.147	6.03	0.15	1.68	0.15	0.478	0.000157	0.367	0.000119	0.302	172	203
1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl) pentan-3-one	$CF_3CF_2COCF(CF_3)_2$	0.019	0.028	0.01	0.411	0.0102	0.114	0.0102	0.033	1.07×10^{-5}	0.025	8.12×10^{-5}	0.021	11.7	13.9
3,3,3-trifluoropropanal	CF_3CH_2CHO	0.008	0.005	0.00221	0.091	0.00225	0.025	0.00225	0.007	2.36×10^{-5}	0.006	1.79×10^{-5}	0.005	2.58	3.06
2-fluoroethanol	CH_2FCH_2OH	0.044	0.012	0.0465	1.91	0.0474	0.53	0.0474	0.151	4.97×10^{-5}	0.116	3.77×10^{-5}	0.095	54.4	64.4
2,2-difluoroethanol	CHF_2CH_2OH	0.167	0.046	0.542	22.3	0.553	6.18	0.553	1.76	0.00058	1.36	0.00044	1.11	634	751
2,2,2-trifluoroethanol	CF_3CH_2OH	0.458	0.117	3.13	129	3.2	35.7	3.2	10.2	0.00336	7.86	0.00254	6.44	3660	4340
HG-04	$CHF_2O(CF_2CF_2O)_4CHF_2$	26.9	1.46	204	8400	392	4380	403	1280	1.56	3660	0.538	1360		
Methyl-perfluoroheptene-ethers	$CH_3OC_7F_{13}$	0.304	0.27	1.32	54.4	1.35	15.1	1.35	4.3	0.00142	3.31	0.00107	2.72	1550	1830
1,1,1-trifluoropropan-2-one	CF_3COCH_3	0.014	0.011	0.00788	0.324	0.00804	0.09	0.00804	0.026	8.42×10^{-5}	0.02	6.39×10^{-5}	0.016	9.23	10.9
1,1,1-trifluorobutan-2-one	$CF_3COCH_2CH_3$	0.018	0.01	0.00834	0.343	0.00851	0.095	0.00851	0.027	8.91×10^{-5}	0.021	6.76×10^{-5}	0.017	9.77	11.6
1-chloro-2-ethenoxyethane	$ClCH_2CH_2OCH{=}CH_2$	0	0.001	1.65×10^{-5}	0.001	1.68×10^{-5}	0	1.68×10^{-5}	0	1.76×10^{-8}	0	1.33×10^{-8}	0	0.019	0.023
2-methylpentan-3-one	$CH_3CH_2COCH(CH_3)_2$	0.015	0.02	0.0175	0.719	0.0179	0.2	0.0179	0.057	1.87×10^{-5}	0.044	1.42×10^{-5}	0.036	44.8	53
Ethyl methyl ether	$CH_3CH_2OCH_3$	0.005	0.002	0.000856	0.035	0.000873	0.01	0.000873	0.003	9.14×10^{-7}	0.002	6.94×10^{-7}	0.002	2.04	2.42

Name	Formula	Lifetime (yr)	Radiative Efficiency (W m^{-2} ppb^{-1})	AGWP-20 (pW m^{-2} yr kg^{-1})	GWP-20	AGWP-100 (pW m^{-2} yr kg^{-1})	GWP-100	AGWP-500 (pW m^{-2} yr kg^{-1})	GWP-500	AGTP-50 (pK kg^{-1})	GTP-50	AGTP-100 (pK kg^{-1})	GTP-100	CGTP-50 (yr)	CGTP-100 (yr)
Major Greenhouse Gases															
Octafluoro-oxolane	c-C_4F_8O	3000	0.463	246	10100	1240	13900	5890	18800	6.18	14500	6.65	16900		
Crotonaldehyde	$CH_3CH{=}CHCHO$	0.001	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl vinyl ketone	$CH_3COCH{=}CH_2$	0.001	0	2.48×10^{-5}	0.001	2.53×10^{-5}	0	2.53×10^{-5}	0	2.64×10^{-8}	0	2.01×10^{-8}	0	0.029	0.034
Allyl ether	$(CH_2{=}CHCH_2)_2O$	0	0.001	1.19×10^{-5}	0	1.22×10^{-5}	0	1.22×10^{-5}	0	1.27×10^{-8}	0	9.65×10^{-9}	0	0.014	0.017
Allyl ethyl ether	$CH_3CH_2OCH_2$ $CH{=}CH_2$	0.001	0.001	3.39×10^{-5}	0.001	3.46×10^{-5}	0	3.46×10^{-5}	0	3.62×10^{-8}	0	2.75×10^{-8}	0	0.04	0.047
(z)-hex-2-en-1-ol	$CH_3CH_2CH_2CH{=}CH$ CH_2OH	0	0.038	0.000223	0.009	0.000228	0.003	0.000228	0.001	2.38×10^{-7}	0.001	1.81×10^{-7}	0	0.261	0.309
(e)-hex-2-en-1-ol	$CH_3CH_2CH_2CH{=}CH$ CH_2OH	0	0.036	0.000208	0.009	0.000212	0.002	0.000212	0.001	2.22×10^{-7}	0.001	1.68×10^{-7}	0	0.243	0.288
Miscellaneous Compounds															
Allyl cyanide	$CH_2{=}CHCH_2CN$	0.002	0	4.08×10^{-5}	0.002	4.16×10^{-5}	0	4.16×10^{-5}	0	4.35×10^{-8}	0	3.3×10^{-8}	0	0.048	0.056
Hexamethyl-disiloxane	$C_6H_{18}OSi_2$	0.025	0.047	0.0418	1.72	0.0426	0.476	0.0426	0.136	4.46×10^{-5}	0.104	3.39×10^{-5}	0.086	48.9	57.9
Octamethyltri-siloxane	$C_8H_{24}O_2Si_3$	0.019	0.06	0.0285	1.17	0.029	0.325	0.029	0.093	3.04×10^{-5}	0.071	2.31×10^{-5}	0.058	33.3	39.4
Decamethyl-tetrasiloxane	$C_{10}H_{30}O_3Si_4$	0.014	0.06	0.0155	0.635	0.0158	0.176	0.0158	0.05	1.65×10^{-5}	0.039	1.25×10^{-5}	0.032	18.1	21.4
Dodecamethyl-pentasiloxane	$C_{12}H_{36}O_4Si_5$	0.011	0.064	0.0107	0.439	0.0109	0.122	0.0109	0.035	1.14×10^{-5}	0.027	8.67×10^{-6}	0.022	12.5	14.8
Hexamethyl-cyclotrisiloxane	$C_6H_{18}O_3Si_3$	0.038	0.1	0.101	4.14	0.103	1.15	0.103	0.328	0.000108	0.252	8.18×10^{-5}	0.207	118	140
Octamethylcyclo-tetrasiloxane	$C_8H_{24}O_4Si_4$	0.027	0.12	0.0648	2.66	0.0661	0.739	0.0661	0.211	6.92×10^{-5}	0.162	5.25×10^{-5}	0.133	75.9	89.8
Decamethylcyclo-pentasiloxane	$C_{10}H_{30}O_5Si_5$	0.016	0.098	0.0253	1.04	0.0258	0.289	0.0259	0.082	2.71×10^{-5}	0.063	2.05×10^{-5}	0.052	29.7	35.1
Dodecamethyl-cyclohexasiloxane	$C_{12}H_{36}O_6Si_6$	0.011	0.086	0.0124	0.51	0.0127	0.142	0.0127	0.04	1.33×10^{-5}	0.031	1.01×10^{-5}	0.026	14.6	17.2
Ethane	C_2H_6	0.159	0.001	0.0383	1.57	0.0391	0.437	0.0391	0.125	4.1×10^{-5}	0.096	3.11×10^{-5}	0.079	0.048	0.056
Propane	C_3H_8	0.036	0	0.00175	0.072	0.00178	0.02	0.00178	0.006	1.87×10^{-6}	0.004	1.42×10^{-6}	0.004	48.9	57.9
Butane	n-C_4H_{10}	0.019	0	0.000542	0.022	0.000553	0.006	0.000553	0.002	5.79×10^{-7}	0.001	4.4×10^{-7}	0.001	33.3	39.4

Table 7.SM.8 | Estimated uncertainty in the global warming potential (GWP) and global temperature-change potential (GTP) for CH_4 showing the total uncertainty as a percentage of the best estimate (expressed as 5–95% confidence interval), and the uncertainty by component of the total emission metric calculation (radiative efficiency, chemistry feedbacks, atmospheric lifetime, CO_2 (combined uncertainty in radiative efficiency and CO_2 impulse response)), carbon cycle response, fate of oxidized fossil methane, and impulse-response function. Uncertainties in individual terms are taken from Section 7.6, except for the CO_2 impulse response which comes from Joos et al. (2013). The impulse-response uncertainties are calculated by taking 1.645 × standard deviation of the GTPs generated from 600 ensemble members of the impulse response derived from FaIRv1.6.2 and MAGICC7.5.1 (Section 7.SM.4.2).

Metric	Percentage Uncertainty in the Metric Best Estimate Due to:							Total Uncertainty (%)
	Radiative Efficiency (%)	Chemical Response (%)	Lifetime (%)	CO_2 (%)	Carbon Cycle (%)	Fossil Fuel Oxidation (%)	Impulse-response Function (%)	
GWP-20	20	14	9	18	3	2	0	32
GWP-100	20	14	14	26	5	7	0	40
GWP-500	20	14	14	29	5	26	0	48
GTP-50	20	14	37	22	17	22	31	64
GTP-100	20	14	18	28	8	60	38	83

Table 7.SM.9 | As Table 7.SM.8, for N_2O.

Metric	Percentage Uncertainty in the Metric Best Estimate Due to:						Total Uncertainty (%)
	Radiative Efficiency (%)	Chemical Response (%)	Lifetime (%)	CO_2 (%)	Carbon Cycle (%)	Impulse-response Function (%)	
GWP-20	16	36	1	18	2	0	43
GWP-100	16	36	3	26	5	0	47
GWP-500	16	36	8	29	5	0	49
GTP-50	16	36	3	25	6	1	46
GTP-100	16	36	7	29	6	2	49

Table 7.SM.10 | As Table 7.SM.8, for CFC-11.

Metric	Percentage Uncertainty in the Metric Best Estimate Due to:					Total Uncertainty (%)
	Radiative Efficiency (%)	Lifetime (%)	CO_2 (%)	Carbon Cycle (%)	Impulse-response Function (%)	
GWP-20	22	3	18	2	0	29
GWP-100	22	12	26	5	0	37
GWP-500	22	19	29	5	0	42
GTP-50	22	14	24	6	4	37
GTP-100	22	28	28	7	7	47

Table 7.SM.11 | As Table 7.SM.8, for PFC-14 (CF_4).

Metric	Percentage Uncertainty in the Metric Best Estimate Due to:					Total Uncertainty (%)
	Radiative Efficiency (%)	Lifetime (%)	CO_2 (%)	Carbon Cycle (%)	Impulse-response Function (%)	
GWP-20	19	0	18	2	0	26
GWP-100	19	0	26	4	0	33
GWP-500	19	0	29	5	0	35
GTP-50	19	0	25	5	2	32
GTP-100	19	0	29	5	1	35

APPENDIX V. INTERNAL SPECIFICATION SHEETS

CUB ACID SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Acid Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	12,000 SCFM	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
dP across Mist Eliminator (Dirty)	[redacted]	
Total dP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow*	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
H2SO4		
Removal Efficiency (%)	≥ 75%	
Scrubber Physical Data		
Scrubber Dimensions	Vendor Supplied Information	
Gas Inlet Size	Vendor Supplied Information	
Gas Outlet Size	Vendor Supplied Information	
Largest Piece Dimensions	Vendor Supplied Information	
Vendor to Provide thick EPDM PAD to support scrubber		

CUB BOILER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Boiler	
Design Data		
Fuel	Natural Gas	
Heat Input Rating, Total	32.7 MMBtu/hr	
Heat Output, Total	26.8 MMBtu/hr	
Air Exhaust Flow Rate	22,500 SCFM	
Outlet Temperature	400 °F	
Design Pressure	[redacted]	
Operating Water Volume	[redacted]	
NFPA Pamphlet 85 Compliance & FM Approval	[redacted]	
Gaseous Component in Scrubber Gas		
NOx		
Maximum Outlet Concentration	9 ppm(v) dry @ 3% O2	
CO		
Maximum Outlet Concentration	50 ppm(v) dry @ 3% O2	
VOC		
Maximum Outlet Concentration	0.0017 lb/MMBtu	
Physical Data		
Shell Diameter	106"	
Motor Size (9 ppm System)	75	
Dimensions	132" x 272" x 145"	

FAB ACID SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Acid Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	80,000 SCFM	
Maximum Flow*	80,000 SCFM	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
DP across Mesh Pad (Dirty)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
HCl		
Removal Efficiency (%)	≥ 60%	
HF		
Removal Efficiency (%)	≥ 60%	
H2SO4		
Removal Efficiency (%)	≥ 75%	
HNO3		
Removal Efficiency (%)	≥ 40%	
VOC (measured as dry methane)		
Outlet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		
Scrubber Dimensions	21'-5" x 15'-4" x 13'-2"	
Gas Inlet Size	40" X 120"	
Gas Outlet Size	66" ID	

	Parameter	Specification	Vendor Proposal
	Largest Piece Dimensions	Vendor Supplied Information	
	Vendor to Provide thick EPDM PAD to support scrubber		

FAB AMMONIA SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Ammonia Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	40,000 SCFM	
Maximum Flow	40,000 SCFM	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
DP across Mesh Pad (Dirty)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation Flow	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
NH3		
Removal Efficiency (%)	≥ 98%	
VOC (measured as dry methane)		
Outlet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		
Scrubber Dimensions	108" L x 128" W x 291" H	
Gas Inlet Size	Vendor Supplied Information	
Gas Outlet Size	Vendor Supplied Information	
Largest Piece Dimensions	Vendor Supplied Information	
Vendor to Provide thick EPDM PAD to support scrubber		

FAB CVD IONIZING WET SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Acid Scrubber with Wet Electrostatic Precipitator (WESP) and NOx Adsorber, collectively an Ionizing Wet Scrubber (IWS)	
Acid Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	26,500 SCFM	
Maximum Flow*	26,500 SCFM	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
DP across Mesh Pad (Dirty)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow*	[redacted]	
Packing Wetting Rate	[redacted]	
NO Oxidizer	Ozone	
Reductant Chemical	Na based	
Gaseous Component in Scrubber Gas		
NO_2		
Removal Efficiency (%)	≥ 90%	
HCl		
Removal Efficiency (%)	≥ 60%	
HF		
Removal Efficiency (%)	≥ 60%	
SiO_2		
Removal Efficiency (%)	≥ 82%	

Parameter	Specification	Vendor Proposal
VOC (measured as dry methane)		
Outlet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		
Scrubber Dimensions	36'-11" x 21 x 13'-6"	
Gas Inlet Size	46"	
Gas Outlet Size	46" ID	
Largest Piece Dimensions	Vendor Supplied Information	
Vendor to Provide thick EPDM PAD to support scrubber		

FAB RCS ABATEMENT SYSTEM
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Regenerative Catalytic Oxidizer System (RCS)	
Abatement System	Regenerative Catalytic Oxidizer with Pre-and Post-Wet Scrubbers	
Pre-Wet Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Stage	[redacted]	
Filtration	[redacted]	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 °F	
Design Operation Flow	[redacted]	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
dP Across Mesh Pad (Dirty)	[redacted]	
Total dP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow	[redacted]	
Packing Wetting Rate	[redacted]	
Regenerative Catalytic Oxidizer Design Data		
Type	[redacted]	
Design Flow	[redacted]	
Maximum Inlet Temperature	80 °F dry bulb	
Minimum Inlet Temperature	60 °F dry bulb	
Relative Humidity	45% RH	
Post-Wet Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Stage	[redacted]	

	Parameter	Specification	Vendor Proposal
	Filtration	[redacted]	
	Ambient Temperature Range	65-75 °F	
	Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
	Gas Inlet Temp / %RH	70 °F	
	Design Operation Flow	[redacted]	
	Packing Velocity, Max	[redacted]	
	Pressure Drop (dP)	[redacted]	
	dP Across Mesh Pad (Dirty)	[redacted]	
	Total dP from inlet to outlet	[redacted]	
	Mist Eliminator Type	[redacted]	
	pH Range	[redacted]	
	Conductivity	[redacted]	
	Recirculation flow	[redacted]	
	Packing Wetting Rate	[redacted]	
Gaseous Component in Exhaust Gas			
	HCl		
	Control Efficiency	99%	
	HF		
	Control Efficiency	99%	
	CF4		
	Control Efficiency	89%	
	C2F6		
	Control Efficiency	98%	
	C4F6		
	Control Efficiency	98%	
	C4F8		
	Control Efficiency	98%	
	CHF3		
	Control Efficiency	98%	
	CH2F2		
	Control Efficiency	99%	
	CH3F		
	Control Efficiency	99%	
	NF3		
	Control Efficiency	95%	

Parameter		Specification	Vendor Proposal
	SF6		
	Control Efficiency	96%	
Vendor to provide 1/4" thick EPDM PAD to support scrubber.			

FAB RCTO
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Rotary Concentrator Thermal Oxidizer (RCTO)	
Inlet Air Conditions:		
Inlet Flow	50,000 SCFM	
Maximum Inlet Temperature	80 °F dry bulb	
Minimum Inlet Temperature	60 °F dry bulb	
Relative Humidity	45% RH	
Concentrator Design Data		
Type	Rotary Zeolite Disc	
Rotor Configuration	[redacted]	
Filtration	[redacted]	
Design Operation Flow	50,000 SCFM	
Maximum Flow	50,000 SCFM	
Ambient Temperature Range	65-75 °F	
Inlet Static Pressure	[redacted]	
Maximum Unit Pressure Drop (dP)	[redacted]	
Oxidizer Design Data		
Type	[redacted]	
Design Operational Flow	[redacted]	
Concentrated Steam Ratio	[redacted]	
Minimum Oxidizing Temperature	1, 400°F	
Heat Input Rating	4.0 MMBtu/hr	
Additional Design Parameters		
VFD Draft Fan	[redacted]	
FRP Combustion Blower	[redacted]	
Heat Exchangers Design Data		
Type	[redacted]	
Maximum Pressure Drop (dP)	[redacted]	
Gaseous Component in Scrubber Gas		
CO		
Outlet Concentration	<100 ppm(v) dry @ 3% O2	
VOC (measured as dry methane)*		
Outlet Concentration	≤ 10 ppm(v)	
VOC (measured as dry methane)*		
Inlet Concentration	< 200 ppm(v)	
Control Efficiency	≥ 90%	
VOC (measured as dry methane)*		

Parameter	Specification	Vendor Proposal
Inlet Concentration	> 2000ppm(v) to ≥ 200 ppm(v)	
Control Efficiency	≥ 97%	
VOC (measured as dry methane)*		
Inlet Concentration	≥ 2000 ppm(v)	
Control Efficiency	98.5%	
** The RCTO system shall meet one of the VOC operating requirements listed above.*		

GAS YARD WATER BATH VAPORIZER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Water Bath Vaporizer	
Design Data		
Fuel	Natural Gas	
Natural Gas Flow	42,000 SCFH	
Heat Input Rating, Total	42.8 MMBtu/hr	
Steam Nominal Vaporization Capacity	42 MMBtu/hr	
Air Exhaust Flow Rate	[redacted]	
Maximum Operational Steam Flow	[redacted]	
Outlet Temperature	750 °F	
Design Pressure	[redacted]	
Water Tank Capacity	[redacted]	
NFPA Pamphlet 85 Compliance & FM Approval	[redacted]	
Gaseous Component in Scrubber Gas		
NOx		
Maximum Outlet Concentration	9 ppm(v) dry @ 3% O2	
CO		
Maximum Outlet Concentration	84 ppm(v) dry @ 3% O2	
VOC		
Maximum Outlet Concentration	0.0054 lb/MMBtu	
Physical Data		
Skid		
Minimum 1/4" Steel Deck Plate on all welded 6" Tubular frame with cross members	Required	
Bath Box		
All-welded steel walls with internal stiffeners and supports for LPG Heat Exchanger	Required	
Dimensions	13' x 40' x 17'	

HPM ACID SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Acid Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	36,500 SCFM	
Maximum Flow	36,500 SCFM	
Packing Velocity. Max	[redacted]	
Pressure Drop (dP)	[redacted]	
DP across Mesh Pad (Dirty)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow*	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
HF		
Removal Efficiency (%)	≥ 98%	
H2SO4		
Removal Efficiency (%)	≥ 75%	
VOC (measured as dry methane)		
Outlet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		
Scrubber Dimensions	17'-5" x 12'-4" x 10'-2"	
Gas Inlet Size	20" X 80"	
Gas Outlet Size	48" ID	
Largest Piece Dimensions	Vendor Supplied Information	
Vendor to Provide thick EPDM PAD to support scrubber		

HPM AMMONIA SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Ammonia Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	18,000 SCFM	
Maximum Flow	18,000 SCFM	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow*	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
NH3		
Removal Efficiency (%)	≥ 98%	
VOC (measured as dry methane)		
Outlet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		
Scrubber Dimensions	17.9 L x 6.3 W x 11.06' H	
Gas Inlet Size	Vendor Supplied Information	
Gas Outlet Size	Vendor Supplied Information	
Largest Piece Dimensions	Vendor Supplied Information	

HPM RCTO
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Rotary Concentrator Thermal Oxidizer (RCTO)	
Inlet Air Conditions:		
Inlet Flow	23,000 SCFM	
Maximum Inlet Temperature	80 °F dry bulb	
Minimum Inlet Temperature	60 °F dry bulb	
Relative Humidity	45% RH	
Concentrator Design Data		
Type	[redacted]	
Rotor Configuration	[redacted]	
Filtration	[redacted]	
Design Operation Flow	23,000 SCFM	
Maximum Flow	23,000 SCFM	
Ambient Temperature Range	65-75 °F	
Inlet Static Pressure	[redacted]	
Maximum Unit Pressure Drop (dP)	[redacted]	
Oxidizer		
Type	[redacted]	
Design Operational Flow	1, 150SCFM	
Concentrated Steam Ratio	[redacted]	
Oxidizing Temperature	1, 400°F	
Heat Input Rating, Total	1.0 MMBtu/hr	
Additional Design Parameters		
VFD Draft Fan	Required	
FRP Combustion Blower	Required	
Heat Exchangers		
Type	[redacted]	
Maximum Pressure Drop (dP)	[redacted]	
Gaseous Component in Scrubber Gas		
VOC (measured as dry methane)*		
Outlet Concentration	≤ 10 ppm(v)	
VOC (measured as dry methane)*		
Inlet Concentration	< 200 ppm(v)	
Control Efficiency	90%	
** The RCTO system shall meet one of the VOC operating requirements listed above.*		

WWT ACID SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Acid Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	15,000 SCFM	
Maximum Flow	15,000 SCFM	
Packing Velocity, Max	[redacted]	
Pressure Drop (dP)	[redacted]	
DP across Mesh Pad (Dirty)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow*	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
HCl		
Removal Efficiency (%)	≥ 98%	
HF		
Removal Efficiency (%)	≥ 98%	
HBr		
Removal Efficiency (%)	≥ 98%	
H3PO4		
Removal Efficiency (%)	≥ 98%	
H2SO4		
Removal Efficiency (%)	≥ 75%	
HNO3		
Removal Efficiency (%)	≥ 40%	
VOC (measured as dry methane)		
Outlet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		

	Parameter	Specification	Vendor Proposal
	Scrubber Dimensions	175" x 106" x 112"	
	Gas Inlet Size	36"	
	Gas Outlet Size	48" ID	
	Largest Piece Dimensions	Vendor Supplied Information	
	Vendor to Provide thick EPDM PAD to support scrubber		

WWT AMMONIA SCRUBBER
NY DATA SHEET

Parameter	Specification	Vendor Proposal
Equipment Name	Ammonia Scrubber	
Scrubber Design Data		
Type	[redacted]	
Orientation	[redacted]	
Location	Indoors	
Ambient Temperature Range	65-75 °F	
Sump Temperature Required at Minimum Ambient Temp	Vendor Supplied Information	
Gas Inlet Temp / %RH	70 degrees F	
Design Operation Flow	2,500 SCFM	
Maximum Flow	2,500 SCFM	
Packing Velocity, Max	500 FPM	
Pressure Drop (dP)	[redacted]	
DP across Mist Eliminator (Dirty)	[redacted]	
Total DP from inlet to outlet	[redacted]	
Mist Eliminator Type	[redacted]	
pH Range	[redacted]	
Conductivity	[redacted]	
Recirculation flow*	[redacted]	
Packing Wetting Rate	[redacted]	
Gaseous Component in Scrubber Gas		
NH3		
Removal Efficiency (%)	≥ 98%	
VOC (measured as dry methane)		
Outet Concentration	≤ 10 ppm(v)	
Scrubber Physical Data		
Scrubber Dimensions	138" L x 72" W x 60" H	
Gas Inlet Size	Vendor Supplied Information	
Gas Outlet Size	Vendor Supplied Information	
Largest Piece Dimensions	Vendor Supplied Information	
Vendor to Provide thick EPDM PAD to support scrubber		

The Request for Proposal (RFP) for The Rail Spur Project has been omitted to protect Confidential Business Information (CBI)