Supplemental Human Health and Environmental Risk Assessment for U.S. Combustion Turbines (2023 Supplement Addendum)

2014 Base Year Evaluation

2023 TECHNICAL REPORT

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ABSTRACT

This report supplements the risk assessments conducted by The Electric Power Research Institute (EPRI)[1] in support of the National Emission Standards for Hazardous Air Pollutants (NESHAP): Stationary Combustion Turbines Risk and Technology Review (RTR)[2]. EPRI has conducted risk assessments for additional turbines that would be subject to the NESHAP for stationary combustion turbines (40 CFR 63, subpart YYYY), which have been identified by the U.S. Environmental Protection Agency (EPA). In total, an additional 132 combustion turbines (CTs) at 44 facilities have been assessed in this supplemental risk analysis. The information presented here provides an evaluation of Hazardous Air Pollutant (HAP) emissions and associated risks from CTs for a 2014 base case year, with emissions and stack parameters developed by EPRI using the National Emissions Inventory (NEI) database and other publicly available data. EPRI has considered potential risk to human health (inhalation and multi-pathway) and the environment from HAP emissions for CTs by evaluating risks associated with these additional turbines.

An investigation of the potential inhalation risks to human health from emissions of HAPs at CTs was performed by EPRI in support of this effort. Human health risks due to inhalation of trace amounts of HAPs emitted from CTs are assessed for each facility in the database of additional turbines. These risk assessments were carried out using current EPA-supported air quality models and archived databases on the location of residents in the vicinity of each combustion turbine stack.

Multi-pathway human health risks for all facilities considered in the supplemental CT risk analysis which emitted persistent and bioaccumulative HAPs (PB-HAPs) were evaluated on a three-tiered screening level using very conservative, health-protective assumptions developed by EPA. Any facilities that still exceeded emissions screening thresholds at the end of the screening analysis would indicate that they may still have the potential for multi-pathway risk for one or more constituents.

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[1] *Inhalation Human Health Risk Assessment for U.S. Stationary Combustion Turbines: 2014 Base Year Evaluation*. EPRI, Palo Alto, CA: 2019. 3002016528.

Multi-Pathway Human Health Risk Assessment for U.S. Stationary Combustion Turbines: 2014 Base Year Evaluation. EPRI, Palo Alto, CA: 2019. 3002016745.

Environmental Risk Screening Assessment for U.S. Stationary Combustion Turbines: 2014 Base Year Evaluation. EPRI, Palo Alto, CA: 2019. 3002017441.

Supplemental Human Health and Environmental Risk Assessment for U.S. Combustion Turbines: 2014 Base Year Evaluation. EPRI, Palo Alto, CA: 2020. 3002020134.

Supplemental Human Health and Environmental Risk Assessment for U.S. Combustion Turbines (2023 Supplement): 2014 Base Year Evaluation. EPRI, Palo Alto, CA: 2023. 3002026130.

[2] https://www.regulations.gov/docket?D=EPA-HQ-OAR-2017-0688

An investigation of the potential environmental (ecological) screening-level risks from emissions of HAPs at these CTs was performed by EPRI. This analysis uses environmental screening thresholds developed by EPA by applying conservative, environmentally-protective assumptions in the Human Exposure Model (HEM4) model and the American Metrological Society/EPA Regulatory Model (AERMOD). In the case that any facility exceeded the environmental screening thresholds at the end of the screening analysis, this would indicate that it may have the potential for widespread adverse environmental effects for one or more constituents and should be evaluated further.

Approach

The CT database published by EPA in January 2023 served as the basis for the supplemental assessment described in this report. Additional information regarding plant configuration, historically reported emissions and fuel use was then compiled to develop emission estimates and stack information. These emission rates, along with physical stack parameters and plant locations, were used as inputs to determine the human health risks and environmental risks associated with the CTs.

An air quality model that simulated downwind concentrations at locations within 50 km of each stack was used to estimate human health risks related to inhalation of pollutants released into the atmosphere from the CTs. EPRI used the maximum modeled concentration and location to define the point of highest inhalation risk for long-term exposure for carcinogen and non-carcinogen air toxics and for short-term exposure for non-carcinogens.

Next, the multi-pathway risk screening assessment was performed for the facilities that emitted pollutants that EPA considers for multi-pathway risk. For five of the six PB-HAPs, a three-tiered screening analysis was conducted using the same methodology as in the previous EPRI study, which follows EPA's methodology for multi-pathway screening that has been used in recent RTRs. The first tier compares facility-wide emissions against emission threshold values established by EPA. Tier 2 screening adjusts the emission threshold values for facilities that did not screen out at Tier 1 by accounting for meteorological characteristics representative for each site as well as the location of lakes relative to each facility. Finally, Tier 3 consists of several refinements that consider the location of farms/gardens, whether the nearby lakes are fishable, and a plume rise analysis. For the sixth PB-HAP, lead, an analysis was conducted following EPA methodology where the estimated 3-month rolling average off-site ambient air concentration was compared to the lead primary National Ambient Air Quality Standard (NAAQS).

Lastly, the environmental risk screening assessment was performed for the facilities that emitted pollutants that EPA evaluates for potential adverse environmental risk. Risks were estimated for the ecological assessment endpoints and ecological benchmarks that EPA considers when assessing potential adverse environmental effects for RTRs. The screening analysis was conducted using the same methodology as in the previous EPRI study, which follows EPA's methodology for environmental risk screening that has been used in recent RTRs. The analysis for acid gases compares the annual average off-site ambient air concentrations to ecological benchmarks for hydrochloric acid (HCl) and hydrofluoric acid (HF). The approach for lead is similar but compares the annual average off-site ambient air concentrations to the secondary NAAQS for lead. The other five PB-HAPs are assessed using a very similar 3-tier screening methodology used by EPRI and EPA for multi-pathway human health risk screening.

Conservative assumptions established by EPA were used throughout the risk assessment to help ensure a conservative analysis of the potential human health and environmental risks from the emitted chemicals assessed in this study.

Results

The facilities included in this EPRI supplemental risk assessment study increased the total facilities assessed by EPRI from 282 to 326, and the total number of CTs assessed by EPRI increased from 902 to 1,034 units.

The inhalation human health risks from combustion turbine HAP emissions for lifetime cancer risk in humans are estimated at less than 1 in 1 million to the individual in the population projected to be most exposed. In the case of HAPs that have the potential to cause non-cancer adverse health effects in humans, the study found that the chronic hazard index (HI) and acute hazard quotient (HQ) from the combustion turbine category were less than 1. These results demonstrate that the inhalation health risks from combustion turbines for each pollutant individually, and all emitted pollutants combined, were below EPA risk thresholds.

Of the 44 facilities considered in the supplemental CT risk analysis, 3 facilities emitted pollutants that EPA considers for multi-pathway risk. The results of the multi-pathway human health risk screening assessment showed that all facilities were below the EPA health risk emissions screening level thresholds. This means that these facilities are likely, within a margin of safety, to have cancer risk values below 1 in 1 million and chronic (long-term exposure) non-cancer risks values below a hazard index of 1. These results demonstrate that the human health risks from CTs at these facilities were below the EPA risk thresholds.

Of the 44 facilities considered in the supplemental CT risk analysis, all 44 emitted pollutants that EPA evaluates for potential adverse environmental risk. The results of the environmental screening assessment showed that all facilities had risks that were below the EPA environmental screening thresholds. As a result, these facilities are likely to have no widespread adverse environmental effects.

Keywords

Inhalation Human Health Risk Assessment
Multi-Pathway Human Health Risk Assessment
Environmental Risk Screening Assessment
Stationary Combustion Turbine
National Emissions Standards for Hazardous Air Pollutants (NESHAP)
Hazardous Air Pollutants (HAPs)

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PRIMARY AUDIENCE: Environmental managers of facilities with stationary combustion turbines that emit hazardous air pollutants (HAPs), U.S. Environmental Protection Agency (EPA), state regulatory agencies, and other stakeholders.

KEY RESEARCH QUESTION

An evaluation of the emissions, stack parameters, associated human health (both inhalation and multi-pathway) risks and potential adverse environmental (ecological) effects of hazardous air pollutants (HAPs) emitted by combustion turbines (CTs) located at major sources in the United States is necessary to determine the residual risk from these sources. These results can inform the Risk and Technology Review (RTR) process and provide an overall assessment of environmental risk from CT HAP emissions.

RESEARCH OVERVIEW

This study investigates the potential risks posed to the environment and to human health from HAPs contained in CT stack emissions. This supplements the previous EPRI studies conducted for inhalation and multi-pathway human health risk and environmental risk by including additional turbines identified by EPA which were not included in the prior analyses. This study conducts a risk analysis for 44 facilities that are major sources of HAPs operating in the United States, totaling an additional 132 CTs.

EPRI conducted an inhalation human health risk assessment of HAP emissions. Emissions estimates and stack information, reviewed and refined from the NEI database to more accurately characterize risk, were used as inputs to the EPA AERMOD dispersion model. The resulting concentration patterns in ambient air were matched with U.S. Census block location data; the inhabited location with the maximum concentration for each HAP was used to estimate inhalation health risks.

Of the 44 facilities in this supplemental analysis, 3 had CTs that emitted pollutants for which EPA assesses for multi-pathway risk. This multi-pathway risk assessment modeling exercise provides useful information on which facilities (if any) have multi-pathway risks above the EPA risk thresholds (cancer risk of 1 in 1 million and hazard index [HI] below 1). Cancer risk and non-cancer hazard risk were determined for model receptors representing gardener, farmer, and fisher populations using EPA's tiered risk screening approach for exposure through incidental ingestion of soil and ingestion of locally grown produce, meat, and eggs from locally raised farm animals, as applicable for each receptor type.

All 44 of the facilities in the supplemental analysis emitted pollutants for which EPA evaluates for environmental effects. This environmental risk screening assessment provides useful information on which facilities (if any) have the potential for widespread adverse environmental effects. Acid gases are assessed for their potential to cause toxic effects on plant growth (phytotoxicity) and on productivity through chronic exposure. Lead is compared with the secondary National Ambient Air Quality Standard (NAAQS), which was developed to provide protection against adverse effects on soil, water, vegetation, wildlife and other environmental endpoints. The other five persistent and bioaccumulative HAPs (PB-HAPs) considered for environmental effects (arsenic, cadmium, mercury, polycyclic organic matter [POM] and dioxins), are considered in ecological analyses because of the ability of these pollutants to bioaccumulate in soil and water and therefore have adverse effects on environmental endpoints such as plants, insectivores, aquatic wildlife (and wildlife that consume fish), and the sediment community.

Conservative assumptions established by EPA are made throughout this risk assessment to help ensure that the results estimate potential risks that are conservative.

KEY FINDINGS

This study found that none of the combustion turbine sources in the source category emitted HAPs in quantities expected to cause lifetime inhalation cancer risk in humans of greater than 1 in 1 million to the individual in the population projected to be most exposed to emissions of those pollutants. In the case of HAPs that have the potential to cause adverse health effects in humans other than cancer, the study found that the chronic hazard index (HI) and acute hazard quotient (HQ) from the combustion turbine category were well below 1.

For multi-pathway human health risks, a total of 3 of the 44 facilities had combustion turbines that emitted pollutants EPA considers for multi-pathway risk. Multi-pathway screening risks for all facilities were below EPA's emissions screening level thresholds.

This study also assessed whether the CTs emitted HAPs in quantities that would be expected to cause widespread, adverse environmental effects. All 132 CTs emitted pollutants EPA considers for environmental effects. The assessment resulted in risks below EPA's environmental screening level thresholds.

WHY THIS MATTERS

A comprehensive evaluation of the residual risk from HAP emissions is necessary to characterize human health and environmental risk from HAP emissions from CTs and to inform the RTR process. The inhalation and multi-pathway human health risk assessments and environmental risk screening assessment for CTs shows that turbines at these facilities are in all cases below EPA's risk thresholds.

HOW TO APPLY RESULTS

This project is designed to serve both as input to regulatory reviews by public agencies and as guidance for additional EPRI research. The results can be used to provide information on potential adverse human health and environmental effects and thereby support the corresponding RTR.

LEARNING AND ENGAGEMENT OPPORTUNITIES

This report will be useful for communicating to public agencies and other stakeholders on the environmental risks related to HAPs emitted from CTs.

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PROGRAM: 235: Air Quality Assessments and Multimedia Characterization, Assessment and Health

ACRONYMS AND ABBREVIATIONS

AEGL	Acute Exposure Guideline Level
AERMOD	American Metrological Society/EPA Regulatory Model
BaP	Benzo(a)pyrene
CO_2	Carbon dioxide
COPC	Compounds of potential concern
CT	Combustion turbine
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
EPRI	Electric Power Research Institute
ESTER	Environmental Screening Threshold Emission Rates
GHG	Greenhouse gases
GHGRP	Greenhouse Gas Reporting Program
HAP	Hazardous air pollutant
HCl	Hydrochloric acid
HEM	Human exposure model
HF	Hydrofluoric acid
HI	Hazard index
HQ	Hazard quotient
km	Kilometer
MACT	Maximum achievable control technology
MRL	Minimum Risk Level
NAAQS	National Ambient Air Quality Standard
NEI	National Emissions Inventory
NESHAP	National Emission Standards for Hazardous Air Pollutants
PAH	Polycyclic aromatic hydrocarbons
PB-HAP	Persistent and bioaccumulative HAP
POM	Polycyclic organic matter
RTR	Risk and Technology Review
SV	Screening value
TCDD	Tetrachlorodibenzo-p-dioxin
tpy	Tons per year

TRIM.FaTE	Total Risk Integrated Methodology: Fate, Transport and Ecological Exposure Module
$\mu g/m^3$	Micrograms per cubic meter
VOC	Volatile organic compound

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1
BACKGROUND AND INTRODUCTION

The Electric Power Research Institute (EPRI) is investigating the potential risks posed to human health and the environment from emissions of hazardous air pollutants (HAPs) from major source stationary combustion turbines (CTs) in the United States post implementation of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for stationary CTs[3]. A part of this effort is documented in related EPRI report 3002016528, *Inhalation Human Health Risk Assessment for U.S. Stationary Combustion Turbines: 2014 Base Year Evaluation* (EPRI 2019a), EPRI report 3002016745, *Multi-Pathway Human Health Risk Assessment for U.S. Stationary Combustion Turbines: 2014 Base Year Evaluation* (EPRI 2019b), EPRI report 3002017441, *Environmental Risk Screening Assessment for U.S. Stationary Combustion Turbines: 2014 Base Year Evaluation* (EPRI 2019c), EPRI report 3002020134, *Supplemental Human Health and Environmental Risk Assessment for U.S. Combustion Turbines: 2014 Base Year Evaluation* (EPRI 2020) and EPRI report 3002026130, *Supplemental Human Health and Environmental Risk Assessment for U.S. Combustion Turbines (2023 Supplement): 2014 Base Year Evaluation*. This report presents an additional supplemental risk analysis for additional units identified by EPA as subject to the NESHAP for stationary CTs in order to assess human health risks and potential adverse environmental (ecological) effects for U.S. CTs.

EPA published an updated turbine database in January 2023 (EPA 2023) with CTs that were identified to be subject to the NESHAP which were not included in the residual risk assessment performed by EPA (EPA 2019) nor in EPRI's turbine database (EPRI 2019a; EPRI 2020; EPRI 2023). Emissions and stack parameters were developed using the same methodology as in EPRI's original risk assessment (EPRI 2019a).

For human health, two types of potential risks are evaluated: inhalation and multi-pathway (ingestion). EPA has established a lifetime cancer risk threshold of 1 in 1 million (EPA 1999, U.S. Code § 7412); for non-cancer health risks, EPA has established chronic and acute HI thresholds of 1 (EPA 1999). Inhalation risks were assessed for both acute and chronic non-cancer health risks and chronic cancer risks using EPA's Human Exposure Model (HEM) and source characterization developed by EPRI.

A three-tiered multi-pathway risk screening assessment was conducted for facilities that emit any of the persistent and bioaccumulative HAPs (PB-HAPs) for which multi-pathway risks are evaluated in order to determine which facilities screen out and can be presumed to not pose multi-pathway risk. For the Tier 1 screening assessment, annual facility-wide emissions are evaluated in relation to EPA-established screening emission thresholds. Tier 2 screening accounts for the facility's proximity to potentially fishable water bodies and potential farms as close as 0.5 km away. This analysis used EPA's Tier 2 Screening Tool—an Access Database file developed to perform the Tier 2 screening based on a set of user inputs. Finally, Tier 3 consists

[3] *National Emission Standards for Hazardous Air Pollutants: Stationary Combustion Turbines Residual Risk and Technology Review*: https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0688-0001

of several potential refinements that consider the location of farms/gardens, whether the nearby lakes are fishable, and a plume rise analysis. For the remaining PB-HAP, lead is assessed separately using a single tier screening assessment following EPA methodology.

In conducting environmental risk assessments, EPA follows a screening approach for all facilities in an industry sector that are subject to a Maximum Achievable Control Technology (MACT) standard for the NESHAP. This screening assessment was conducted by EPRI using similar risk screening procedures that EPA has applied in recently published Risk and Technology Reviews (RTRs) (EPA 2017). Risk related to acid gases were assessed using annual average concentrations from the inhalation modeling, compared to each pollutant's respective environmental screening threshold. For the remaining six pollutants of concern for potential environmental risk (lead and other PB-HAPs), an ecological screening assessment was also conducted, following EPA methodology.

Report Organization

Section 2 provides details regarding the methodology used to develop emissions and stack parameters used as inputs to characterize risk. Information regarding the inhalation human health risk assessment for the additional turbines is provided in Section 3. The multi-pathway risk screening methodology and results are presented in Section 4. The methodology and results for the environmental risk screening assessment are in Section 5. Conclusions are provided in Section 6 and references are available in Section 7. Appendix A provides the Turbine Database spreadsheet that contains the supplemental database of combustion turbines in the United States for which risk is being analyzed.

2
DEVELOPMENT OF COMBUSTION TURBINE MODELING INPUT PARAMETERS

EPRI identified a list of 103 units at 44 facilities from EPA's January 2023 Turbine Database which were not included in EPRI's initial risk assessments but would potentially need to be included in a complete risk assessment of the source category. In addition, EPRI identified additional turbines that were not in the EPA January 2023 Turbine Database which have also been included in this supplemental risk assessment. Information on the changes from EPA's 2023 Turbine Database is provided in Table 2-1. Details on each of the emission units analyzed in this supplemental risk assessment are provided in Appendix A. The resulting database included in this supplemental analysis is a total of 132 CTs.

Table 2-1
Emission Unit Changes from EPA's January 2023 Turbine List for This Supplemental Risk Assessment

Facility Name	Comment
Ogden Compressor Station	EU 19 identified in EPA's 2023 turbine database. This facility permitted two turbines in April 2021, EU 19 and EU 20, per the construction permits (21-A-137 and 21-A-138). Both turbines were added to this analysis.
Northern Natural Gas Co - Bushton	Unit 33 identified in EPA's 2023 turbine database as a new turbine. The facility also has one existing turbine, EU-32, which was not accounted for in EPA's 2023 turbine database. Both Unit 33 and EU-32 were added to this analysis.
Perulack Compressor Station	EPA identified two Solar Titan 130 replacement turbines in the 2023 turbine database. However, per permit 34-05002, this facility has three Dresser Clark turbines (Source ID 034, 035, and 036); one GE turbine (Source ID 037); and one Solar turbine (Source ID 038). The two Solar Titan 130 replacement turbines identified in EPA's 2023 turbine database have not begun operation at this facility yet. Therefore, the five existing turbines at this facility were added to this analysis and the new replacement Solar Titan 130 turbines were not included.
Kinder Morgan Production Company LLC Iraan	One turbined identified in EPA's 2023 turbine database. This facility is assumed to be the Yates Gas Plant, as this was the only Kinder Morgan facility in Iraan, Texas that was permitted for stationary combustion turbines. Included all three stationary combustion turbines permitted at the Yates Gas Plant.
Houston Central Plant	Two additional turbines identified at this facility in addition to the four turbined identified by EPA. All six turbines included in this analysis.
Enterprise Mont Belvieu Complex	January 2023 turbine database identified 16 turbines; however, emission inventory data indicates 35 turbines operating at this facility. Included all 35 turbines in this analysis.

Table 2-1 (continued)
Emission Unit Changes from EPA's January 2023 Turbine List for This Supplemental Risk Assessment

Facility Name	Comment
INEOS Chocolate Bayou Steam Generating Station	Two turbines identified in EPA database; however, emission inventory data indicates that there is a third turbine located at this facility. Included all three turbines in this analysis.

EPRI compiled model input parameters for the 132 total additional turbines at 44 facilities using publicly available data from historical emissions inventories, permits and permit applications and other documents available by the state agencies. If stack parameter data was unable to be obtained through publicly available information from the state, the stack parameter information included with the EPA National Emissions Inventory (NEI) database was used. In some cases, stack parameter data such as velocity and temperature were unavailable from publicly available information or from the NEI database, and the 5th percentile among all CTs within EPRI's turbine database was used. This is likely conservative, as using temperatures and velocities on the lower end of the range is expected to result in worse dispersion characteristics (i.e., cooler temperature and lower velocity would result in less plume rise and likely more concentrated pollutant concentrations closer to the facility).

When available, the actual emissions reported to the state for 2014 (or available operating year for turbines that began operation after 2014) were used as the basis for emissions. This year was selected as it represents the base case year for both the EPRI studies and the EPA residual risk analysis. The maximum historical fuel use over the most recent available period was used in combination with published emission factors to estimate emissions from the CTs when historically reported emissions to the state were unavailable. Though EPA has developed the RTR using 2014 as the base year for the evaluation, EPRI conservatively chose the maximum fuel use over the most recently available period starting with the base year (2014-2022) to help ensure that health risks have not been underestimated. Fuel use was obtained from the data for 2014-2022 submitted to the state, when available.

EPA's information in Table 2 – Table 6 of Appendix 1 in the residual risk assessment (EPA 2019) was used as a general guide to assist in determining the set of pollutants for which emissions would be expected from combustion of natural gas and/or fuel oil in the CTs. Emission factors from these tables were used in conjunction with historical fuel use information, turbine ratings and/or historical annual volatile organic compound (VOC) emissions as reported to the state to estimate HAP emissions from the CTs when historically reported HAP emissions were unavailable or incomplete. Emission factors from EPA AP-42 Section 3.1[4] were used. Hydrochloric acid and n-hexane emission factors for natural gas-fired or oil-fired turbines are not available in EPA AP-42 nor reported by most of the facilities, but EPA has chosen to include these pollutants in their risk analysis. Therefore, to be conservative EPRI has included these pollutants as well, using Tables 2 through 6 in Appendix 1 of EPA's combustion turbine residual risk assessment (EPA 2019).

[4] https://www.epa.gov/sites/default/files/2020-10/documents/c03s01.pdf

A few facilities located in Ohio, Alabama, Michigan and Iowa have combustion turbines which only fire natural gas. However, the emissions inventory online reporting systems for these turbines have emission factors for natural gas-fired turbines for metals, such as cadmium, chromium, manganese, mercury and nickel. Published emission inventory calculation methodology documentation indicated that emission factors came from the EPA WebFIRE database[5]. Upon investigation, EPRI confirmed that the emission factors for metals that were applied to natural gas turbines in WebFIRE came from the California Air Resources Board Air Toxics database[6] for turbines which fired refinery fuel gas and/or fuel oil, and there were no available emission factors for these pollutants for natural gas-fired turbines. In addition, Table 2 of Appendix 1 in the residual risk assessment (EPA 2019) does not list any of these pollutants as expected HAPs for natural gas-fired turbines. Therefore, based on this information, EPRI did not include reported emissions of metals in the risk analysis for turbines permitted to only fire natural gas, as these pollutants would not be expected from natural gas-fired turbines and there was no available data to support their inclusion.

If actual reported fuel use or emissions data from state emission inventories was unavailable, emissions from the 2014 NEI database were used. If a turbine was not in operation in 2014 or did not report HAP emissions in the 2014 NEI, the 2020 NEI database was used to fill in missing information. In instances where data was not available from the NEI nor actual reported data to the respective state agency, the annual fuel use during the most recently available years at the time of this study (2014–2021) was estimated for each turbine using the Greenhouse Gas Reporting Program (GHGRP) database (EPA 2022a), which provides GHG emissions by fuel type for each unit. Carbon dioxide (CO_2) emissions were converted to fuel use using the appropriate CO_2 emission factor for each fuel type from the EPA GHG Reporting Rule[7]. The maximum calculated fuel use in the 2014– 2021 period was chosen to determine emissions, as described above.

Otherwise, EPRI conservatively used the potential HAP emissions from permits or permit applications if available, or estimated the potential to emit using the heat input capacity of the turbine and assuming maximum possible operation (8,760 hours per year).

Uncertainty in Emission Estimates

All of the emissions estimates calculated in this study contain some level of uncertainty due to numerous assumptions in their derivation. The degree to which these assumptions impact the calculated values used in the risk assessment models are discussed here in both qualitative and quantitative terms.

There are uncertainties regarding the accuracy of the data used to determine a representative fuel use in the GHGRP. EPA notes that data in the GHGRP are not directly reported to EPA in all cases. Some values have been estimated by EPA based on publicly available reported data (EPA 2022a).

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[5] https://epa.ohio.gov/divisions-and-offices/air-pollution-control/reports-and-data/faqs; https://www.iowadnr.gov/Environmental-Protection/Air-Quality/Emissions-Inventory/Emissions-Estimate-Tools; https://www.michigan.gov/egle/about/organization/air-quality/air-emissions

[6] https://www.arb.ca.gov/app/emsinv/catef_form.html

[7] 40 CFR Part 98. Mandatory Greenhouse Gas Reporting.

Emissions estimates based on emission factors and fuel usage in this analysis could be corroborated with actual emissions measurements through stack testing to ensure accuracy. A detailed measurement campaign is out of the scope for this study, however. EPRI has used the best data that are currently available, with reported actual emissions, measured fuel analyses and recorded fuel use information directly from the owners and operators when possible. In addition, some levels of conservatism were included to minimize the potential for underestimating risk. This includes using the maximum fuel use for 2014-2022 or the use of potential emissions when actual emissions data was unavailable and could not be developed. EPRI therefore concludes that using emissions estimates based on the methodology discussed above is appropriate for this study. In addition, other conservative measures, such as determining an overall chronic HI by summing the HQs among all HAPs regardless of target organ, are taken when estimating risks and are discussed further below.

3

INHALATION HUMAN HEALTH RISK ASSESSMENT

Methodology for Assessing Inhalation Risk

This analysis was based on the methodology detailed in Section 4 of the EPRI inhalation risk analysis report (EPRI 2019a). Three types of inhalation risks were evaluated: chronic non-cancer risk, acute non-cancer risk, and cancer risk. The inhalation risk assessment used the Human Exposure Model (HEM), which simulates annual average concentrations and maximum 1-hour concentrations for a full year of meteorology using AERMOD and can model many facilities simultaneously. HEM was applied using the concentration (dose)-response factors supplied with the program and default model input parameters. Facility-specific source information included stack location, stack base elevation, stack height, stack inner diameter, gas exit velocity and exit temperature. The latest version of the model at the time of this assessment, HEM4 Version 4.2, was used for this modeling.

For this assessment, AERMOD-ready surface and upper-air meteorological data available on the HEM4 website were used. The closest station to each facility was selected from this database. HEM4 estimates the chronic hazard index (HI) and inhalation cancer risk at prescribed population-based receptors that represent the centroids of the year 2020 U.S. Census blocks. Receptor data also included terrain elevation. For cancer risk and chronic HI, HEM4 computes the risk at each receptor following the same methodology as described previously. The long-term cancer and non-cancer risk, acute toxic endpoints, and unit risk estimates in the HEM4 library were applied for this assessment.

The chronic dose-response factors assume that there is a continuous exposure over 1 year, and the cancer unit risk estimates inherently assume 70 years of continuous exposure. These long-term dose response factors are based on a 70-kg body weight and 20-m^3/day inhalation rate. For the acute toxic endpoints, EPA has compiled information from a variety of sources. For this study, the methodology applied in EPA's RTR was followed (EPA 2019). Per EPA, acute concentrations are compared to both "no effects" reference levels for the general public, such as the California Reference Exposure Level (REL) (OEHHA 2016) or Minimal Risk Level (MRL) (ASTDR 2017), and to emergency response levels such as Acute Exposure Guideline Levels (AEGLs) and Emergency Response Planning Guidelines (ERPGs). If none of these values exist, acute effects for that HAP are not evaluated because the risk resulting from acute exposure is considered minimal.

For this inhalation assessment, it is assumed that all HAP contributions to long-term risks are additive. Acute risks are evaluated by computing hazard quotients (HQs), defined as the ratio of the modeled concentrations to the corresponding toxic endpoint. For acute effects, the maximum HQ among all HAPs is used to assess potential for risk. For chronic effects, a HI is conservatively determined as an overall HI by summing the HQs among all HAPs regardless of target organ. EPA's practice for determining the chronic HI is to segregate the effects by target organ (for example, respiratory system or nervous system) and report the highest value. EPRI performs this refinement to segregate by target organ only if the HI exceeds the EPA risk threshold. The EPA chronic and acute risk threshold is a HI or HQ of less than 1 (EPA 1999). The lifetime incremental inhalation cancer risk associated with each carcinogenic HAP is computed by multiplying the modeled long-term average concentration by the unit risk estimate. The maximum individual lifetime inhalation cancer risk is computed by summing the cancer risk among all carcinogenic HAPs. The lowest, most stringent EPA health risk threshold for lifetime cancer risk to the maximum exposed individual is less than 1 in 1 million (10^{-6}). HEM4 was applied using the concentration (dose)-response factors supplied with the program, default model parameters, and facility-specific source information.

To estimate the short-term (acute) risk, EPA RTR guidance (EPA 2019) suggests that the annual average emission rates be adjusted upward by a default factor of 10 to account for variability and that this peak emission rate be used to estimate maximum 1-hour concentrations. The 99th percentile 1-hour dispersion factors were estimated with HEM4 and EPA's default peak-to-mean ratio of 10 applied, consistent with EPA guidance. Further refinements to the estimate of acute risk could be made by developing unit-specific acute multipliers (peak-to-mean ratios). For example, EPRI's previous inhalation risk analysis (EPRI 2019a) applied an acute multiplier of 2 for two facilities, Salinas River Cogeneration and Sargent Canyon Cogeneration, when scaling long-term emissions to determine acute human health risk. This was based on the hours of operation for the Salinas and Sargent turbines, which were 8,198 and 8,736 hours, respectively. Following EPA methodology (EPA 2019), preliminary acute multipliers of 1.07 and 1.003, respectively, calculated using a ratio of potential to actual annual operating hours. Such a low acute multiplier indicates a very limited number of non-steady state operation events. The acute multipliers were rounded up to 2 to help account for emissions variability during startup and non-steady state operations. This methodology allows for EPRI to reasonably account for higher short-term HAP emissions during the very infrequent startup and shutdown events in lieu of source-specific maximum short-term emissions information.

Results of the Supplemental Inhalation Risk Assessment

The results of the cancer risk assessments for the additional facility are provided in Table 3-1. The highest modeled cancer risk was 0.33 in a million. This is less than the previous maximum cancer risk from stationary CTs of 0.76 in a million, detailed in Section 4 of the original and supplemental EPRI report (EPRI 2019a; EPRI 2020; EPRI 2023), and is less than the 1 in 1 million EPA risk threshold. The maximum chronic hazard index was 0.003, and the maximum acute hazard risk was 0.33, which are both well below the EPA risk threshold of 1. These were both also below the overall maximum chronic hazard index of 0.03 and maximum acute hazard risk of 0.59 for the entire CT source category, detailed in Section 4 of the previous EPRI reports.

Table 3-1
Supplemental Inhalation Risk Assessment Results

Facility Name	Cancer Risk (per million)	Top Contributor	Percent of Risk	Hazard Index	Top Contributor	Percent of Risk	Acute Hazard Quotient	HAP
Sunshine Gas Producers LLC	0.02	Formaldehyde	92%	1.95E-04	Formaldehyde	71%	3.65E-02	Formaldehyde
Concord Compressor Station	0.01	Formaldehyde	94%	6.36E-05	Formaldehyde	67%	3.41E-03	Formaldehyde
Houston Central Plant	0.09	Formaldehyde	90%	1.57E-03	Acrolein	44%	2.66E-01	Formaldehyde
Iraan (Yates Gas Plant)	0.01	Formaldehyde	96%	1.01E-04	Formaldehyde	76%	6.01E-02	Formaldehyde
Cornell University Main Campus	0.02	Formaldehyde	67%	1.93E-04	Formaldehyde	68%	3.68E-03	Formaldehyde
Northern Natural Gas Co - Bushton	0.005	Formaldehyde	95%	5.57E-05	Formaldehyde	65%	3.95E-02	Formaldehyde
Northern Natural Gas Co - Clifton	0.01	Formaldehyde	92%	1.20E-04	Formaldehyde	57%	2.83E-02	Formaldehyde
Northern Natural Gas Co - Mullinville	0.13	Formaldehyde	94%	1.43E-03	Formaldehyde	70%	1.54E-01	Formaldehyde
Northern Natural Gas Co - Beatrice	0.01	Formaldehyde	95%	6.09E-05	Formaldehyde	67%	6.02E-03	Formaldehyde
Gulf Clean Energy Center (formerly Plant Crist)	0.002	Formaldehyde	39%	1.06E-04	Manganese compounds	59%	8.03E-04	Formaldehyde
Citrus County Combined Cycle Station	0.06	Formaldehyde	95%	6.83E-04	Formaldehyde	71%	6.49E-02	Formaldehyde
Muskegon River Compressor Station	0.0005	Formaldehyde	90%	7.89E-06	Hydrochloric acid	43%	3.33E-04	Formaldehyde
Panhandle Eastern Pipe Line - Liberal Station	0.02	Formaldehyde	85%	2.30E-04	Formaldehyde	62%	5.87E-03	Formaldehyde
Panhandle Eastern Pipe Line - Greensburg Station	0.003	Formaldehyde	94%	3.56E-05	Formaldehyde	63%	2.20E-03	Formaldehyde
Panhandle Eastern Pipe Line - Olpe Station	0.004	Formaldehyde	90%	4.25E-05	Formaldehyde	59%	2.70E-03	Formaldehyde
Eastern Gas Transmission and Storage - Finnefrock Compressor Station	0.01	Formaldehyde	65%	1.54E-04	Formaldehyde	43%	6.11E-03	Formaldehyde
Eastern Gas Transmission and Storage - Punxsutawney Compressor Station	0.01	Formaldehyde	89%	1.01E-04	Formaldehyde	50%	2.97E-03	Formaldehyde
Eastern Gas Transmission and Storage - Sabinsville Compressor Station	0.14	Formaldehyde	96%	1.44E-03	Formaldehyde	72%	7.99E-02	Formaldehyde
Currant Creek Power Plant	0.04	Formaldehyde	95%	4.33E-04	Formaldehyde	68%	1.54E-02	Formaldehyde
Ascend Performance Materials	0.01	Formaldehyde	70%	1.57E-04	Acrolein	48%	2.07E-02	Acrolein
Transco Compressor Station 165 & 166	0.04	Formaldehyde	91%	5.30E-04	Formaldehyde	57%	1.49E-02	Formaldehyde
O'Connor Plant	0.06	Formaldehyde	95%	6.69E-04	Formaldehyde	71%	9.42E-02	Formaldehyde
Ogden Compressor Station	0.01	Formaldehyde	95%	8.70E-05	Formaldehyde	71%	5.18E-03	Formaldehyde

Facility Name	Cancer Risk (per million)	Top Contributor	Percent of Risk	Hazard Index	Top Contributor	Percent of Risk	Acute Hazard Quotient	HAP
Archer Daniels Midland Corn Processing	0.001	Formaldehyde	37%	2.95E-05	Acrolein	54%	7.48E-04	Acrolein
DTE Marietta	0.02	Formaldehyde	94%	2.27E-04	Formaldehyde	72%	2.15E-02	Formaldehyde
Choctaw County Generating Plant	0.04	Formaldehyde	87%	6.51E-04	Formaldehyde	45%	1.28E-02	Formaldehyde
Naval Station Norfolk (NAVSTA Norfolk)	0.06	Formaldehyde	59%	8.81E-04	Manganese compounds	36%	1.05E-02	Formaldehyde
Primary Products Ingredients Americas	0.01	Formaldehyde	95%	1.05E-04	Formaldehyde	64%	2.56E-03	Formaldehyde
ANR Sulphur Springs CS	0.005	Formaldehyde	95%	5.00E-05	Formaldehyde	68%	3.12E-03	Formaldehyde
ANR LaGrange CS	0.02	Formaldehyde	95%	1.92E-04	Formaldehyde	64%	3.87E-02	Formaldehyde
Ceredo Compressor Station	0.002	Formaldehyde	85%	2.23E-05	Formaldehyde	49%	6.84E-04	Formaldehyde
Lake Side Power Plant	0.16	Formaldehyde	94%	1.69E-03	Formaldehyde	69%	3.17E-02	Formaldehyde
Perulack Compressor Station	0.33	Formaldehyde	98%	2.97E-03	Formaldehyde	86%	3.26E-01	Formaldehyde
Flint Hills Resources Pine Bend Refinery	0.001	Formaldehyde	84%	3.56E-05	Acrolein	38%	6.44E-04	Acrolein
Cherokee Station	0.14	Formaldehyde	95%	1.47E-03	Formaldehyde	71%	4.19E-02	Formaldehyde
Enterprise Mont Belvieu Complex	0.33	Formaldehyde	95%	3.47E-03	Formaldehyde	71%	1.12E-01	Formaldehyde
Montgomery County Power Station	0.17	Formaldehyde	95%	1.74E-03	Formaldehyde	70%	3.48E-02	Formaldehyde
J. Wayne Leonard Power Station	0.01	Formaldehyde	97%	1.15E-04	Formaldehyde	45%	2.37E-03	Formaldehyde
Lake Charles Power Station	0.05	Formaldehyde	95%	5.28E-04	Formaldehyde	70%	3.45E-02	Formaldehyde
Mansfield Mill	0.01	Formaldehyde	95%	7.93E-05	Formaldehyde	71%	1.05E-02	Formaldehyde
Hobbs Generating Station	0.003	Formaldehyde	59%	8.33E-05	Acrolein	51%	7.71E-03	Acrolein
INEOS Chocolate Bayou Steam Generating Station (CBSG Station)	0.02	Formaldehyde	95%	1.73E-04	Formaldehyde	71%	2.07E-02	Formaldehyde
Seadrift Operations	0.05	Formaldehyde	95%	5.37E-04	Formaldehyde	71%	6.49E-02	Formaldehyde
University of Michigan	0.01	Formaldehyde	95%	9.63E-05	Formaldehyde	71%	4.24E-03	Formaldehyde

4
MULTI-PATHWAY SCREENING ANALYSIS

Multi-Pathway Risk Screening Assessment Methodology

Multi-pathway risk screening was conducted in a three-tiered analysis for five of the six PB-HAPs considered for multi-pathway exposure and in a single tiered screening analysis for the sixth PB-HAP, lead. The three-tiered screening analysis was conducted following the same methodology for multi- pathway screening detailed in Section 2 of the previous EPRI risk assessment report (EPRI 2019b) for the five PB-HAPs. Lead was assessed separately following EPA's methodology, as described herein (EPA 2022b).

For the five PB-HAPs, the first multi-pathway screening tier compares facility-wide emissions for the source category against emission threshold values established by the EPA. Tier 2 screening adjusts the emission threshold values for facilities that did not screen out at Tier 1 by accounting for meteorological characteristics representative of each site as well as the location of lakes relative to each facility. Finally, Tier 3 consists of several refinements that account for the location of farms/gardens, whether the nearby lakes are fishable, and a plume rise analysis.

Tier 1 Multi-Pathway Screening Assessment

Facility-wide annual emissions from combustion turbines of the five PB-HAPs were compared to the Tier 1 screening thresholds, shown in Table 4-1. These screening thresholds were developed by EPA by applying TRIM.FaTE using worst-case assumptions for wind direction frequency, wind speed, mixing depth, precipitation, and location of water bodies and farms (EPA 2018a). Of the 44 facilities included in this supplemental risk analysis, 3 facilities had CTs that emitted one or more of the PB-HAPs identified by EPA as contributing to multi-pathway risk. Tier 1 screening was conducted for all 4 facilities. Given that Tier 1 is a highly conservative screening approach, the Tier 1 values themselves are not suitable to quantify health risk—but rather to identify facilities for which, even under very conservative assumptions, risk will remain well below EPA's risk thresholds.

Table 4-1
Screening Threshold Emission Rates (tpy) for Multimedia Ingestion Exposures

Pollutant	Screening Threshold (tpy)	Basis of Threshold
Arsenic	2.08E-04	Cancer
Cadmium	2.38E-03	Non-cancer
Mercury, divalent	1.46E-04	Non-cancer
POM, as benzo(a)pyrene (BaP) equivalents	3.72E-03	Cancer
Dioxins as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) equivalents	6.02E-10	Cancer

Facilities with emissions from CTs of one or more these PB-HAPs were ranked and are shown in Table 4-2. This ranking was conducted according to the sum of the factors by which emissions exceed the Tier 1 thresholds, or the screening values (SVs), which are rounded to the nearest whole number. When considering cancer risk, EPA sums the SVs for all pollutants with a carcinogenic-based risk threshold (arsenic, POM, and dioxins) to determine whether a facility screens out (SV ≤1). Non-cancer pollutants (cadmium and mercury) are considered individually. Facilities that screened out at Tier 1 were presumed to not pose a significant multi-pathway health risk and were excluded from further consideration.

Table 4-2
Rank-Ordering by SV of the Tier 1 Risk Screening Assessment Results

Rank by Total SV	Facility Name	Facility Location	Cancer SV	Cadmium SV	Mercury SV
1	Gulf Clean Energy Center (formerly Plant Crist)	Pensacola, FL	9	1	2
2	Naval Station Norfolk (NAVSTA Norfolk)	Norfolk, VA	0	0	0
3	Cornell University Main Campus	Ithaca, NY	0	0	0

Tier 2 and Tier 3 Multi-Pathway Screening Assessment

EPRI conducted the multi-pathway Tier 2 residual risk screening for the Gulf Clean Energy Center facility that did not screen out for the five PB-HAPs in Tier 1 using the Tier 2 Screening Tool made publicly available by the EPA on December 8, 2022. This tool is a comprehensive lookup table developed to scale the Tier 1 screening assessment results specifically for the Tier 2 assessment and a similar tool was used for the initial multi-pathway risk screening assessment detailed in the previous EPRI report (EPRI 2019b). Tier 2 emissions screening thresholds account for the actual distance from the facility to a potential farm or fishable water body and the representative meteorological conditions at the facility (wind speed and wind direction frequency, precipitation, and mixing height), which typically reduces the estimated risk. Tier 2 risk screening results are shown in Table 4-3. This facility did not fully screen out at Tier 2 and required Tier 3 refinements.

Table 4-3
Rank-Ordering by SV of the Tier 2 Risk Screening Assessment Results

Rank by Total SV	Facility Name	Facility Location	Cancer SV	Cadmium SV	Mercury SV
1	Gulf Clean Energy Center (formerly Plant Crist)	Pensacola, FL	2	0	0

Tier 3 refinements were incorporated for the facility that did not screen out at Tier 2. These refinements included evaluation of land use sectors which contain farms and sectors which are considered urban areas. A list of areas excluded from consideration by receptor scenario is shown in Table 4-4. For the farmer scenario, no farms were identified within 5 km of the facility center; therefore, the farmer scenario SVs within 5 km were excluded. For the rural gardener scenario, populated areas within 5 km are considered urban areas by U.S. Census Bureau (U.S.

Census Bureau 2023); therefore, rural gardener scenario SVs for all sectors within 5 km were excluded. Following these Tier 3 refinements, all facilities fully screened out. Results after incorporating the Tier 3 refinements are detailed in Table 4-5.

Table 4-4
Tier 3 Exclusions

Facility Name	Receptor Type	Distance from Facility (km)	Sectors Excluded
Gulf Clean Energy Center (formerly Plant Crist)	Farmer	0 - 5	All sectors
	Rural Gardener	0 - 5	All sectors in acknowledgement that residential areas have been designation as an urban area by the U.S. Census Bureau

Table 4-5
Tier 3 Risk Screening Assessment Results

Plant Name	Plant Location	Cancer SV	Cadmium SV	Mercury SV
Gulf Clean Energy Center (formerly Plant Crist)	Pensacola, FL	1	0	0

This screening analysis shows that all facilities were below the EPA multi-pathway human health risk screening level thresholds, demonstrating that these facilities are likely to have cancer risk values below 1 in 1 million and chronic (long-term exposure) non-cancer risk below a HI of 1 within a margin of safety.

Multi-Pathway Screening Assessment for Lead Compounds

Lead compounds are one of six PB-HAPs that EPA assesses for multi-pathway human health risk. A single-step screening approach was developed by EPA to determine a facility's potential multi-pathway risk as a result of chronic exposure to lead compounds. EPRI performed the lead screening approach following EPA methodology for RTRs (EPA 2022b). The multi-pathway risk screening approach compares the estimated 3-month rolling average lead concentrations to the National Ambient Air Quality Standard (NAAQS) for lead, which is0.15 $\mu g/m^3$ on a 3-month rolling average basis. The primary NAAQS are intended to protect humans from both excess inhalation and ingestion exposures while the secondary NAAQS are intended to protect the environment from adverse effects. For multi-pathway effects, the modeled annual lead concentrations are compared with the primary NAAQS, which is the same as the secondary NAAQS. EPA states that values below the NAAQS are considered to have a low potential for multi-pathway risks (EPA 2022b).

Of the 44 facilities, 3 facilities had CTs that emitted lead compounds. The lead screening analysis was performed by using the HEM4 inhalation risk inner receptor model output file to calculate the facility-wide lead air concentration at each modeling receptor. The inner receptor file provides modeled concentrations at receptors that represent census block locations based on the 2020 Census (Figure 4-1). The inner receptor files for each facility were from HEM4 modeling performed in Section 3 of this report. The maximum annual average concentration over the model domain for each facility is then identified, which is multiplied by 4 to estimate a worst case 3-month average concentration and compared to the NAAQS.

Results from this analysis demonstrate that all facilities with CTs emitting lead compounds were less than the 0.15 µg/m^3 NAAQS. Therefore, lead emissions from this source are considered to have a low potential for multi-pathway risk. The largest lead air concentration at any facility was 0.0000013 µg/m^3. Lead screening results sorted from largest to smallest concentration are provided in Table 4-6.

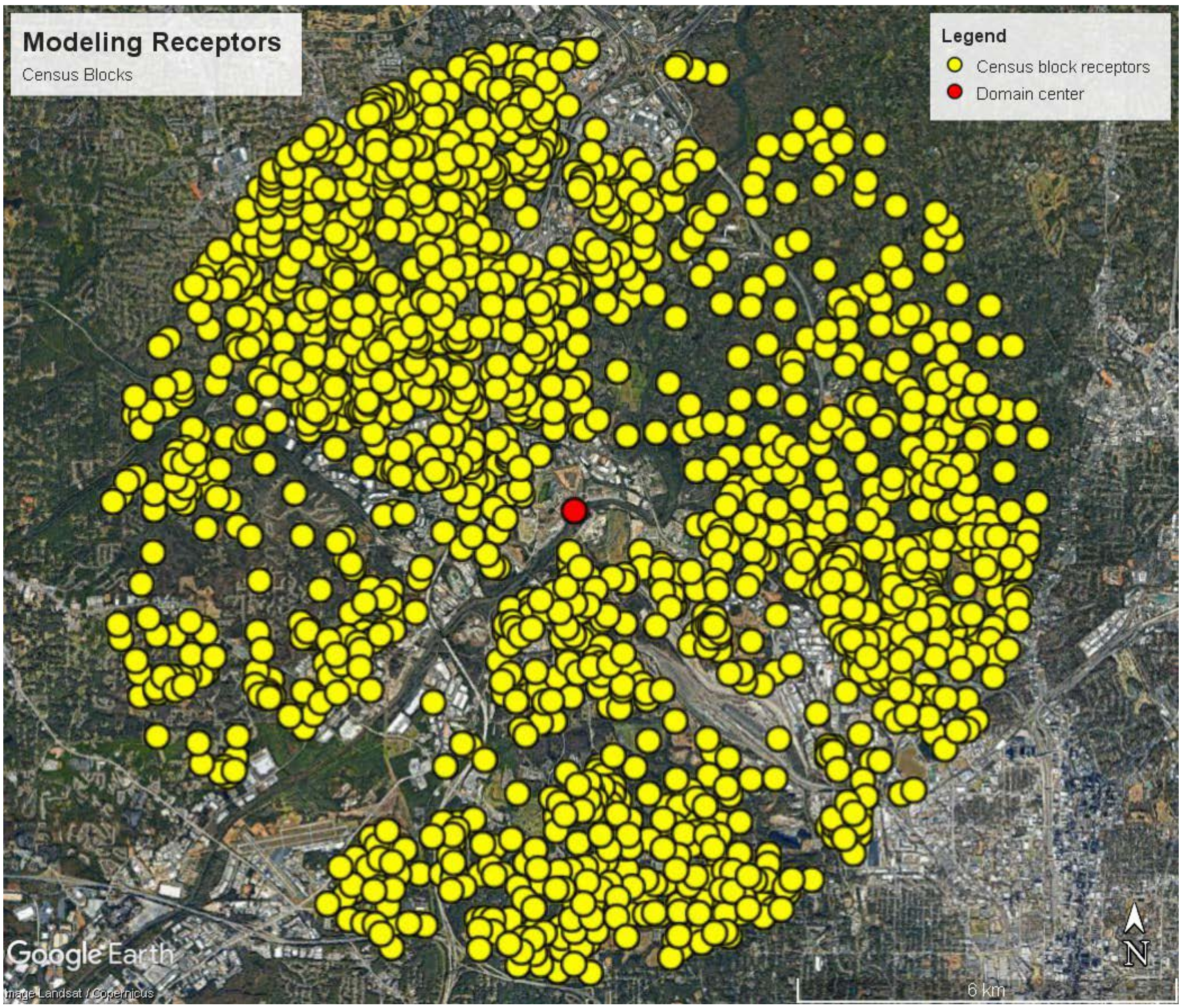

Figure 4-1
Example Census Block Receptors for Modeling

Table 4-6
Lead Multi-Pathway Risk Screening Assessment Results

Facility #	Facility Name	City, State	Estimated 3-month Average Air Conc. (µg/m^3)
294	Gulf Clean Energy Center (formerly Plant Crist)	Pensacola, FL	1.33E-06
311	Naval Station Norfolk (NAVSTA Norfolk)	Norfolk, VA	3.04E-07
289	Cornell University Main Campus	Ithaca, NY	2.24E-08

5
ENVIRONMENTAL RISK SCREENING ASSESSMENT

An environmental risk screening assessment was performed for the facilities included in this supplemental analysis, as all 44 facilities had CTs which emitted pollutants that EPA evaluates for potential adverse environmental risk. Risks were estimated for the ecological assessment endpoints and ecological benchmarks that EPA considers when assessing potential adverse environmental effects for RTRs. Following EPA's approach, The environmental assessment looks at potential ecological effects from emissions of acid gases of hydrochloric acid (HCl) and hydrofluoric acid (HF), lead, and PB-HAPs that are also the focus of the multi-pathway screening assessment (arsenic, cadmium, polycyclic aromatic hydrocarbons (PAHs), mercury and dioxins/furans).

Acid Gases

The acid gases HCl and HF are known to have the potential to cause adverse environmental impacts. Specifically, these acid gases can cause damage to vegetation. EPA has developed a two-step screening approach to determine whether a facility has the potential to cause damage to plant life as a result of chronic exposure to these acid gases. EPRI conducted the acid gases screening approach following EPA methodology for RTRs (EPA 2017) and EPRI's previous environmental screening assessment (EPRI 2019c). The screening approach first determines whether average off-site acid gas concentrations at any receptor in the modeling domain are greater than EPA-defined environmental screening thresholds, or ecological benchmarks. The ecological benchmarks chosen by EPA are 50 $\mu g/m^3$ for HCl, and 0.4 $\mu g/m^3$ and 0.5 $\mu g/m^3$ for HF (EPA 2017). The second screening step calculates an area-weighted concentration for comparison to the ecological benchmarks to determine whether the facility has the potential to cause widespread, adverse environmental effects. The area-weighted concentration calculation multiplies each receptor concentration by the area that each modeling receptor characterizes, and divides by the total model domain area for the facility.

All CTs at the 44 facilities assessed in this study emitted HCl and no CTs emitted HF. The acid gas screening analysis was performed using the RTR Acid Gas Eco Screen spreadsheet-based tool, which was provided on December 8, 2022 by EPA upon request. As discussed in the tool's documentation, this tool reads the polar receptor model output files from the HEM4 Inhalation Risk Model. Polar receptor files provide HAP concentrations at modeling receptors that represent 13 rings of 16 receptors each that radiate from the facility center out to 50 km (Figure 5-1). The EPA screening tool also allows the user to identify the distance to the facility fence line, with a default input of zero meters. EPRI used the conservative default distance to fence line of zero for all facilities. Polar receptor files for each facility were developed by HEM4 during the inhalation risk assessment, as detailed in Section 3 of this report.

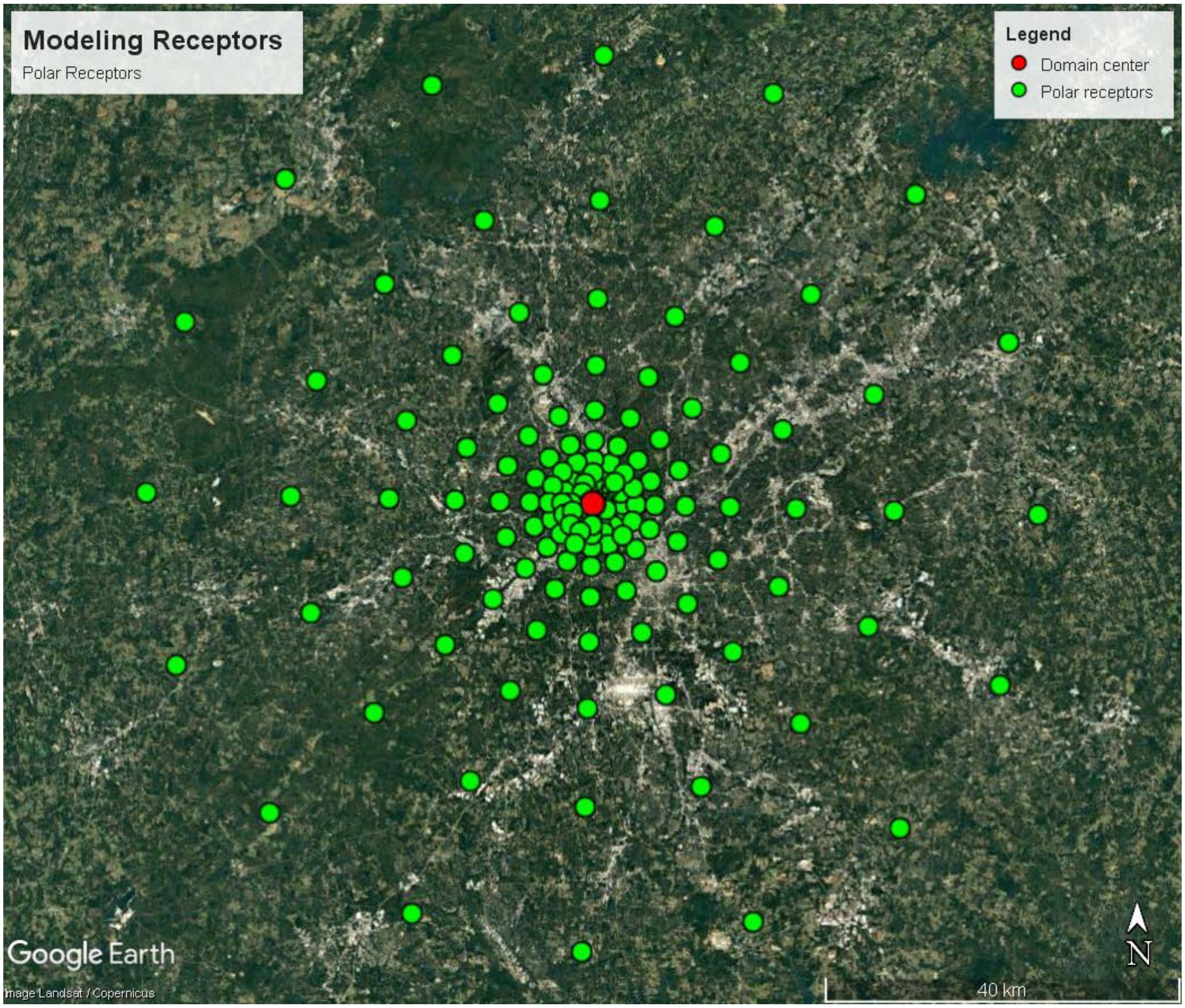

Figure 5-1
Example Polar Receptor Grid

Acid gas screening analysis results are expressed by facility in terms of the off-site area-weighted-average air concentration and the associated SV for each ecological benchmark. The SV is the ratio of the area-weighted concentration to the benchmark concentration. The percent of the facility domain where individual modeling receptors exceeded the benchmark is also determined.

Results from this screening analysis indicated that all facilities were less than the EPA ecological benchmark of 50 $\mu g/m^3$. The largest area-weighted average chronic air concentration was 0.000090 $\mu g/m^3$ with an SV of 0.0000018. Acid gas screening results sorted from largest to smallest SV are provided in Table 5-1. As shown in this table, no part of the modeling domain exceeded the benchmark concentration for any of the facilities, which means that no individual receptors had concentrations greater than the benchmark and screened out in the first screening step.

Table 5-1
Acid Gas Environmental Risk Screening Assessment Results Ranked by SV

Facility #	Facility Name	City, State	Area-weight, Ave. Chronic Air Conc. (μg/m^3)	HCl SV	Area of Exceedance (km^2)
295	Citrus County Combined Cycle Station	Crystal River, FL	9.01E-05	1.80E-06	0
310	Choctaw County Generating Plant	French Camp, MS	7.46E-05	1.49E-06	0
320	Enterprise Mont Belvieu Complex	Mont Belvieu, TX	6.57E-05	1.31E-06	0
316	Lake Side Power Plant	Vineyard, UT	6.10E-05	1.22E-06	0
322	J. Wayne Leonard Power Station	Montz, LA	5.30E-05	1.06E-06	0
323	Lake Charles Power Station	Westlake, LA	4.95E-05	9.91E-07	0
321	Montgomery County Power Station	Willis, TX	4.65E-05	9.30E-07	0
294	Gulf Clean Energy Center (formerly Plant Crist)	Pensacola, FL	4.33E-05	8.66E-07	0
303	Currant Creek Power Plant	Mona, UT	4.15E-05	8.30E-07	0
319	Cherokee Station	Denver, CO	4.11E-05	8.21E-07	0
325	Hobbs Generating Station	Hobbs, NM	3.54E-05	7.07E-07	0
327	Seadrift Operations	North Seadrift, TX	3.42E-05	6.85E-07	0
287	Houston Central Plant	Sheridan, TX	2.72E-05	5.43E-07	0
305	Transco Compressor Station 165 & 166	Chatham, VA	2.51E-05	5.02E-07	0
304	Ascend Performance Materials	Decatur, AL	2.44E-05	4.87E-07	0
326	INEOS Chocolate Bayou Steam Generating Station (CBSG Station)	Alvin, TX	1.92E-05	3.84E-07	0
285	Sunshine Gas Producers LLC	Sylmar, CA	1.41E-05	2.82E-07	0
317	Perulack Compressor Station	Lack Township, PA	1.38E-05	2.76E-07	0
300	Eastern Gas Transmission and Storage - Finnefrock Compressor Station	Renovo, PA	1.19E-05	2.38E-07	0
312	Primary Products Ingredients Americas	Lafayette, IN	1.13E-05	2.26E-07	0
318	Flint Hills Resources Pine Bend Refinery	Rosemount, MN	8.47E-06	1.69E-07	0
291	Northern Natural Gas Co - Clifton	Clifton, KS	8.12E-06	1.62E-07	0

Table 5-1 (continued)
Acid Gas Environmental Risk Screening Assessment Results Ranked by SV

Facility #	Facility Name	City, State	Area-weight, Ave. Chronic Air Conc. (µg/m^3)	HCl SV	Area of Exceedance (km^2)
324	Mansfield Mill	Mansfield, LA	8.05E-06	1.61E-07	0
314	ANR LaGrange CS	LaGrange, IN	7.63E-06	1.53E-07	0
289	Cornell University Main Campus	Ithaca, NY	7.54E-06	1.51E-07	0
290	Northern Natural Gas Co - Bushton	Bushton, KS	6.83E-06	1.37E-07	0
293	Northern Natural Gas Co - Beatrice	Beatrice, NE	5.77E-06	1.15E-07	0
308	Archer Daniels Midland Corn Processing	Cedar Rapids, IA	5.38E-06	1.08E-07	0
315	Ceredo Compressor Station	Ceredo, WV	5.20E-06	1.04E-07	0
311	Naval Station Norfolk (NAVSTA Norfolk)	Norfolk, VA	4.60E-06	9.20E-08	0
292	Northern Natural Gas Co - Mullinville	Mullinville, KS	4.13E-06	8.26E-08	0
306	O'Connor Plant	La Salle, CO	3.69E-06	7.39E-08	0
296	Muskegon River Compressor Station	Marion, MI	3.65E-06	7.31E-08	0
299	Panhandle Eastern Pipe Line - Olpe Station	Olpe, KS	3.46E-06	6.91E-08	0
297	Panhandle Eastern Pipe Line - Liberal Station	Liberal, KS	2.97E-06	5.95E-08	0
307	Ogden Compressor Station	Boone, IA	2.66E-06	5.31E-08	0
298	Panhandle Eastern Pipe Line - Greensburg Station	Greensburg, KS	2.56E-06	5.12E-08	0
313	ANR Sulphur Springs CS	Sulphur Springs, IN	2.54E-06	5.09E-08	0
309	DTE Marietta	Marietta, OH	2.22E-06	4.43E-08	0
288	Iraan (Yates Gas Plant)	Iraan, TX	2.07E-06	4.15E-08	0
302	Eastern Gas Transmission and Storage - Sabinsville Compressor Station	Westfield, PA	1.54E-06	3.08E-08	0
286	Concord Compressor Station	Springville, NY	1.52E-06	3.04E-08	0
301	Eastern Gas Transmission and Storage - Punxsutawney Compressor Station	Punxsutawney, PA	1.37E-06	2.74E-08	0
328	University of Michigan	Ann Arbor, MI	1.03E-06	2.06E-08	0

Lead Compounds

Lead compounds are one of six PB-HAPs that EPA assesses for its potential to cause adverse environmental effects. Similar to the multi-pathway screening assessment, a single-step screening approach was developed by EPA to determine a facility's potential environmental risk as a result of chronic exposure to lead compounds. EPRI performed the lead screening approach following EPA methodology for RTRs (EPA 2017). The environmental risk screening approach compares the modeled annual lead concentrations to the secondary NAAQS for lead (0.15 µg/m^3), which are the same as the primary NAAQS, but intended to protect the environment from adverse effects.

As noted in Section 4, of the 44 facilities, 3 facilities had CTs that emitted lead compounds. Using the HEM4 inhalation risk inner receptor model output file, the facility-wide lead air concentration was calculated at each modeling receptor. This file provides modeled concentrations at receptors that represent census block locations based on the 2020 Census (Figure 4-1). The inner receptor files for each facility were from HEM4 modeling performed in Section 3 of this report. The maximum annual average concentration over the model domain for each facility is then identified and compared to the NAAQS.

Results from this analysis indicated that all facilities with CTs emitting lead compounds were less than the 0.15 µg/m^3 NAAQS. Therefore, lead emissions from this source category are considered unlikely to cause adverse environmental effects. The largest lead air concentration at any facility was 0.00000033 µg/m^3. Lead screening results sorted from largest to smallest concentration are provided in Table 5-2.

Table 5-2
Lead Environmental Risk Screening Assessment Results

Facility #	Facility Name	City, State	Air Conc. (µg/m^3)
294	Gulf Clean Energy Center (formerly Plant Crist)	Pensacola, FL	3.32E-07
311	Naval Station Norfolk (NAVSTA Norfolk)	Norfolk, VA	7.61E-08
289	Cornell University Main Campus	Ithaca, NY	5.61E-09

PB-HAPs

Environmental screening for the five remaining PB-HAPs is performed in three tiers, where each tier accounts for more site-specific refinements. This screening was conducted for all 4 facilities in this supplemental analysis that are major sources of HAPs with CTs in the United States and emit any of the five PB-HAPs. The environmental risk screening assessments of the five PB-HAPs are described next.

Tier 1 Environmental Risk Screening Assessment and Selection of Facilities for Tier 2 Screening

Tier 1 environmental screening was conducted for facilities with CTs that emitted any of the five PB-HAPs. The five PB-HAPs for this three-tier screening are as follows:

- POM as BaP equivalents
- Dioxins as 2,3,7,8-TCDD equivalents
- Arsenic
- Cadmium
- Mercury compounds

Facility-wide emissions were compared to the Tier 1 Environmental Screening Threshold Emission Rates (ESTER) developed by EPA using chronic exposure ecological benchmarks for various assessment endpoints, detailed in Section 3.1.1 of EPA's environmental screening technical support document (EPA 2017). The types of benchmarks assessed in this analysis include surface soil, surface water body, and wildlife that feed on contaminated fish. EPA applied TRIM.FaTE using conservative assumptions for food web properties, wind direction frequency, wind speed, mixing depth, precipitation, and location of water bodies to determine emission rates that can be assured to result in values less than the ecological benchmarks.

The Tier 1 assessment applies highly conservative methods to estimate risk to help ensure that the modeled risk is much greater than the actual risk. Because Tier 1 is a highly conservative screening approach, the Tier 1 values themselves are not suitable to quantify potential environmental risk—but rather to identify facilities for which, even under very conservative assumptions, are not likely to result in widespread, adverse environmental effects (EPA 2017). In accordance with EPA's methodology, facilities with annual emissions from CTs of the five PB-HAPs that are less than Tier 1 screening thresholds are presumed to not pose a risk to the environment and were excluded from further consideration.

Of the 44 facilities, 3 facilities emitted one or more of the five assessed PB-HAPs. Note that no CTs emitted POM or dioxin emissions and these pollutants were not included in this analysis. All facilities screened out at the Tier 1 level and did not need further evaluation.

6
CONCLUSIONS

This study investigated the potential risks posed to human health and the environment from HAPs contained in CT stack emissions. This supplemental risk assessment provides useful information on which facilities (if any) have the potential for risk to human health or widespread adverse environmental effects. Assumptions established by EPA and included throughout this risk assessment help ensure that the results conservatively estimate potential health and environmental risks.

A supplemental turbine database was developed by EPRI for the additional turbines identified by EPA as part of the stationary CT source category. Historical emission inventories submitted to the state regulatory agency in conjunction with other publicly available information were used as the basis for the emissions and stack parameters.

Inhalation Risk Assessment

Information from the supplemental turbine database and data gathered by EPRI were used as inputs to the EPA AERMOD dispersion model in order to conduct an inhalation human health risk assessment of HAP emissions. The resulting concentration patterns in ambient air were matched with U.S. Census block location data; the inhabited location with the maximum concentration for each HAP was used to estimate inhalation health risks. This study found that none of the inhalation risks from CT HAP emissions is expected to cause lifetime cancer risk in humans of greater than 1 in 1 million to the individual in the population projected to be most exposed to emissions of those pollutants. In the case of HAPs that have the potential to cause adverse health effects in humans other than cancer, the study found that the chronic HI and acute HQ from the combustion turbine category were well below 1. These results demonstrate that the inhalation health risks from CTs for each chemical individually, and all emitted chemicals combined, were well within EPA's risk thresholds.

Multi-Pathway Screening Risk Assessment

Two types of multi-pathway human health risks were evaluated—chronic non-cancer risk and cancer risk—to determine which facilities (if any) have multi-pathway risks above EPA's risk thresholds of 1 in 1 million cancer risk and HI of 1. EPRI evaluated multi-pathway human health risks for all facilities considered in this supplemental CT risk analysis on a screening level using very conservative, health-protective assumptions developed by EPA. Of the 44 facilities, 3 had CTs that emitted pollutants that EPA considers for multi-pathway risk.

The three-tiered screening analysis for five of the six PB-HAPs was conducted following EPA's methodology for multi-pathway screening. The first tier compared facility-wide emissions against emission threshold values that EPA has established. Tier 2 screening adjusted the emission threshold values for facilities that did not screen out at Tier 1 by considering meteorological characteristics representative for each site as well as the location of lakes relative to each facility. Lastly, Tier 3 screening adjusted the emission threshold values for facilities that did not screen out of Tier 2 by considering the location of farms and urban areas relative to the facility. At the end of the screening analysis, all 3 facilities screened out. For the sixth PB-HAP, lead, the single tiered screening analysis was conducted to compare off-site modeled concentrations to the lead NAAQS. All 3 facilities had concentrations below the NAAQS and therefore screened out.

Environmental Risk Assessment

Acid gases were assessed for their potential to cause toxic effects on plant growth (phytotoxicity) and on productivity through chronic exposure. Lead was compared against the secondary NAAQS, which was developed to provide protection against adverse effects on soil, water, vegetation, wildlife, and other environmental endpoints. The other five HAPs considered for environmental effects (arsenic, cadmium, mercury, POM, and dioxins) were included in this assessment because of the ability of these pollutants to bioaccumulate in soil and water. Therefore, these pollutants have the potential to have adverse effects on environmental endpoints such as plants, insectivores, aquatic wildlife (and wildlife that consume fish), and the sediment community.

All 44 facilities considered in the supplemental CT risk analysis emitted pollutants that EPA evaluates for potential adverse environmental risk. The results of the environmental risk assessment showed that all facilities were below the EPA environmental screening thresholds. As a result, these facilities are likely to have no widespread adverse environmental effects.

7
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A
TURBINE DATABASE USED IN SUPPLEMENTAL RISK ANALYSES

The Turbine Database spreadsheet contains the supplemental database of combustion turbines in the United States for which risk is being analyzed. It includes location, stack parameter and emissions information used in modeling.

To open the spreadsheet:

- Click the paperclip icon to access the *Attachments* panel.
- Double click the file titled Appendix A – Turbine Database.xlsx.

B

PUBLICLY AVAILABLE FILES USED IN SUPPLEMENTAL RISK ANALYSES

The files within Appendix B contain the publicly available information compiled to develop emissions and stack parameters for the combustion turbines assessed in the supplemental risk analyses. A list of the files is provided below.

Click on File Name to access Appendix B files

File Name	Facility	Additional Comments
FAC285_ENG_Fac ID_ 139938 - Revision Date_ 6_30_2017.pdf	Sunshine Gas Producers LLC	Operating permit with stack heights and diameters
FAC285_Sunshine Gas Producers CY20 EI totals.pdf	Sunshine Gas Producers LLC	2020 facility-wide emission inventory report
FAC289_Cornell University Permit.pdf	Cornell University Main Campus	Operating permit with stack heights and diameters
FAC291_Clifton 2020 Emission Inventory by Unit_v1.pdf	Northern Natural Gas Co - Clifton	2020 emission inventory report
FAC293_Northern NG Co 23382 - DEQ Report - ANNUAL AIR EMISSIONS.zip	Northern Natural Gas Co - Beatrice	2016-2022 emission inventory reports
FAC294_0330045 2021.pdf	Gulf Clean Energy Center (formerly Plant Crist)	2021 emission inventory report
FAC294_0330045 2022.pdf	Gulf Clean Energy Center (formerly Plant Crist)	2022 emission inventory report
FAC294_Gulf Power Crist Power Plant PSD (FINAL).pdf	Gulf Clean Energy Center (formerly Plant Crist)	Air permit to construct application with source parameters

File Name	Facility	Additional Comments
FAC295_0170004_EIs.zip	Citrus County Combined Cycle Station	2018-2022 emission inventory reports
FAC295_0170004-055-AC - Final Permit.pdf	Citrus County Combined Cycle Station	Air permit to construct with stack heights and diameters
FAC304_AEERS 2022 EST.pdf	Ascend Performance Materials	2022 emission inventory report
FAC305_Sta 165_ Application (PSD)_49470041.pdf	Transco Compressor Station 165 & 166	Air permit to construct application with potential emissions
FAC305_Station 165 Modeling Report 10_17_2019.pdf	Transco Compressor Station 165 & 166	Air dispersion modeling report in support of the air permit to construct application with source parameters
FAC306_CDPHEAER_DCP_Operating_Company__LP_-_2021.xlsx	O'Connor Plant	2021 emission inventory report
FAC307_Northern NG Co Ogden TVOP.pdf	Ogden Compressor Station	Title V operating permit with source parameters
FAC308_15-A-500-P.pdf	Archer Daniels Midland Corn Processing	Air permit to construct with source parameters
FAC309_EIS201920202021.zip	DTE Marietta	2019-2021 emission inventory reports
FAC309_Permit to Install DTE Marietta 4-29-19.pdf	DTE Marietta	Air permit to construct with turbine make/model/capacity
FAC311_60941 - Application - 20160211_330510.pdf	Naval Station Norfolk (NAVSTA Norfolk)	Air permit to construct application with permitted operating hours on each fuel
FAC312_CY21 2022_06_30_157-00033.pdf	Primary Products Ingredients Americas	2021 emission inventory report
FAC313_065-00019_EIs.zip	ANR Sulphur Springs CS	2014-2021 emission inventory reports
FAC314_087-00004_EIs.zip	ANR LaGrange CS	2014-2021 emission inventory reports

File Name	Facility	Additional Comments
FAC315_Ceredo App AXExport-20230609-040536-2379-file0001.pdf	Ceredo Compressor Station	Air permit to construct application with source parameters
FAC317_1215358[34-05002]_Issued_v1.pdf	Perulack Compressor Station	Title V operating permit with turbine makes/models/capacities
FAC318_Permit Major Amend 3701842.pdf	Flint Hills Resources Pine Bend Refinery	Operating permit with source parameters
FAC321_AIR NSR_143912-261371_Permits_Public_20180327.pdf	Montgomery County Power Station	Air permit to construct application with source parameters
FAC322_9824354.pdf	J. Wayne Leonard Power Station	Air permit to construct application with source parameters
FAC323_11884075.pdf	Lake Charles Power Station	Operating permit with source parameters
FAC324_11311716.pdf	Mansfield Mill	Air permit to construct application with source parameters
FAC325_Hobbs2EI06202023.xlsx	Hobbs Generating Station	2019 and 2021 emission inventory report
FAC325_HobbsEI06202023.xlsx	Hobbs Generating Station	2014-2018 emission inventory report
FAC325_RS27652_Application (P244R2).pdf	Hobbs Generating Station	Air permit to construct application with source parameters
FAC326_4cd8b0233e9843f9ba27558e68404a9b.1641318559.pdf	INEOS Chocolate Bayou Steam Generating Station	Air permit to construct application with source parameters
FAC327_RN102181526202308110733383ACTHIST.pdf	Seadrift Operations	2014-2021 emission inventory report
FAC328_Univ of Mich EI CY2014.pdf	University of Michigan	2014 emission inventory report

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