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Technical Report
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February 2016

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Executive Summary

Through the Renewable Fuel Standard (RFS), the Energy Independence and Security Act of 2007 mandates increased use of biofuels. Although biofuels in general have been found to have lower life cycle greenhouse gas (GHG) emissions compared to petroleum fuels on a fuel content basis, biomass feedstock production, harvesting, transportation, processing, and conversion are expected to emit a wide range of other air pollutants. Air pollution affects both human health and the natural environment. To develop sustainable advanced biofuels, one of the goals of the Bioenergy Technologies Office (BETO) at the Department of Energy is to minimize air pollutant emissions across the entire biofuel supply chains, as stated in their Multi-Year Program Plan (EERE 2015).

Biorefineries (refineries that produce biofuels) are subject to environmental laws, including complex air quality regulations that aim to protect and improve the quality of the air. These regulations govern the amount of certain types of air pollutants that can be emitted from different types of emission sources. The federal Clean Air Act (CAA) requires states to regulate stationary and mobile sources pursuant to an Environmental Protection Agency (EPA)-approved State Implementation Plan (SIP) for implementation, maintenance, and enforcement of the National Ambient Air Quality Standards (NAAQS). The NAAQS set ambient concentration limits for six air pollutants (ozone, particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and lead), also called criteria air pollutants. States regulate stationary sources of criteria pollutants (such as biorefineries) through their permitting program to ensure attainment and/or maintenance of the NAAQS. State permitting of new and modified stationary sources follows federal guidance under the EPA's New Source Review (NSR) program.[1,2] The NSR requires most air pollutant-emitting stationary sources to obtain an air permit prior to beginning construction and then another air permit to operate.[3] The type of air permit required can vary depending on the degree of attainment with the NAAQS[4] in the area where the source is located and the magnitude of the emissions from the facility.

While it is important for stakeholders to understand the potential implications for air quality from a growing biofuel industry (due to the possibility of an increase in stringency of the air quality standards, and the fact that some areas of the country are already out of compliance with one or more of current NAAQS), there is a general lack of information and knowledge about the type and magnitude of potential air pollutant emissions from the production of new advanced biofuels because of the nascent stage of this emerging industry. As a first step to assess the air quality and human health impact of advanced biofuels, this analysis assesses federal air pollutant emission regulations potentially applicable to a hypothetical biorefinery and estimates the magnitude of emissions from the pathway design. The design examined has been chosen by BETO for further research and development from a number of pathways that can produce infrastructure-

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[1] For additional information on the NSR program, refer to the EPA's NSR website: http://www2.epa.gov/nsr/.

[2] For the EPA websites provided herein, if *http://* is not working, try *https://* instead.

[3] In some jurisdictions, the permit authority will issue a combined construction and operating permit.

[4] Each state has a network of stations to monitor ambient concentration of criteria pollutants. The EPA uses the monitoring data, as well as other information, to determine each area's NAAQS attainment status on a pollutant by pollutant basis. Areas with ambient concentration below the NAAQS are designated attainment areas while areas exceeding the NAAQS are designated nonattainment areas (with further gradations depending on the severity of nonattainment).

compatible[5] hydrocarbon biofuels. The biofuel conversion process, described in Davis et al. (2013), is referred to as sugars-to-hydrocarbons (HC)[6] in this report, and whose product is diesel-range fuels.

To understand the potential applicability of certain federal air quality regulations and the level of air permitting required, this report provides preliminary estimates of uncontrolled potential-to-emit (PTE) and PTE based on the design case (Davis et al. 2013). Whereas uncontrolled PTE reflects the maximum amount of emissions a source (a sugars-to-HC biorefinery in this analysis) would generate if it were operating continuously at full capacity without any restrictions in place, PTE takes into consideration legally enforceable limitations (e.g., requirements to use emissions control devices or production rate limitations included in an enforceable air permit). PTE can also be referred to as post-permit PTE, limited PTE, or controlled PTE for permitted sources. It should be noted that the preliminary estimates of PTE presented in this analysis are intended for a standalone biorefinery with a capacity to convert 2,000 dry metric tons of biomass per day.

To determine which federal air emission regulations potentially apply to the sugars-to-HC biorefinery, we first identified the types of regulated air pollutants emitted to the ambient environment by the biorefinery as a whole and from certain, specific equipment. Some regulations apply to the entire facility while others apply to specific equipment; and different regulations are applicable to different pollutants or classes of pollutants. Based on the design case (Davis et al. 2013), criteria air pollutants, and their precursors[7] (including NO_x, SO_2, CO, volatile organic compounds [VOCs], PM, and lead), various hazardous air pollutants (HAPs), and GHG emissions (mainly carbon dioxide [CO_2]) are expected to be emitted from several areas of the biorefinery. Ammonia (NH_3) and sulfuric acid mist (H_2SO_4) are also expected to be emitted from certain equipment.

Once the regulated air pollutants are identified, the next step is to review the applicability criteria of federal air quality regulations to determine whether the sugars-to-HC biorefinery or specific equipment therein is subject to it. Due to uncertainties in many design parameters, we analyzed all potentially applicable federal standards that regulate air pollutants emitted from stationary sources, including New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP), and permitting requirements including the NSR (construction permit) program and Title V Operating Permit program.[8] Based on the review, there are several NSPS standards that are potentially applicable to the boiler, storage tanks, reactors, equipment leaks, and emergency equipment in the sugars-to-HC biorefinery. Because the biorefinery is essentially a chemical process[9] plant, it is subject to one of two chemical

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[5] "Infrastructure" refers to fuel transport, storage and refueling infrastructure.

[6] A more complete name for this process is the dilute-acid and enzymatic deconstruction of biomass to sugars and biological conversion of sugars to hydrocarbons.

[7] Precursors are pollutants that participate in reactions in the atmosphere forming other pollutants that are subject to NAAQS (e.g., VOC is a precursor to ground level ozone, which is a criteria air pollutant subject to NAAQS).

[8] Each of these programs is described in detail at http://www2.epa.gov/regulatory-information-topic/air.

[9] The sugars-to-HC biorefinery will produce hydrocarbon biofuels via a biological conversion process. The Standard Industrial Classification (SIC) for a similar cellulosic biorefinery currently in construction in Clinton, North Carolina (Carolina Cellulosic Biofuels) is 286. SIC 286 belongs to the industry producing industrial organic chemicals. The sugars-to-HC biorefinery is expected to fall under SIC 286.

manufacturing NESHAP depending on whether the design plant is determined to be a major[10] or minor (area source) of HAP emissions (refer to Section 3.2.1). In addition, there are specific NESHAP that may be applicable to the boiler and the emergency equipment at the biorefinery.

Within the limits of our methods and data availability, a preliminary estimation of facility-wide uncontrolled PTE and PTE, summarized in Table ES-1, was developed for the regulated air pollutants identified for the sugars-to-HC biorefinery built to the design case (Davis et al. 2013). Determining the PTE for a new planned (but unbuilt) facility is often an iterative process between design and environmental engineers, and permitting authorities. Environmental engineers calculate the emissions and provide feedback to the design engineers when estimated emission levels indicate that regulations or a higher level of permit requirements may be triggered. This gives the design engineers opportunity to explore air pollution control devices (add-on controls) or alternative design options for reducing emissions below certain levels to avoid certain rules and permit requirements that may add cost, complexity, uncertainty and time to the permitting process. The environmental engineers also will inform the design engineers when a regulation will require controls to be included in the design of the biorefinery. The preliminary estimates of PTE presented in this document reflect the inclusion of air pollution controls that are currently planned in the design case (Davis et al. 2013), and also the inclusion of air pollution controls that would be required to comply with applicable federal regulations, which can be made federally enforceable in a permit. The preliminary estimates of PTE do not include any additional emission reductions that a source may elect to add to avoid rules or more stringent permit requirements. In addition, the preliminary estimates of PTE do not take into consideration possible emission reductions, which would be required after completing a full determination of best available control technology (BACT)[11] for regulated pollutants, which are subject to prevention of significant deterioration (PSD) review (refer to footnote 12). Section 5 includes a discussion about possible approaches engineers might adopt regarding further emission reductions.

The estimates of uncontrolled PTE and PTE are considered “preliminary” in this document because of the lack of emissions test data and design information for some specific processes at the biorefinery and the numerous assumptions required to perform the PTE calculations. Although more detailed data specific to the biorefinery process would provide greater assurance on the PTE emissions from the design plant, it is not necessary to have all of these specifics when applying for a permit. If there is uncertainty in any of the PTE calculations, the permitting authority can require stack testing in the final permit. It is important to estimate emissions as accurately as possible when applying for a permit. If inaccurate emission estimates are made, they can delay the issuance of the permit. For example, if the PTE indicates that a new source is not subject to major source NSR permitting and then it is determined, after construction and stack testing, that the source is major and should have applied for a major source NSR permit, the source will have to apply for a new permit, possibly install additional control devices, and not be able to operate until the permitting issue is resolved.

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[10] Major under NSR is a specifically-defined term used to designate the applicability of certain permitting programs to a facility. What constitutes a major source under NSR varies according to what type of permit is involved, the pollutant(s) being emitted, and the attainment designation of the area where the source is located. In general, a source is major for NSR if its emissions exceed certain thresholds.

[11] Refer to Section 5 for emission controls, which would likely be considered BACT.

Table ES-1. Preliminary Estimates of Uncontrolled PTE and PTE of Criteria Air Pollutants (and Precursors), Total Unspeciated HAP, GHG, NH_3, and H_2SO_4 Emissions in Tons per Year (tpy) from a Sugars-to-HC Biorefinery per the Design Case (Davis et al. 2013)

Pollutant	Uncontrolled PTE (tpy)	PTE (tpy)[a]	Major source threshold under NSR or Title V (tpy)
Particulate matter (filterable) ($PM_{filterable}$)[b]	2.8×10^3	9.1×10^1	1.0×10^2
Particulate matter with less than 10 micrometers in diameter (PM_{10})[b]	2.6×10^3	4.4×10^1	1.0×10^2
Particulate matter with less than 2.5 micrometers in diameter ($PM_{2.5}$)[b]	1.7×10^3	2.0×10^1	1.0×10^2
Sulfur dioxide	1.4×10^3	1.1×10^2	1.0×10^2
Nitrogen oxides	7.8×10^2	3.5×10^2	1.0×10^2
Carbon monoxide	2.1×10^3	1.6×10^3	1.0×10^2
Volatile organic compounds	2.0×10^3	1.4×10^2	1.0×10^2
Lead	1.7×10^{-1}	1.7×10^{-1}	1.0×10^2
GHG (CO_2 equivalent)[c]	1.7×10^6	1.7×10^6	Not applicable
Hazardous air pollutants (total)	5.3×10^2	8.4×10^1	2.5×10^1
Ammonia	2.0	2.0	1.0×10^2
Sulfuric acid mist	2.2×10^1	2.2×10^1	1.0×10^2

[a] Preliminary estimates of PTE take into account potential federally enforceable limitations in a permit or federal air regulations, which are discussed in Section 5 of the main report.
[b] PM is regulated as filterable PM, while PM_{10} and $PM_{2.5}$ are regulated as the total of filterable PM in the size fraction (i.e., PM_{10} or $PM_{2.5}$) and condensable PM. Specifically, PM is measured using EPA Method 5. Filterable PM_{10} and $PM_{2.5}$ are measured using EPA Method 201A whereas Method 202 measures condensable PM. All condensable PM is included in the $PM_{2.5}$ and PM_{10} size fractions.
[c] The EPA recently announced that it will be revising the permitting rules to exempt GHG emissions generated from processing waste-derived feedstocks and feedstocks from sustainable forest or agricultural practices (Voegele 2014). The vast majority of GHG emissions from the design plant will likely fit this exemption and will not need to be counted to determine the permitting applicability. Yet until the permitting rules are final, we provide an estimate of total GHG emissions.

As indicated by the preliminary estimates of PTE (taking into account legally enforceable limitations) reported in Table ES-1, the sugars-to-HC biorefinery would be considered a major source under the NSR program[12] because at least one regulated, non-GHG pollutant (e.g., NO_x, CO) exceeds the major source threshold. Therefore, the sugars-to-HC biorefinery as currently designed would be expected to be required to determine PSD applicability for each regulated pollutant emitted (PM, PM_{10}, VOC, NO_x, CO, SO_x, H_2SO_4 mist, and GHG emissions) by using their respective Significant Emissions Rates (SERs) [13]. If the design biorefinery is located in a nonattainment area, it would be subject to: (1) Nonattainment New Source Review (NNSR) for the nonattainment pollutant(s) with a PTE greater than 100 tpy (or lower, depending on the

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[12] The NSR permits can be divided into two types of permits, i.e., major (source) and minor (source) NSR permits. There are two sets of major NSR permitting provisions that can apply to major NSR sources: prevention of significant deterioration (PSD) and nonattainment NSR (NNSR). PSD requirements can apply to any NSR regulated pollutants except for nonattainment pollutants in the area the new source is to be located. The major threshold for PSD to apply to chemical process plants is 100 tpy of any one of PSD regulated air pollutants. In addition to criteria air pollutants, PSD applies to other pollutants, including fluorides, sulfuric acid mist, hydrogen sulfide, total reduced sulfur, GHGs, and certain contaminants from municipal solid waste plants. NNSR applies when a new source meets two criteria: 1) the source is to be constructed in a nonattainment area and 2) the source is major for the nonattainment pollutant. The NNSR major source threshold is 100 tpy (or lower in some nonattainment areas depending on nonattainment severity classifications) for a nonattainment pollutant.
[13] Refer to Appendix A for SERs for regulated air pollutants under the NSR program.

nonattainment severity classification), and (2) PSD review for attainment pollutants and other NSR regulated pollutants[14] (e.g., H_2SO_4 mist) with PTE greater than SER, as long as one attainment pollutant has a PTE greater than 100 tpy.

Because any facility with a major source permit under PSD or NNSR is also required to obtain a Title V permit, the sugars-to-HC biorefinery then would be subject to Title V permitting requirements. In addition to air pollutants regulated by the NSR program, the Title V operating permit program also addresses HAP and pollutants included in Section 112 (r) of the CAA[15] (e.g., NH_3). Our preliminary estimates of PTE, shown in Table ES-1, indicate the sugars-to-HC biorefinery would also exceed the major threshold for HAP emissions which, for the purpose of Title V permitting, is 10 tpy for a single HAP or 25 tpy for any combination of HAP.

It should be noted that the current design of the sugars-to-HC biorefinery (Davis et al. 2013) did not have a design goal to minimize air pollutant emissions. (The goal of the current design is to estimate fuel selling price, which does not require as detailed specifications as is necessary for an accurate estimation of air pollutant emissions.) It is reasonable to expect that emissions could be reduced as the biorefinery technology matures and the entire process continues to be optimized. Caution is advised in using the preliminary estimates reported here for decision making because there are significant uncertainties with regard to many design parameters relevant to estimating air pollutant emissions. In addition, because the cellulosic biorefineries are only beginning to enter commercial operation, there is a lack of emissions measurements from facilities using similar processes to the novel ones envisioned in the design case (Davis et al. 2013), which can be used to validate our estimates. Control strategies (control methods and devices) that can be used to reduce air pollutants emitted from unit operations at the biorefinery will be investigated in our future work. While results are preliminary, they are helpful to inform process design and provide information to evaluate how incorporating necessary emission controls may impact biofuel production cost. Moreover, this work helps biorefinery developers understand permitting requirements and therefore mitigate uncertainty in the air permitting process.

Report Structure

In Section 1 of this report, we provide an overview of air pollutant emissions addressed by federal air regulations. Section 2 provides a brief overview of the conversion process employed by the sugars-to-HC biorefinery. Section 3 reviews and analyzes the federal air regulations potentially applicable to the sugars-to-HC biorefinery. Section 4 documents the approaches, data, and assumptions used for estimating the preliminary uncontrolled PTE of regulated air pollutants expected to be emitted from each emission unit at the sugars-to-hydrocarbon biorefinery described in Davis et al. (2013). Section 5 summarizes the results of the preliminary estimation of facility-wide PTE and discusses the federally enforceable limitations upon which PTE is based as well as possible additional emission reductions a design biorefinery might consider.

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[14] A source would not be required to obtain a PSD permit on the sole basis of their PTE of GHG emissions exceeding the threshold as per the U.S. Supreme Court ruling (U.S. Supreme Court 2014).

[15] Section 112(r) of Clean Air Act Amendments of 1990 refers to the Accidental Release Prevention Requirements: Risk Management Program Requirements. This regulation covers many pollutants, often referred to as 112(r) pollutants. (See Appendix B for a list of these pollutants.) An estimate of PTE for these pollutants must be included in a Title V Operating permit application, but generally, no other requirements apply to these pollutants with respect to a Title V permit.

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1 Background: Air Pollutant Emissions Addressed by Federal Air Regulations

The United States Congress established much of the basic structure of the Clean Air Act (CAA) in 1970, which set into motion a nationwide effort to improve the country's air quality. Subsequent revisions were made in 1977 and 1990 to improve the effectiveness of the CAA and to target newly identified air pollution concerns such as acid rain and the damage of ozone-depleting substances to stratospheric ozone layer (EPA 2013a). Under the CAA, the Environmental Protection Agency (EPA) is charged with developing and implementing a wide range of regulatory programs targeted at various air pollution problems.

The CAA requires the EPA to set and revise National Ambient Air Quality Standards (NAAQS) for certain common and widespread pollutants, known as criteria pollutants (i.e., sulfur dioxide [SO_2], carbon monoxide [CO], particulate matter [PM], nitrogen oxides [NO_x], ozone, and lead). Implementing the air quality standard is a joint responsibility of states and the EPA; states are responsible for developing enforceable state implementation plans to meet and maintain air quality per the NAAQS while the EPA assists states' efforts through providing technical and policy guidance and reviewing states' plans to ensure they comply with the CAA. In the case that a state fails to adopt and implement an adequate plan, the EPA is required to issue a federal implementation plan (EPA 2013a). Ultimately, federal highway funds can be withheld should a state not develop an adequate plan.

Because atmospheric air pollutant concentrations cannot be directly controlled (to maintain compliance with the NAAQS), the EPA is authorized to set standards for allowable emissions from various types of sources while also considering current air quality conditions of a particular location. In this context, the EPA sets emissions standards for new and modified stationary pollution sources in source categories that could significantly endanger air quality. These "New Source Performance Standards" (NSPS) typically apply to industrial facilities such as manufacturing facilities and power plants, but can also apply to smaller equipment such as wood stoves. The NSPS standards limit emissions and/or specify technology that is currently available which limits emissions; however, the NSPS generally only apply to new sources built after a specified date.

The CAA includes a list of hazardous air pollutants (or HAPs; also known as toxic air pollutants). The EPA is required to regulate these pollutants from each category of sources that emit one or more HAP(s) via regulations called National Emission Standards for Hazardous Air Pollutants (NESHAP). The regulations must be based on the average performance of the top 12% best performing sources in a source category. This is referred to as Maximum Achievable Control Technology (MACT). Eight years after the compliance date of the MACT standard, the CAA requires the EPA to review the MACT rule and revise the MACT standards, if necessary, based on an assessment of the potential residual health risk to populations exposed to any HAP emissions that are still emitted from the sources in a source category. The CAA also requires the EPA to perform a review to determine if any improvements in technology have occurred since the MACT was established that would lower the potential emissions from the source category. This is referred to as a technology review, and is performed simultaneously along with the risk review (as a "risk and technology review"). The NESHAP implementation and enforcement is typically delegated to the states, but both the EPA and the states can implement and enforce the standards (EPA 2013a).

In addition to the NSPS and NESHAP pollutants, other air pollutants that may be emitted from the sugars-to-hydrocarbon (HC) (hereafter referred to as sugars-to-HC) biorefinery and may also be regulated by the CAA include 112(r) pollutants (see footnote 14) and greenhouse gases (GHG), as discussed below.[16]

- When Congress passed the CAA Amendments of 1990, Section 112(r) required the EPA to publish regulations and guidance for chemical accident prevention at facilities using substances that pose the greatest risk of harm from accidental releases. These regulations require facilities of all sizes that use certain regulated flammable and toxic substances to develop a Risk Management Program (RMP) (EPA 2009). These plans must be revised and resubmitted to the EPA every five years; see Appendix B for a list of these chemicals.
- In 2009, the EPA determined that GHGs threaten public health and welfare, and in 2010, it issued a regulation applicable to mobile sources to reduce GHG emissions. The EPA proposed a plan to cut carbon pollution from existing power plants on June 2, 2014, using the authority under Section 111 of the CAA. Future GHG regulations that apply to power plants or other types of industrial sources will also use the authority under Section 111 of the CAA. The regulated pollutant, GHG, is the combination of emissions of carbon dioxide, nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

As part of the amendments to the CAA in 1977, Congress established the New Source Review (NSR) program that requires a facility[17] to apply for a construction (or pre-construction) permit **before** a project is built or modified. The NSR permit is a legal document that the facility must abide by. There are three types of NSR permitting requirements; the source may have to meet one or more of these permitting requirements. The three types of NSR requirements are:

1. Prevention of Significant Deterioration (PSD) permits,[18] which are required for new sources[19] that are major for at least one pollutant, for which the area is in compliance with the NAAQS

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[16] The CAA also requires the EPA to phase out the production and import of listed ozone-depleting substances, including halons, chlorofluorocarbon, and hydrochlorofluorocarbon substances. The EPA is required to issue regulations that: (1) reduce the use and the emissions of these substances and (2) prohibit replacement (provided the EPA has identified an alternative that is available and poses lower risk) of any ozone-depleting substance with a substitute substance that it determines may present negative effects to human health or the environment. However, the biorefinery is not expected to emit these ozone-depleting substances.

[17] A facility is generally defined as any source of air pollution. In this document, a facility is used to mean a combination of all operations at one location.

[18] PSD permits are also required for major modifications at major PSD sources; however, this document focuses on construction of new sources and does not address modifications of existing sources and the applicability of PSD.

[19] A major PSD source is a source that has a potential-to-emit (PTE) greater than or equal to the following thresholds of a pollutant for which the area is in attainment with the pollutants' NAAQS.

- 100 tpy, if part of the 28 listed source categories (see Appendix C)
- 250 tpy for all other sources not part of the 28 listed source categories.

2. Nonattainment NSR (NNSR) permits,[20] which are required for new sources[21] that are major for a pollutant, for which the area is in nonattainment with the NAAQS[22]
3. Minor source permits.

If a source has a potential-to-emit (PTE) (refer to section 4.1 for definition) of one or more pollutant(s) over the major source threshold, the source is considered major. A new major source must perform a PSD review (i.e., PSD permit) for all pollutants which have a PTE greater than their respective Significant Emissions Rates (SERs) (see Appendix A for SER). For example, the SER for NO_x is 40 tpy, which is lower than the 100 tpy major source threshold for chemical process plants. Because the biorefinery produces hydrocarbon biofuels, it is deemed a chemical process plant. If a planned source has a PTE of CO of 120 tpy and a PTE of NO_x of 50 tpy and it will be located in a CO and NO_x attainment area, it will be required to perform a PSD review for both CO and NO_x because the source is a major PSD source and the PTE of CO and NO_x exceeds the SER for both CO and NO_x. The SER values for all regulated air pollutants under the NSR program are equal to or below 100 tpy; therefore, any pollutant with a PTE at a major source level also exceeds its SER value.

Furthermore, the 1990 CAA amendments require all **major** sources (see Appendix D) of air pollution and certain other sources to apply for and obtain *operating permits* that assure compliance with all of their CAA requirements. This kind of operating permit, required under Title V of the CAA, is called a Title V operating permit. The primary purpose of the Title V permit program is to develop permits that contain all the emission standards, monitoring, record keeping, and reporting requirements that apply to a source.

Many facilities may want to avoid having to obtain a Title V permit because of the fees and complexity of developing annual emission estimates. It is possible for a Title V source to become a non-Title V source by taking federally enforceable limits on the pollutants for which the source is major. Both the NSR permits (also known as construction permits) and Title V operating permits generally are issued by state and local permitting agencies under EPA-approved programs (EPA 2013a).

To summarize, Table 1 shows the regulated pollutants addressed by federal permitting programs. For a complete list of regulated pollutants, refer to Appendix B.

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[20] NNSR permits are also required for major modifications at major NNSR sources; however, this document focuses on construction of new sources and does not address modifications of existing sources and the applicability of NNSR.

[21] A major NNSR source is a source that has a PTE greater than or equal to the applicable major source threshold (listed in Appendix E) of a pollutant for which the area is in nonattainment with the pollutants' NAAQS.

[22] A nonattainment area is any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the NAAQS for the pollutant.

Table 1. Air Pollutants Addressed by Federal Permitting Programs

Air Pollutants	NSR Regulated Pollutants (Pollutants addressed in NSR Permits, aka pre-construction permits)	Regulated Pollutants (Pollutants addressed in Title V Operating Permits)
Criteria Pollutants and their Precursors	✓	✓
NSPS Pollutants	✓[a]	✓
HAP		✓
Ozone Depleting Substances	✓	✓
112(r) Pollutants		✓
GHG	✓	✓

[a] Excluding total suspended particulates, which are also referred to as PM.

2 Overview of the Process for Biological Conversion of Cellulosic Sugars-to-Hydrocarbon (HC)

Implementation of the Renewable Fuel Standard is expected to result in construction of new biofuel facilities using advanced technologies. One of the plausible technology pathways investigated by the National Renewable Energy Laboratory (NREL) is the biological conversion of cellulosic sugars-to-HC blendstock products in the diesel boiling range (Davis et al. 2013). The design case developed by NREL, which is documented in Davis et al. (2013), is used as the basis for quantifying potential emissions of regulated air pollutants for this conversion technology. Such a biorefinery is considered a point source of air pollutant emissions.

The sugars-to-HC biorefinery uses preprocessing (deacetylation) and co-current dilute-acid pretreatment of lignocellulosic biomass, followed by enzymatic hydrolysis of the remaining cellulose, followed by hydrolysate conditioning and bioconversion of the resulting hexose and pentose sugars to yield diesel-range fatty acids (Davis et al. 2013). The designed biorefinery is divided into nine areas briefly described as follows (adapted from Davis et al. 2013).

> *Area 100: Feedstock handling*. The feedstock, which is a blend of corn stover (modeled as 60% by weight [wt]), switchgrass (35%), and urban wood waste (5%) (Kenney et al. 2013), is delivered to the feed handling area from a uniform-format feedstock supply system (also known as biomass depot). (Emissions from biomass depot are outside the scope of this report.) After minimum handling and storage, the feedstock is conveyed to the pretreatment area (Area 200).
>
> *Area 200: Pretreatment and conditioning*. The biomass feedstock is processed in an alkaline deacetylation step to remove non-fermentable components, then is drained and treated with a dilute sulfuric acid (H_2SO_4) catalyst at a high temperature for a short time to liberate the hemicellulose sugars and break down the biomass for enzymatic hydrolysis. Ammonia (NH_3) is then used to raise the pH of the whole pretreated slurry for enzymatic hydrolysis.
>
> *Area 300: Enzymatic hydrolysis, hydrolysate conditioning, and bioconversion*. Enzymatic hydrolysis is initiated in a high-solids continuous reactor using a cellulite enzyme prepared onsite. The partially hydrolyzed slurry is next batched to one of several parallel bioreactors. Once the hydrolysis is completed, the slurry is then fed to a vacuum filter press to remove lignin while the remaining sugar stream is split into a small fraction sent directly to the batch bioreactors and a large fraction concentrated in a vacuum evaporation system. The concentrated sugar slurry is cooled and inoculated with the generic bioconversion microorganism. The conversion step proceeds under aerobic reactor conditions to convert cellulose and xylose to free fatty acids (FFAs). The resulting broth is sent to the product recovery area (Area 500). The lignin exiting the filter press is sent to the combustor in Area 800.
>
> *Area 400: Cellulase enzyme production*. Purchased glucose (corn syrup) is the primary carbon source for onsite enzyme production. The reactors are loaded initially with the glucose/sophorose carbon source and nutrients including corn steep liquor, ammonia, and SO_2. After the initial cell growth period, additional substrate is added to maintain protein production. The entire fermentation broth, containing the secreted enzyme, is fed to Area 300 to carry out enzymatic hydrolysis.

Area 500: Product recovery and upgrading. The FFA product (from Area 300) is phase-separated from water via decantation and centrifugation. The heavy liquid (water) phase is sent to wastewater treatment (WWT) (Area 600) while the recovered FFA product (> 99% purity) is sent to product upgrading in an onsite hydrotreating facility (including reactors, fresh and recycle gas compressors, flash columns, and product fractionation utilizing purchased hydrogen). The primary product from the hydrotreating section is a diesel-range paraffinic product suitable as a diesel blendstock. The hydrotreating section also includes a pressure swing adsorption (PSA) unit in the recycle gas loop to remove CO_2 generated during decarboxylation.

Area 600: WWT. Wastewater streams are treated by anaerobic and aerobic digestion. The methane-rich biogas from anaerobic digestion is sent to the combustor (Area 800), where sludge from the digesters is also burned. The treated water is suitable for recycling and is returned to the process.

Area 700: Storage. This area provides bulk storage for chemicals used and produced in the process, including corn steep liquor, NH_3, H_2SO_4, nutrients, water, and product.

Area 800: Combustor, boiler, and turbogenerator. The solids from the filter press and WWT are combusted along with the biogas from anaerobic digestion and the tailgas from the hydrotreater PSA unit to produce high-pressure steam for electricity production and process heat. The boiler produces steam to be used in the process and any excess steam is converted to electricity via a turbogenerator for use in the plant and for sale to the grid.

Area 900: Utilities. This area includes a cooling water system, chilled water system, process water manifold, and power systems.

3 Analysis of Air Regulations Potentially Applicable to the Sugars-to-HC Biorefinery

The first step to determine which federal air regulations potentially apply to the biorefinery using the biological conversion of cellulosic sugars to HC is to identify the type of regulated air pollutants emitted to the environment by the biorefinery or specific equipment (some regulations apply to the entire facility while others apply to specific equipment). The design case documented in Davis et al. (2013) along with the Aspen Plus model (a process simulation model) developed for this conversion process is the basis for identifying regulated air pollutants, which could be emitted from the facility and specific equipment. The potentially emitted pollutants include six criteria air pollutants (NO_x, SO_2, CO, volatile organic compound [VOC][23], lead, and particulate matter with diameter less than or equal to 2.5 micrometer [$PM_{2.5}$]/ particulate matter with diameter less than or equal to 10 micrometer [PM_{10}]) from various equipment (e.g., hydrotreating reactor, pre-heater, bioreactor). In addition, some HAPs are likely to be generated from emission points including the pre-heater, boiler, hydrotreater, aerobic digester (for WWT), and equipment leakage. GHG emissions (mainly carbon dioxide [CO_2]) are expected to be emitted from several areas of the biorefinery. NH_3 and H_2SO_4 mist are also expected to be emitted from certain equipment. Table 2 summarizes the equipment likely to generate air pollutants. In most cases, the equipment does not necessarily emit air pollutants directly to the atmosphere; instead, the air pollutants from the equipment are collected and then fed to other portions of the process and released through the atmospheric vents of other equipment.

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[23] A VOC is defined in Code of Federal Regulations 40 CFR 51.100 as any compound of carbon—excluding several compounds listed in the definition, such as carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate—which participates in atmospheric photochemical reactions.

Table 2. Equipment/Operations Likely To Generate Air Pollutants (by Plant Area as Specified in Davis et al. 2013)

Plant Area	Equipment/Activities	Air Pollutants
Area 100: Feed handling	Feedstock unloading, storage, and conveyance	PM, PM_{10}, $PM_{2.5}$
Area 200: Pretreatment and conditioning	Pre-steamers (M-204) and Pretreatment Reactors (M-207)	VOC, HAP, SO_2, H_2SO_4 mist
	Flash tank (T-204) [a]	VOC, HAP, SO_2, H_2SO_4 mist
	Ammonia addition tank	NH_3
	Leaking equipment [b]	VOC, HAP
Area 300: Enzymatic hydrolysis, hydrolysate conditioning, and bioconversion	Enzymatic hydrolysis reactors (F-300A)	VOC, HAP
	Filter press (S-205)	VOC, HAP
	Aerobic bioreactors (F-300B) and storage tank (T-306B)	CO_2, VOC, HAP
	Leaking equipment [b]	VOC, HAP
Area 400: Cellulase enzyme production	Bioreactors (F-400, F-401, F-402, and F-403), and tanks (T-405, T-406, and T-410)	CO_2, NH_3, SO_2
	Leaking equipment [b]	VOC, HAP
Area 500: Product recovery and upgrading	Pre-heater (no ID provided in design report)	PM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, CO_2, VOC, HAP
	Hydrotreating process (S-570)	CO_2, VOC, HAP
	Leaking equipment [b]	VOC, HAP
Area 600: WWT	Anaerobic digester (T-606)	CH_4, CO_2, VOC, HAP
	Aerobic digester (T-608)	CO_2, VOC, HAP
	Leaking equipment [b]	VOC, HAP
Area 700: Storage	RDB product storage tank	VOC, HAP
	Sulfuric acid tank	H_2SO_4 mist, SO_2
	Ammonia storage tanks	NH_3
	Loading operations	VOC, HAP
Area 800: Combustor, boiler, and turbogenerator	Boiler [c] (M-803)	PM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, CO_2, VOC, HAP, H_2SO_4 mist, NH_3
Area 900: Utilities	Cooling towers	PM, PM_{10}, $PM_{2.5}$, VOC, HAP
	Fire pump	PM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, CO_2, VOC, HAP
	Emergency generator	PM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, CO_2, VOC, HAP
Truck traffic	Dust from roads of traffic of trucks hauling feedstock, other raw materials, waste, and product [b]	PM, PM_{10}, $PM_{2.5}$

[a] The flash vapor from the flash tank is condensed and sent to Area 600.

[b] These air pollutants are released to the atmosphere as fugitive emissions.

[c] For regulatory purposes, the term 'boiler' includes the plant's combustor as per 40 CFR Part 63, Subpart DDDDD – National Emissions Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers and Process Heaters.

Once the regulated air pollutants are identified, the next step is to review the applicability criteria of each federal standard to determine whether a facility or specific equipment is subject to it. There are two types of federal standards that regulate air pollutants from industrial plants: NSPS and NESHAP. The complete set of the NSPS is codified in Title 40, Part 60 of the Code of Federal Regulations (CFR). The complete set of the NESHAP is codified in Title 40, Parts 61 and 63 of the CFR. An electronic copy of all of the federal rules can be accessed at http://www.ecfr.gov/cgi-bin/text-idx?SID=de83df0816d6189bf8c0a725ddaee344&tpl=/ecfrbrowse/Title40/40tab_02.tpl. NSPS and NESHAP can apply to a facility as a whole, or to only a portion of the facility (e.g., a federal standard may only apply to a specific piece of equipment at the facility). As part of the regulatory analysis for the design biorefinery, all of the NSPS and NESHAP were reviewed to identify which may apply to the sugars-to-HC biorefinery as well as the equipment used in the biorefinery.

3.1 Regulatory Applicability Analysis: Specific NSPS that may Apply to the Biorefinery

Although biorefinery developers should consider all NSPS when planning compliance measures for their facility, the NSPS listed below are likely to be all of the NSPS that could apply to the biorefineries that use a biological conversion of cellulosic sugars-to-HC process described in Davis et al. (2013) based on the review of NSPS and EPA's applicability determination index database.[24] NSPS under the CAA dictate the level of pollution that a new source may produce.

- Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units (40 CFR 60, Subpart Db)
- Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units (40 CFR 60, Subpart Dc)
- Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced After July 23, 1984 (40 CFR 60, Subpart Kb)
- Standards of Performance for Volatile Organic Compound Emissions From Synthetic Organic Chemical Manufacturing Industry (SOCMI) Reactor Processes (40 CFR 60, Subpart RRR)
- Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemical Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006 (40 CFR 60, Subpart VVa)
- Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (40 CFR 60, Subpart IIII)

Using the specific information for the design plant including capacity and size of equipment in the design case (Davis et al. 2013), more specific applicability determinations can be made. This is discussed in Sections 3.1.1 through 3.1.6.

3.1.1 *NSPS that may Apply to the Boiler (Area 800)*

Based on the size of the boiler (about 805 MMBtu/hr as shown in the Aspen model for the design case in Davis et al. 2013), the boiler would be subject to the Boiler NSPS for Industrial-Commercial-Institutional Steam Generating Units (40 CFR 60, Subpart Db) with a design rate greater than 100 MMBtu/hr (or 29 MW). This rule would limit SO_2 emissions from the boiler located in Area 800 of the biorefinery to 0.20 lb/MMBtu or less. The NO_x limit in this rule is not

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[24] The applicability determination index database can be found at https://www.fedcenter.gov/Bookmarks/index.cfm?id=4759.

expected to be applicable to the boiler because the boiler is designed to burn natural gas for less than 10% of the time annually (only during start-up).[25] The boiler NSPS (40 CFR 60, Subpart Db) limits filterable PM to 0.03 lb/MMBtu. If the biorefinery had boilers smaller than 100 MMBtu/hr (or 29 MW), then the boilers could be subject to Subpart Dc (instead of Subpart Db). Refer to Table F-1 in Appendix F for additional details regarding applicability of 40 CFR 60, Subpart Db.

The boiler in Area 800 of the biorefinery burns sludge and other materials as boiler feed, which could be considered "wastes". If the boiler feed is considered "wastes", it is possible that one of the waste incinerator NSPS rules could apply instead; specifically, 40 CFR 60, Subpart CCCC for Commercial and Industrial Solid Waste Incineration Units (CISWI) may apply. In order for the boiler feed to be considered a fuel (rather than "wastes"), the standards outlined in the EPA's Identification of Non-Hazardous Secondary Materials (NHSM) rule in 40 CFR 241, Subpart B (GPO 2013) must be met. To meet the requirements in 40 CFR 241, Subpart B, the boiler feed (sludge and other materials) must be:

- Burned onsite (i.e., remains in the control of the generator)
- Managed as a valuable commodity (i.e., being stored for reasonable time frame as determined on a case-by-case basis, and releases to the environment are prevented)
- Have a meaningful heating value and be used as a fuel in a combustion unit that recovers energy.

It is reasonable to assume the boiler feed used at the sugars-to-HC biorefinery meets these criteria and, therefore, it is expected that the boiler feed would be considered a fuel rather than "waste". Also, in the NHSM rule, the EPA has already determined that "dewatered pulp and paper sludges that are not discarded and are generated and burned onsite by pulp and paper mills" are non-wastes when used as a fuel in a combustion unit (for details about this determination, refer to EPA 2013b). While pulp and paper mills are not exactly the same industrial setting as the biorefinery being studied here, the rationale that the EPA has applied in the determination for the pulp and paper sludges likely would apply also to the sludges generated from the sugars-to-HC biorefinery. For this analysis, it is assumed that the boiler feed is not a solid waste.

The pre-heater in Area 500 is not likely to be considered "steam generating units" because it does not generate steam. Therefore, the pre-heater will not be subject to the boiler NSPS.

3.1.2 *NSPS that may Apply to Storage Tanks (Area 700)*

Storage tanks in the biorefinery could be subject to control requirements under the NSPS for Volatile Organic Liquid Storage Vessels (40 CFR 60, Subpart Kb). However, in order to be subject to the control requirements in this rule, a tank must meet a minimum capacity threshold (19,813 gallons) and store organic liquids with certain vapor pressure specifications. Subpart Kb control requirements do not apply to storage vessels with a capacity greater than or equal to 39,890 gallons storing a liquid with a maximum true vapor pressure less than 3.5 kilopascals

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[25] The boiler NSPS (40 CFR 60, Subpart Db) exempts boilers from the NO_x emission limits if the fossil fuel capacity factor is limited to less than 10%. The design case boiler only uses natural gas (and no other fossil fuel) during start-up, which is much less than 10% of the time.

(kPa) or with a capacity greater than or equal to 19,813 gallons but less than 39,890 gallons storing a liquid with a maximum true vapor pressure less than 15.0 kPa.

Although the renewable diesel blendstock (RDB) tank located in Area 700 has a capacity of 750,000 gallons, which is greater than the capacity threshold (39,890 gallons), the maximum true vapor pressure of RDB[26] is estimated to be much lower than the true vapor pressure threshold of 3.5 kPa for this size of the storage vessel. As such, the control requirements in 40 CFR 60, Subpart Kb would not apply to the RDB tank. None of the other storage tanks in the design biorefinery contains volatile organic liquids. Therefore, this NSPS will not be applicable to any storage tanks in the sugars-to-HC biorefinery.

3.1.3 *NSPS that may Apply to the Reactors (Areas 200, 300, and 400)*

The reactors in Areas 300 and 400 of the design biorefinery are exempt from the NSPS for VOC Emissions from Synthetic Organic Chemical Manufacturing Industry (SOCMI) Reactor Processes (40 CFR 60, Subpart RRR) because these reactors are designed and operated as a batch operation. However, the continuous pretreatment reactors in Area 200[27] may be subject to 40 CFR 60, Subpart RRR.

For Subpart RRR to apply, these continuous reactors must be part of a process unit that produces any of the chemicals listed in §60.707 (Subpart RRR) as a product, co-product, by-product, or intermediate. The continuous pretreatment reactors in Area 200 are not expected to produce a product, co-product, by-product, or intermediate, which is on the list in §60.707. It is possible that very small amounts of acetic acid, which is a chemical listed in §60.707, are emitted from the biorefinery, but it is not considered a product, by-product, co-product, or intermediate because acetic acid is not isolated for sale or use in another process. Therefore, the sugars-to-HC biorefinery is not subject to Subpart RRR.

3.1.4 *NSPS that may Apply to Equipment Leaks (Areas 200 through 700)*

Certain equipment at the sugars-to-HC biorefinery could be subject to the equipment leak NSPS (40 CFR 60, Subpart VVa). This rule applies to the synthetic organic chemicals manufacturing industry, which means any industry that produces, as intermediates or final products, one or more of the chemicals listed in §60.489 (Subpart VVa). Although the design biorefinery generates small amounts of acetic acid, glycerol, succinic acid, and furfural in the process, which are listed in §60.489, they are not considered to be products, co-products, by-products, or intermediates because they are not isolated for sale or used in another process. Therefore, the design plant is not subject to Subpart VVa.

3.1.5 *NSPS that may Apply to the Emergency Equipment (Area 900)*

The design case (Davis et al. 2013) does not include emergency equipment, but it is typical for such facilities to have a fire pump and/or an emergency generator that is an internal combustion engine. Following the design case for cellulosic biomass to ethanol (Humbird et al. 2011), we

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[26] The vapor pressure of RDB is assumed to be similar to that of petroleum diesel production (Davis and McCormick 2014). The true vapor pressure of No.2 diesel fuel is 0.011 psia (i.e., 0.08kPa) at 77 F (EPA 2006b).

[27] The reactors in Area 200 are described in Davis et al. (2013) as batch reactors; however, the residence time is small. Therefore, the assumption being made here is that the reactors in Area 200 are continuous and meet rule applicability of Subpart RRR.

assume emergency equipment will be in included in the sugars-to-HC design biorefinery. Depending on their size and design, the equipment can be subject to an internal combustion engine NSPS at 40 CFR 60, Subpart IIII. Generally, if new equipment is purchased, the purchased equipment will meet this rule, because many requirements in 40 CFR 60, Subpart IIII apply to the equipment manufacturer rather than the operator of the equipment. Refer to Table F-2 in Appendix F for additional details regarding applicability of 40 CFR 60, Subpart IIII.

3.1.6 *Summary of the NSPS that may Apply to the Biorefinery*

To summarize, Table 3 lists all NSPS that may be applicable to specific equipment at the sugars-to-HC biorefinery per the design case documented in Davis et al. (2013).

Table 3. NSPS Potentially Applicable to Certain Equipment at the Sugars-to-HC Biorefinery

Design Plant Area	Affected Equipment	Federal Rule	Target Pollutant(s)	Notes Regarding Applicability
Area 800	Boiler [M-803]	Boiler NSPS, 40 CFR 60, Subpart Db	SO_2, PM, and NO_x	The boiler (M-803) located in Area 800 of the design plant would be subject to 40 CFR 60, Subpart Db based on the design case (Davis et al. 2013).
Area 900	Compression Ignition Internal Combustion Engines	Engine NSPS 40 CFR 60, Subpart IIII	PM, Non-methane hydrocarbons + NO_x	It is assumed the biorefinery will have a fire pump and/or an emergency generator that uses an internal combustion engine (despite a lack of inclusion in the design case [Davis et al.2013]). Depending on the size and design, this engine could be subject to an internal combustion engine NSPS at 40 CFR 60, Subpart IIII.

3.2 Regulatory Applicability Analysis: Specific NESHAPs that may Apply to the Sugars-to-HC Biorefinery

NESHAPs can apply to major sources of HAPs or to certain area sources of HAPs. Major sources of HAP are defined as sources that have the PTE greater than 10 tpy of any single HAPs and/or greater than 25 tpy of a combination of HAPs. Area sources are defined as sources that have a PTE less than the major source thresholds of HAPs.[28]

Although biorefinery developers should consider all NESHAPs when planning compliance measures for their facility, the NESHAPs listed below are likely to be all of the NESHAPs that could apply to biorefineries that use a biological conversion of cellulosic sugars-to-HC process described in Davis et al. (2013).

- National Emission Standards for Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing (40 CFR 63, Subpart FFFF)
- National Emission Standards for Hazardous Air Pollutants for Chemical Manufacturing Area Sources (40 CFR 63, Subpart VVVVVV)

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[28] The term “area source” is typically the phrasing used in NESHAP; it is synonymous with the phrase “minor source of HAP”.

- National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters (40 CFR 63, Subpart DDDDD)
- National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources (40 CFR 63, Subpart JJJJJJ)
- National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (40 CFR 63, Subpart ZZZZ)

Using the specific information in the design case (Davis et al. 2013), more specific applicability determinations can be made; these are discussed in Sections 3.2.1 through 3.2.4.

3.2.1 *NESHAPs that may Apply to the Whole Facility*

There are no NESHAPs that are specific to a biorefinery process; however, the sugars-to-HC biorefinery is essentially a chemical processing plant and as such, it is subject to one of two chemical manufacturing NESHAPs, depending on whether the biorefinery is a major or area source of HAPs. These two NESHAPs are: the NESHAP for Miscellaneous Organic Chemical Manufacturing (40 CFR 63, Subpart FFFF), commonly referred to as the "MON", and the NESHAP for Chemical Manufacturing Area Sources (40 CFR 63, Subpart VVVVVV), commonly referred to as "CMAS". CMAS is an area source HAP rule while the MON is applicable to major sources of HAPs. These rules are mutually exclusive since a facility is classified either major or area based on the expected level of HAP emissions; therefore, the biorefinery would be subject to only one of these rules.

For the MON to be applicable, the source must be a major source of HAPs and fall under the North American Industry Classification System (NAICS) 3-digit code 325 or one of the following 3-digit Standard Industrial Classification (SIC) codes: 282, 283, 284, 285, 286, 287, 289, or 386. It is likely that the biorefinery will fall under the SIC 286.[29] For the CMAS to be applicable, the biorefinery must be an area source of HAPs and make as a byproduct[30] (or use as feedstocks) one of the HAPs listed in Appendix G at a concentration greater than 0.1 wt% in any process vent or liquid stream. The HAP list includes 1,3-butadiene and acetaldehyde, which could be in the by-product streams of the biorefinery.

MON and CMAS generally have applicability criteria to determine whether an individual emission point is required to be controlled, monitored, or only a record of its existence needs to be maintained. For example, the equipment leak provisions in the MON apply only to equipment that are "in organic HAP service". "In organic HAP service" is defined as equipment, which is in contact with a process stream that contains an individual HAP of at least 5 wt%. Detailed information is needed to identify if there are any streams that have greater than 5% of an individual HAP. Similarly, information is needed to determine the full applicability for each emission point once the detailed engineering design of a specific biorefinery is available. Refer

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[29] The SIC for a similar biorefinery that is currently in construction (Carolina Cellulosic Biofuels, LLC located in Clinton, North Carolina) is 2869; this was determined by looking at the air permit which can be obtained here: https://xapps.ncdenr.org/aq/docs/FDocs_Search.jsp. This facility will produce 20 million gallons per year of cellulosic biofuel from locally grown energy crops, agricultural residues, and woody biomass through enzymatic hydrolysis.

[30] CMAS defines "by-product" as a chemical (liquid, gas, or solid) that is produced coincidentally during the production of the product. This definition may be different from that in the NSPS, e.g., 40 CFR 60, Subpart RRR.

to Table H-1a and H-1b in Appendix H for additional details of 40 CFR 63, Subpart FFFF and 40 CFR 63, Subpart VVVVVV respectively..

3.2.2 *NESHAP that may Apply to the Boiler (Area 800)*

There are also NESHAPs that could apply to the boiler(s). Because the boiler feed is not likely to be considered "waste" (see Section 3.1.1), one of the two NESHAPs could apply to the boiler at the sugars-to-HC biorefinery: NESHAP (40 CFR 63, Subpart DDDDD) applies to boilers at facilities that are major sources of HAPs, and the other (40 CFR 63, Subpart JJJJJ) applies to boilers at facilities that are area sources of HAPs. Either one or the other will likely apply to the boiler at the sugars-to-HC biorefinery in a mutually exclusive fashion.

40 CFR 63, Subpart DDDDD also applies to process heaters at facilities, which are major sources of HAPs. If the sugars-to-HC biorefinery is determined to be a major source, the pre-heater in Area 500 is likely considered a "process heater" under the 40 CFR 63, Subpart DDDDD. The combustion gases in process heaters do not come into direct contact with process materials. Refer to Table H-2a and H-2b in Appendix H for additional details of 40 CFR 63, Subpart DDDDD and 40 CFR 63, Subpart JJJJJ respectively.

3.2.3 *NESHAPs that may Apply to the Emergency Equipment*

The design case (Davis et al. 2013) does not include emergency equipment, but it is typical for such facilities to have a fire pump and/or an emergency generator that uses an internal combustion engine. Depending on their size and design, the emergency equipment can be subject to an internal combustion engine NESHAP at 40 CFR 63, Subpart ZZZZ. This regulation applies to engines at both major and area sources of HAPs, but the specific requirements in this rule are dependent on whether the facility is a major or area source of HAPs. Generally, if new equipment is purchased, the manufacturer of the internal combustion engine will ensure its engines meet this rule. Refer to Table H-3a and Table H-3b in Appendix H for additional details of 40 CFR 63, Subpart ZZZZ.

3.2.4 *Summary of the NESHAPs that may Apply to the Biorefinery*

Based on the review of the applicability of all NESHAPs, Table 4 summarizes the specific NESHAPs that may be applicable to the sugars-to-HC biorefinery. CMAS and MON apply to a number of emission release points at the biorefinery whereas the other NESHAPs apply to only specific pieces of equipment at the design biorefinery as shown in Table 4.

Table 4. NESHAPs Potentially Applicable to the Sugars-to-HC Biorefinery

Design Plant Area	Affected Emission Release Points or Equipment	Federal Rule	Target Pollut-ant(s)	Notes Regarding Applicability
Areas 200, 300, 400, 500, 600, 700, 800, 900	**Emission Release Points:** Process Vents, Equipment Leaks, Storage Tanks, Wastewater Treatment, Heat Exchange System (including Cooling Tower)	Chemical Manufacturing NESHAP, either CMAS (40 CFR 63, Subpart VVVVVV) or MON (40 CFR 63, Subpart FFFF)	HAP	If the sugars-to-HC biorefinery is a major source of HAP, MON would apply. If the sugars-to-HC biorefinery is an area source of HAP, CMAS would apply.
Area 800	**Equipment:** Boiler [M-803] Pre-heater [located in Area 500 of the biorefinery]	Boiler NESHAP, either 40 CFR 63, Subpart JJJJJJ Or Subpart DDDDD	HAP	40 CFR 63, Subpart DDDDD applies to boilers at major sources of HAP. If the biorefinery is a major source of HAP, 40 CFR 63, Subpart DDDDD also applies to process heaters. 40 CFR 63, Subpart JJJJJJ applies to area sources of HAP. Process heaters are not subject to 40 CFR 63, Subpart JJJJJJ.
Area 900	**Equipment:** Emergency equipment (Reciprocating Internal Combustion Engines)	Internal Combustion Engine NESHAP, 40 CFR 63, Subpart ZZZZ	HAP	It is assumed the biorefinery will have a fire pump and/or an emergency generator that uses an internal combustion engine. Depending on the size and design, this engine could be subject to an internal combustion engine NESHAP at 40 CFR 63, Subpart ZZZZ. The specific requirements in this rule are dependent on whether the facility is an area source or a major source of HAPs.

4 Estimation of Potential-to-Emit (PTE) of Regulated Air Pollutant Emissions for the Sugars-to-HC Biorefinery

4.1 Definition of PTE

When preparing air permit applications and determining regulatory applicability for a planned source, the PTE of each regulated air pollutant from all activities at the source is considered. PTE is used to determine the applicability of many federal (and state) air emission regulations, as well as the construction and operating permitting requirements for a planned source. There are other criteria which play a role in determining regulatory applicability, but PTE must always be considered. PTE usually refers to the PTE of a specific regulated pollutant from the entire source. However, some rules may require PTE for a specific piece of equipment or process line to determine applicability; therefore, it is necessary to determine the PTE of each piece of equipment or process line. A bottom-up emission inventory is expected to be submitted with a permit application, along with documentation on how emissions are estimated.

The federal regulations define PTE as "the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of fuel combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable"[31] (EPA 1996).

By definition, PTE refers to the **greatest** amount of a pollutant that a source can release into the atmosphere. It is always larger and is often much larger than a source's actual emissions. The PTE for each pollutant must be determined on a site-specific basis. The definition of PTE has several terms and phrases that can be interpreted in different ways; therefore, there have been significant discussions, controversy, and court cases, which have led to clarifications of the language over the last several decades. This section provides additional details on what is meant by maximum capacity to emit, physical or operational design factors, and enforceable limitations, as well as a discussion of fugitive emissions and how they are counted in PTE calculations.

In most cases, PTE refers to an annual rate and is presented in units of tons per year (tpy). This convention is adopted in this analysis as well.

4.1.1 *Maximum Capacity to Emit*

For each pollutant, PTE estimates the highest possible emissions rate the specific source is capable of emitting. Generally, this means calculating the PTE based on:

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[31] The term "federally enforceable" refers to all limitations and conditions which are enforceable by the administrator of the EPA including: 1) requirements developed pursuant to any NSPS or NESHAP, 2) requirements within any applicable federally approved state implementation plan (SIP), and 3) any requirements contained in a permit issued pursuant to federal PSD regulations, or pursuant to PSD or operating permit provisions in a SIP, which has been federally approved.

1. The maximum capacity at which the equipment is capable of operating. In most cases this is the equipment's design capacity.
2. Continuous operations, i.e., 24 hours a day, 365 days a year (8,760 hours per year).
3. **Worst** case emission factor for a given pollutant used for the entire year. For example, if a source burns multiple types of fuel (e.g., biomass and coal) in the boiler, the fuel that emits the most for each pollutant is assumed to be burned year round for 8,760 hours per year. If a source uses different raw materials in its process, the PTE of a pollutant is calculated using the raw materials that would result in the greatest amount of emissions of that pollutant.

4.1.2 *The Physical and Operational Design Factors*

The physical and operational design factors can be taken into account when calculating PTE. For a physical limitation to be taken into account in the calculation of PTE, it must be an unchanging and unavoidable physical constraint. For instance, a boiler may have low NO_x burners. The burners are part of a boiler's physical design and result in NO_x emissions that are lower than would be emitted with conventional burners. Such an inherent physical limitation to pollutant emissions can be taken into account in calculating PTE. Operational factors can also affect the PTE. These factors could include the types of raw materials and fuels used during the operation, whether a unit operation is continuous and the length of a batch cycle. For example, a source that only burns natural gas in their boiler has a lower PTE for SO_2 than one that also burns oil. A boiler might be physically capable of burning oil and natural gas, but if the source has never burned oil and has no oil storage, their PTE likely would be based on just burning the natural gas.

There are three general categories of physical and operational design factors that are important to be aware of when calculating PTE, discussed below in detail:

1. Process designs that have inherent physical limitations or bottlenecks;
2. Non-continuous operations;
3. Controls that are integral to the process.

4.1.2.1 Inherent Physical Limitations or Rate Limiting processes ("Bottlenecks")

Physical limitations that limit the source's ability to operate at a maximum rate should be taken into account in PTE calculations. Bottlenecks in process lines are an obvious example of such limitations. For instance, if a biorefinery is producing enzyme onsite to be used for the enzymatic hydrolysis of cellulose, then the biorefinery cannot hydrolyze cellulose any faster than enzyme can be produced. In calculating the PTE for enzymatic hydrolysis, the capacity of the slower process (in this case, enzyme production process, which is the bottleneck) should be taken into account.

4.1.2.2 Non-Continuous Operations

Non-continuous operations present a dilemma in calculating PTE. As discussed above, the PTE is generally calculated based on the maximum design capacity, operated 8,760 hours per year. For non-continuous operation, there could be a very high emissions rate in certain hours whereas little or no pollutants are emitted during other hours. When present, non-continuous operations are a type of inherent design limitation. Depending on how a source operates, the source may carry out each sequential step one at a time (i.e., not starting the next step until the previous one is completed). This means that not all of their process equipment is operated at all times and some may stand idle at times. The EPA has provided specific guidance on three types of non-continuous operations, i.e., emergency generators, country grain elevators, and batch chemical production operations (Seitz 1995a, 1995b, and 1996).

4.1.2.3 Controls that are Integral to the Process

A source's PTE is calculated without any consideration of the effect of air pollution control equipment unless the controls are considered federally enforceable. However, certain operations can employ process equipment that can function as an air pollution control device in another configuration. Under such circumstances, the air quality regulations are not the driving force for the installation of a specific piece of equipment; instead the equipment is installed as part of the process and would be in place regardless of air pollution reduction concerns. For example, sources, which have dry solid raw materials, often use pneumatic conveyance to move the materials from one place to another. With a pneumatic conveyance system, air is used as a fluid stream to convey the materials. When the material reaches its destination in the plant (e.g., a storage hopper), a baghouse is often used to separate the solids from the air; the solids drop into a hopper or process equipment and the air is released to the atmosphere. If approved by a permitting authority, the baghouse, in this situation, is not considered a control device; rather it is considered a piece of process equipment and the PTE is calculated based on the collection efficiency of the baghouse. The baghouse used as part of the process is referred to as a "control that is integral to the process". Controls that are integral to the process are considered part of the physical or operational design of the process and can be considered when calculating the source's PTE. However, when control equipment can be considered an integral part of an emission unit's physical or operational design is determined on a case-by-case basis. It is the source's responsibility to request control equipment be considered part of the process and to submit sufficient information to prove that the control equipment is integral to the process. The criteria used to determine whether a control device is integral to the process is described in an EPA memorandum (Solomon 1995). The criteria include:

- The process cannot operate without the control equipment;
- The control equipment serves a primary purpose other than pollution control;
- The control equipment has an overwhelming positive net economic effect.

4.1.3 Enforceable Limitations

There are two main sources of federally enforceable limitations: permit limitations and regulatory provisions. For a permit limit to be federally enforceable and eligible to be treated as part of the process design and counted in PTE calculations, the limit must be included in a permit prepared under an EPA-approved permit program and the limit must be enforceable as a practical matter (Hunt and Seitz 1989). For limits to be enforceable as a practical matter, they have to be based on a parameter that can be easily monitored or verified, e.g., a limit on operating hours or fuel use. A limit on emissions is generally not considered practically enforceable (unless continuous emission monitoring systems are used) because it is impossible to monitor compliance. However, parameters on which emission rates are dependent (e.g., operating hours, type of fuel, amount of fuel, production rate) can often be monitored, and when adequately monitored, are considered enforceable as a practical matter. Limits are included in a permit in order to make them enforceable. Limitations contained in permits can take many forms (e.g., production limits, and operational limits).[32]

NSPS, NESHAP, and state regulations[33] can provide other enforceable limitations that can be factored into PTE calculations, as long as the regulation (or permit) contains the necessary monitoring, recordkeeping, and reporting to ensure that the limitations are achieved. These limitations would not be considered "permit limits" because the emission reduction authority would be derived from the NSPS, NESHAP, or state regulations and not from the permitting program itself; the regulatory limitations imposed by NSPS, NESHAP, and state regulations apply even if the source does not have a permit.

4.1.4 *Fugitive Emissions*

Because the design sugars-to-HC biorefinery is a chemical process plant (refer to footnote 8), which is one of the 28 listed source categories (See Appendix C), fugitive emissions from the design biorefinery must be included in the PTE calculation. Fugitive emissions are "those emissions that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening" as defined in federal regulations (40 CFR 70.2). The fugitive emissions definition does not depend on how the emissions are actually released to the environment; it depends on whether it is feasible to collect the emissions and release them through a stack (or similar device).

The determination of whether emissions are fugitive can be a controversial decision. If emissions from a given activity can be collected and passed through a stack at another location, even though the source does not collect the emissions, it is unlikely that the emissions would ever be considered fugitive. For example, NSPS requires that landfill gas be collected and controlled. Even if a landfill is not subject to the NSPS and does not collect landfill gas, the emissions of landfill gas would not be considered fugitive because it is a standard practice to collect the emissions and vent them. Therefore, they do not meet the definition of fugitive. However, the emissions then would be considered uncontrolled and count towards the landfill's PTE.

4.2 General Approach to Estimation of PTE

In calculating PTE, both technical and federally enforceable limitations must be taken into consideration. Technical factors include 1) using the best emissions data, which reflects the design of the process to estimate the maximum emissions as accurately as possible, and 2) evaluating physical and operational design factors and making proper judgments regarding whether the process has a bottleneck or controls that are integral to the process. Federally enforceable limitations include 1) any emission limitations specified in NSPS, NESHAP, or state regulations that can be considered federally enforceable, and 2) permit limits, which are requested by a source and are established in a permit.

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[32] For examples of practically enforceable limitations, refer to Section VII of the following EPA website: http://www.epa.gov/reg3artd/permitting/limitPTEmmo.htm.

[33] State regulations are only federally enforceable if they are part of the State's approved implementation plan. A State regulation that is not in the approved State Implementation Plan can also become federally enforceable for a specific facility if it is included in a federally enforceable permit.

The source can, for example, consider taking a limit based on the production rate or amount of fuel used, or decide to install a control device to meet the limit it will be requesting. Before a source requests federally enforceable avoidance limits, the source needs to ascertain that it can operate within the avoidance limits at all times. For instance, a limit on the production rate would not be appropriate for a source that expects to operate at or near its maximum capacity year round. A control device can be added, but the additional costs of installing a control device to avoid the applicability of a rule or a specific type of permit might not be economically justified. Also, based on how the source will be limited, the permitting authority will include monitoring, recordkeeping, and reporting requirements in the permit that ensure continuous compliance with the permit limits. In addition, the source must consider which emission units are best to be limited in their operation because not all emission units likely will need to have emissions limited for the source to avoid a given regulation or permit type. The source must contemplate all of these issues when calculating its PTE and developing its permit strategy.

Because the determination of PTE involves various policy and regulatory factors and decisions, as well as emission calculations, the source often presents two sets of values for PTE representing the different stages in the process of developing, reviewing and refining PTE. Therefore, we mimic this process in this analysis. We first estimate “uncontrolled PTE” to represent the maximum capacity to emit taking into account physical and operational limitations; then we estimate “PTE” to refer to the value, as defined, to include federally enforceable limitations from NSPS, NESHAP, and any avoidance limitations the sugars-to-HC biorefinery may want to request to be included in a permit.

We estimate uncontrolled PTE for the regulated air pollutants identified in Table 2 for the sugars-to-HC biorefinery in the subsections below, where technical factors for calculating uncontrolled PTE are discussed in “Maximum Capacity to Emit and Physical/Operational Limitations” and regulatory and permit limits for calculating PTE values are discussed in “Federally Enforceable Limitations”. However, to complete the permit strategy and the facility’s permitting plan, emissions from the entire source need to be considered. Therefore, federally enforceable limits and preliminary estimates of PTE are discussed in further detail in Section 5.

When a permitting authority reviews a source’s emission calculations presented in its permit application, the permitting authority tries to determine if the best emission factors and emission estimation methodologies are being used given the type of operation being permitted. In general, results from stack testing from the same or very similar operation are the most preferred data to be used for calculating emissions. If such data are not available, emission factors from the EPA’s Compilation of Air Pollutant Emission Factors, referred to as AP-42 (EPA 2015), are well accepted among permitting authorities. If emissions data are not available for a specific process, an engineering calculation, information based on a similar source, or a very conservative assumption can be used. The permitting authority wants to ensure that the PTE is calculated for a worst case scenario. If the permitting authority is uncertain about any of the emission calculations, the authority may require a different method to be used, and will likely require an emission stack test once the facility is constructed.

4.2.1 *Area 100 – Feedstock Handling*

Maximum Capacity to Emit and Physical/Operational Limitations

The feedstock handling area (Area 100) includes the transfer of the blended feedstock from a truck to conveyors and then to cement domes (C-104) for storage (Davis et al. 2013). Conveyors will also be used to transfer the feedstock from storage to the process. All conveyors will be enclosed, and the exhaust is routed to a baghouse through six dust collection systems (M-106), which control the release of PM to the atmosphere from the equipment.[34]

A method for calculating emissions that are controlled by a baghouse is to use the outlet grain loading (GL) associated with the bagfilters in the baghouse and the actual flowrate through the baghouse (for example see Utah Department of Environmental Quality 2014). Multiplying the GL by the actual flowrate (AFR) results in the controlled emissions from the baghouse. The uncontrolled emissions can be derived by dividing the controlled emissions by one minus the baghouse efficiency, using Eq. 1. It is assumed that the enclosures and duct work captures 100% of the dust from the handling and transfer of the feedstock and routes it through the baghouse. This is a typical assumption, but should be verified with plant designers before calculations are submitted to the state permitting agency.

$$Uncontrolled\ PTE = GL\left(\frac{gr}{scf}\right) * \frac{1}{7000}\left(\frac{lbs}{gr}\right) * AFR\ (cfm) * 60\left(\frac{min}{hr}\right) * 8{,}760\left(\frac{hrs}{yr}\right) * \frac{1}{2000}\left(\frac{ton}{lbs}\right) \div (1-E) \qquad \text{- Eq. 1}$$

Where:

Uncontrolled PTE = the maximum capacity to emit taking into account operational and design factors but without federally enforceable limitations included (tpy)
GL = grain loading, which is the concentration of particulates in the outlet stream of the baghouse (grains[35] per cubic foot [gr/scf])
AFR = actual flow rate [cubic feet per minute (cfm)]
E = fractional collection efficiency of the baghouse (unitless)

The GL value used to calculate uncontrolled PTE (0.004 gr/scf) for the sugars to HC biorefinery is based on Abengoa Bioenergy Biomass of Kansas (ABBK)'s air permit application (Kansas Department of Health and Environment 2011; WLA 2011). The AFR used is based on the design case (Appendix A in Davis et al. 2013), which indicates six systems each with an AFR of 8,500 cubic cfm. The control efficiency of the baghouses for PM, PM_{10}, and $PM_{2.5}$ is assumed to be 99% (EPA 2003b).

All the PM emissions are assumed to be less than 10µm in diameter (i.e., PM emissions are equivalent to PM_{10} emissions), and $PM_{2.5}$ emissions are 17% of PM_{10} emissions per the methodology in ABBK's air permit application (Kansas Department of Health and Environment 2011; WLA 2011). The preliminary estimates of uncontrolled PTE of PM, PM_{10}, and $PM_{2.5}$ from

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[34] The feedstock handling operation does not employ pneumatic conveyance as described in 4.1.2.3, where the baghouse might be considered integral to the process. The baghouse in Area 100 is a control device.
[35] Grain is a unit of mass. 7000 grains = 1 pound.

the baghouse are shown in Table 5 (refer to worksheet “Area100 - Feed Handling” of Appendix I for calculations).

Table 5. Preliminary Estimates of Uncontrolled PTE of PM, PM_{10}, and $PM_{2.5}$ from Feedstock Handling in Area 100

Pollutant	Uncontrolled PTE (tpy)
PM	7.7×10^2
PM_{10}	7.7×10^2
$PM_{2.5}$	1.3×10^2

Federally Enforceable Limitations

In order to include the emission reductions from the use of the baghouse in calculating the PTE, the baghouse must be federally enforceable. As discussed previously, federally enforceable limitations are from regulations or are established in air permits. Most states have PM regulations; however, they often do not include the monitoring and associated recordkeeping and reporting requirements to ensure continuous compliance with the regulation; therefore, these state PM regulations are not considered practicably enforceable. If a regulation is not practicably enforceable, it cannot be considered federally enforceable. In developing the air permit, the permitting authority will include the monitoring requirements necessary to ensure that the baghouse performs as expected (e.g., monitor pressure drop hourly) and meets the state regulation, thereby making the regulations practicably enforceable and thus federally enforceable. Therefore, in this situation, including the state PM rule as a federally enforceable limit will reduce the source’s PTE to the level required by the state PM regulation. For example, if a state rule limits the PM emissions to 10 lbs/hour from each of the six dust collection systems that are controlled by the baghouse, this would bring the PTE of PM to a total of 264 tpy for all six operations. The baghouse is capable of reducing the emissions further, but the state rule in this example would only provide federally enforceable limitation on PTE of 264 tpy.

In addition to a state PM regulation, the source may request a limit on their PTE to avoid the applicability of a regulation, major NSR or Title V permits. A PTE of 264 tpy from the baghouse (in the example above) is enough to trigger both major NSR and Title V permitting without any additional activities at the site. Therefore, the source likely will want to take further limitations on the baghouse. However, without examining the emissions of all pollutants from the entire source, a final permit strategy cannot be developed here. By considering the total emissions of other pollutants the strategy for PM can be determined. For example, if PM is the only regulated air pollutant the source emits at or above the major source threshold, then limiting the PTE further from the baghouse to below the major source threshold could make the source no longer a major source. However, if the facility is a major source for a pollutant other than PM, then the source will want to limit their emissions of PM to below the significant emission rate (see Appendix A). The federally enforceable limitations the source may request will depend on the emissions from other PM emitting units at the facility. The permit strategy for PM, PM_{10} and $PM_{2.5}$ for the sugars-to-HC biorefinery is discussed in more detail in Section 5.

4.2.2 *Area 200 – Pretreatment and Conditioning*

Maximum Capacity to Emit and Physical/Operational Limitations

Pretreatment and conditioning (Area 200) includes a series of reactors and processing steps where sodium hydroxide, sulfuric acid, and ammonia are used to make the biomass easier to process in subsequent steps. Although not explicitly tracked in the design case (Davis et al. 2013), the chemical reactions occurring in the reactors likely produce VOC emissions, in particular, acetic acid (through reaction between acetyl and hydroxide). The design case indicates that the removal of acetic acid and acetate is crucial for achieving desirable biofuel yields as these components inhibit subsequent hydrolysis (Davis et al. 2013). The acetic acid is removed from the feedstock during pretreatment and is discharged into a wastewater stream (Davis et al. 2013). Acetic acid has a low vapor pressure (0.3 psia or 2.1 kPa at 25°C) and is highly soluble in water and is, therefore, not expected to be emitted from the wastewater in significant quantities. As a preliminary conservative estimate, we assume that approximately 0.1% of acetic acid (discharged to wastewater treatment) is emitted as VOC. It should be noted that the mass flow of acetic acid is not clearly documented in the design case (Davis et al. 2013). We estimated the mass flow rate of acetic acid as 1,875 kg/hr based on the weight percentage of acetate in the biomass feedstock (1.8% on a dry mass basis, Table 1 in Davis et al. 2013) and the feedstock flow rate (104,167 kg/hr).

Dilute H_2SO_4 is added to the first pretreatment reactor without rapid mechanical agitation or other processing step that could produce H_2SO_4 aerosol. Little to no emissions of H_2SO_4 is expected to be emitted. However, as a preliminary, conservative estimate, it is assumed that 0.1% of H_2SO_4 could be emitted as H_2SO_4 mist. Emissions of SO_2 are not expected, even under conservative considerations, because sulfur in dilute H_2SO_4 will not be in an environment that could lead to its oxidation to SO_2.

A limited amount of produced sugars is expected to degrade to other organics, including furfural and 5- 5-hydroxymethyl furfural (Davis et al. 2013). The degraded organics could include VOC, yet almost all of these organics are expected to be entrained in the condensed vapor from the flash tank or sent to wastewater treatment. As a preliminary conservative estimate, we assume that 0.1% of furfural is not entrained in the condensate and is emitted as VOC.

HAPs are not expected to be emitted because: (1) no HAP-containing organic solvents are used, (2) there is no waste stream combustion associated with this step, and (3) none of the modeled byproducts is HAP.

After the hydrolysate slurry is cooled and sent to a conditioning reactor, ammonia (NH_3) is added to raise the pH to 5. This step is completed in the NH_3 addition tank, which is equipped with a static mixer. It is expected that some NH_3 will be emitted from the conditioning of hydrolysate slurry. It is also reasonable to assume that some NH_3 will be emitted from the two 28,000 gallon storage tanks in Area 400. Using the NH_3 emissions rate calculated for ABBK, a cellulosic ethanol production plant (Appendix C in WLA Consulting 2011), we estimated a NH_3 emission rate of about 0.026 lb/hr from the combination of conditioning hydrolysate slurry and the two NH_3 storage tanks in Area 400. This estimation was calculated by scaling emissions based on NH_3 usage ratio (i.e., NH_3 usage rate at the sugars-to-HC biorefinery divided by NH_3 usage rate at ABBK) and the ABBK's NH_3 emissions rate.

Table 6 shows our preliminary estimates of uncontrolled PTE of VOC, H_2SO_4 and NH_3 emissions from pretreatment and conditioning as well as the two NH_3 storage tanks in Area 400. Detailed calculations can be found in the Worksheet "Area 200 - Pretreatment" in Appendix I.

Table 6. Preliminary Estimates of Uncontrolled PTE of VOC, H_2SO_4, and NH_3 from Pretreatment and Conditioning in Area 200

Pollutant	Uncontrolled PTE (tpy)
VOC	4.9
H_2SO_4	7.8
NH_3[a]	1.1×10^{-1}

[a] The PTE of NH_3 includes emissions from NH_3 conditioning in Area 200 and the NH_3 tanks in Area 400.

Because the uncontrolled PTE for VOC, H_2SO_4, and NH_3 are based on the general assumptions that 0.1% of the pollutant is emitted from the process and that the NH_3 is emitted in a similar amount calculated in the ABBK permit application, it is very likely that the state permitting authority will include stack testing as a requirement in the permit to prove that the estimated emissions are accurate.

Federally Enforceable Limitations

There are no current regulations that could apply to Area 200 to provide a basis for a federally enforceable limitation. The design case (Davis et al. 2013) currently does not incorporate emission control device for reducing VOC, H_2SO_4 and NH_3 from Area 200. Either the MON or CMAS NESHAP likely will apply to the source; however, these two rules only apply to HAP emissions. Because no HAP emissions are expected from this area (i.e., the VOCs emitted from this area are not HAP), these HAP rules will not require control for VOC from this area of the plant.

The facility could decide to add a control device to reduce VOC emissions and request a limit as part of a major NSR and/or Title V avoidance limit; however, this cannot be determined without reviewing the emissions from the whole biorefinery. Also, because the emissions are relatively small from Area 200, it may not be worth putting a control device in place, even if an avoidance limit is being requested.

4.2.3 *Area 300 – Enzymatic Hydrolysis, Hydrolysate Conditioning, and Bioconversion*

Maximum Capacity to Emit and Physical/Operational Limitations

In Area 300, cellulose is converted to glucose using cellulose enzymes. The enzymatic hydrolysis portion of the process follows the same steps used to produce cellulosic ethanol described in Humbird et al. (2011), which is similar to that employed by ABBK. Once the glucose production is complete, the hydrolysate is processed through conditioning to concentrate the glucose prior to the aerobic conversion to FFA (Davis et al. 2013). Although the ABBK uses fermentation (i.e., anaerobic conversion), the enzymatic hydrolysis process in our design case is generally similar to that used by ABBK. ABBK used data from a vendor to estimate these emissions. Using the data from ABBK's calculations of VOC emissions from enzymatic hydrolysis (Appendix C in WLA Consulting 2011), we estimate an emission rate of 0.012 lb of VOC per lb of ethanol produced from ABBK's enzymatic hydrolysis and fermentation. We assume the emission rate of VOC from Area 300 in our biorefinery is the same as that from the enzymatic hydrolysis and fermentation process in ABBK, except that the emission rate is based on producing free fatty acids (FFA) instead of ethanol. Specifically, we used an emission rate of 0.012 lb of VOC per lb of FFA.

Acetaldehyde, methanol, and acrolein are documented VOC/HAP byproducts of ethanol production (Wisler and Teller 2006). Research on the hydrocarbon metabolic pathways of aerobic bioconversion using lignocellulosic hydrolysate has not produced results relevant to the estimation of PTE for the sugars-to-HC conversion of Davis et al. (2013). The design case (Davis et al. 2013) indicates the organism used for the biological conversion is a placeholder. Therefore, the types of VOC and HAP emissions from the enzymatic hydrolysis and bioconversion step are unknown. As a preliminary conservative estimate, it is assumed that 10% of the VOC emissions from these processes are a combination of HAP. It is not possible to speciate VOC and HAP at this stage of biorefinery design though such speciation likely would be necessary for obtaining air permits.

The bioconversion reactions in Area 300 generate CO_2 emissions (Table 14 of Davis et al. 2013). Based on the information in the design case (Stream 390 of the Aspen model in Davis et al. 2013), CO_2 is emitted from the bioconversion reactor vent at a rate of 184,807 tpy.

Table 7 summarizes the preliminary estimates of uncontrolled PTE of VOC, HAP, and CO_2 emissions for Area 300. Detailed calculations can be found in the Worksheet "Area 300 - Enzymatic Hydrolysis" in Appendix I.

Table 7. Preliminary Estimates of Uncontrolled PTE of VOC, HAP, and CO_2 from Enzymatic Hydrolysis, Conditioning, and Bioconversion in Area 300

Pollutant	Uncontrolled PTE (tpy)
VOC	1.8×10^3
HAP	1.8×10^2
CO_2	1.8×10^5

Federally Enforceable Limitations

No emission control or operational limitation is currently incorporated in the design case (Davis et al. 2013) to reduce VOCs, HAPs, and CO_2 emissions from this area. Either the MON or CMAS may apply to the sugars-to-HC biorefinery and, if so, the process vents from this area would likely be required to control HAP emissions based on the rule. Also, the estimated uncontrolled PTE for VOC from this area is large enough to trigger major NSR permitting without including contributions from other areas of the biorefinery. The installation of best available control technology (BACT) as part of NSR review might lead to control of these emissions. The HAP reduction required by NESHAP might also lead to VOC reduction (see Section 5 for more details).

The uncontrolled PTE of VOCs is estimated based on the assumption that the VOC emissions from this process area are similar to those from a process at a cellulosic ethanol plant; however, this assumption may not be appropriate to the design case discussed here. It is important to investigate other methods for estimating VOC and HAP emissions from the unit operations in Area 300 to develop more accurate estimates once additional design specifics are available (e.g., the type of organisms used for the aerobic conversion).

4.2.4 *Area 400 – Cellulase Enzyme Production*

Maximum Capacity to Emit and Physical/Operational Limitations

The cellulase enzyme used in Area 300 is produced onsite in Area 400 using glucose, water, corn steep liquor, antifoam (corn oil), NH_3, host nutrients, SO_2 and air. Because SO_2 (a nutrient) is stored in pressurized cylinder and is fed to the reactors stoichiometrically, no SO_2 emissions are expected from the cylinder. However, as a preliminary conservative estimate and to account for the potential of SO_2 to be emitted, we assume 1% of SO_2 is left over and emitted as SO_2 (based on experience writing air permit applications for analogous processes). According to the design case (Stream 440 of the Aspen model in Davis et al. 2013), NH_3 is emitted at a rate of 0.2 kg/hr. In addition, CO_2 is generated from cellulase seed fermenters and cellulase fermenter at a rate of 47.7 and 1147.9 kg/hr, respectively, during the enzyme production.

Table 8 shows the preliminary estimates of uncontrolled PTE of SO_2, NH_3 and CO_2 from Area 400. Detailed calculations can be found in the Worksheet "Area 400 - Enzyme Production" in Appendix I.

Table 8. Preliminary Estimates of Uncontrolled PTE of SO_2, NH_3, and CO_2 from Enzyme Production in Area 400

Pollutant	Uncontrolled PTE (tpy)
SO_2	8.2×10^{-1}
NH_3	1.9
CO_2	1.2×10^{4}

Federally Enforceable Limitations

Because no emission control device is currently employed in the design case for mitigating these emissions (Davis et al. 2013) and there are currently no regulations that are applicable to Area 400, the PTE is expected to be identical to the uncontrolled PTE for SO_2, NH_3 and CO_2 emissions from Area 400. Also, because the emissions from Area 400 are relatively low, it likely would be impractical to install a control device to reduce emissions further.

4.2.5 *Area 500 – Product Recovery and Upgrading*

Maximum Capacity to Emit and Physical/Operational Limitations

Following FFA product concentration, the product is upgraded in a hydrotreater to refine the oxygenated intermediate material into saturated paraffin components suitable for blending as a diesel blendstock. Exhaust from the hydrotreater in Area 500 is primarily H_2 and CO_2 and is routed through a PSA unit to remove CO_2 and produce a high concentration H_2 stream. The high concentration H_2 stream is routed back to the process and mixed with the product stream from the bioreactors. The tailgas of the PSA is split; a portion is sent to be combusted in a pre-heater used to heat the FFA stream prior to a two stage hydrotreating process and the remaining portion is sent to be combusted in the boiler in Area 800. The tail gas stream contains approximately 54 volume% of H_2 (5.2% by weight) and 46 volume% of CO_2 (94.5% by weight) with trivial amounts of water, pentadecane, and hexadecane.

Although adsorbers are often used as emission control devices, the PSA is used as a separator in Area 500 and should be considered integral to the process. Also, the only regulated pollutants from the PSA are the CO_2 emissions and the trivial amounts of pentadecane and hexadecane. The

PSA separates the process streams into two process streams, so it does not destroy or capture materials before they are released to the atmosphere like a control device does.

The pre-heater in Area 500 burns fuel and generates air emissions. Based on the design case (Davis et al. 2013), the pre-heater with a capacity of 2.3 MMBtu/hr (Davis et al. 2013) is expected to burn natural gas during the startup (less than 10% of time annually) and burns the PSA tailgas during normal operation. To calculate the uncontrolled PTE for a combustion unit that burns multiple fuels, the calculation is conducted assuming the worst case fuel for each pollutant emitted. In the case of the pre-heater in Area 500, the PSA tailgas is expected to generate higher NO_x emissions than natural gas because the primary combustible component in tailgas is hydrogen, which has higher flame temperature leading to more NO_x than natural gas (EPA 1993). The NO_x emissions created from burning this tailgas in the pre-heater are estimated using an EPA emissions factor of 0.162 lb/MMBtu (EPA 1993). This emissions factor can be used for refinery fuel gas-fired heaters that combust fuel gas containing high amounts of hydrogen as per the EPA's guidance (EPA 1993).

Emissions of non-NO_x criteria pollutants and HAP are expected to be negligible while burning the tailgas because there is little to no hydrocarbons and sulfur in the tailgas. As such, very little, if any, HAP, VOC, PM, CO, and SO_2 emissions are expected. For these pollutants, the uncontrolled PTE is calculated based on using natural gas 100% of the time, because natural gas is the worst case fuel for these pollutants. The natural gas emission factors are derived from the EPA's AP-42 Chapter 1.4 (EPA 1998). Because the tailgas used as a fuel contains a large amount of CO_2 emissions, it is not evident which fuel is the worst case fuel for GHG emissions. We estimated the uncontrolled PTE of GHG emissions at 4,100 and 1,200 tpy of CO_2 equivalent, respectively, assuming burning either tailgas or natural gas 100% of the time. The comparison indicates tailgas is the worst case fuel for GHG emissions and therefore, the uncontrolled PTE of GHG emissions for the pre-heater is based on burning tailgas 100% of the time.

Table 9 summarizes preliminary estimates of uncontrolled PTE of criteria air pollutants, HAP, and GHG emissions from the combustion of tailgas and natural gas in the Pre-heater in Area 500. Detailed calculations for tailgas combustion can be found in the Worksheet "Area 500 - Pre-heater" in Appendix I.

Table 9. Preliminary Estimates of Uncontrolled PTE of Criteria Air Pollutants, HAP, and GHG Emissions from the Pre-heater in Area 500

Pollutant	Uncontrolled PTE[a] (tpy)
PM	1.9×10^{-2}
PM_{10}	7.4×10^{-2}
$PM_{2.5}$	7.4×10^{-2}
SO_2	5.9×10^{-3}
NO_x	1.6[a]
VOC	5.4×10^{-2}
CO	3.9×10^{-1}
Lead	4.9×10^{-6}
GHG (CO_2 equivalent)	4.1×10^{3}[a]
HAP	1.8×10^{-2}

[a] All PTE estimates except NO_x and GHG assume the use of 100% natural gas. The PTE for NO_x and GHG is based on 100% tail gas, as a worst case assumption.

Federally Enforceable Limitations

No emission control device is currently employed in the design case (Davis et al. 2013) for mitigating these emissions from Area 500. The pre-heater could be subject to the boiler NESHAP, 40 CFR 63, if the biorefinery is a major source of HAP and if the pre-heater meets the applicability criteria (heat input capacity) in the rule. Because the pre-heater has a heat input capacity less than 10 MMBtu/hr (i.e., below the threshold for process heater to be subject to boiler NESHAP), the pre-heater in the sugars-to-HC biorefinery is not subject to the boiler NESHAP, 40 CFR 63. Given the small amount of uncontrolled PTE of emissions from the pre-heather, it will likely not make sense to install a control device to reduce emissions further.

4.2.6 *Area 600 – Wastewater Treatment Plant (WWTP)*

Maximum Capacity to Emit and Physical/Operational Limitations

Wastewater from Areas 200, 300, 500, and 800 will be sent to the wastewater treatment plant (WWTP) (Davis et al 2013). A portion of the VOCs and HAPs produced in these areas would be expected to be in the wastewater sent to the WWTP and likely would be released from the wastewater either as fugitive emissions (i.e., when wastewater is open to the atmosphere and/or wastewater vapors leak through sewers, drains, or other equipment in the WWTP), or vented from treatment process equipment. There could be other air pollutant emissions (e.g., NO_x) emitted from WWTP. However, sufficient information is not available in the design case (Davis et al. 2013) or from permits issued to similar biorefineries (e.g., ABBK) to determine exactly which air pollutants will be emitted.

Typically, a software program (e.g., INTERCEPTOR, TOXCHEM, or WATER9) is used to estimate air emissions associated with wastewater treatment. These software programs require facility-specific wastewater characteristics, contaminant properties, and the process design and operating information to estimate VOC/HAP emission rates. Because the facility-specific contaminant properties are not readily available from the design case (Davis et al. 2013), we estimate a preliminary uncontrolled PTE of VOC by assuming 0.1% of furfural (which is a VOC) in the wastewater will be emitted as fugitive emissions. Per the design case (Davis et al. 2013), the black liquor and flash condensate stream going into the WWTP has a furfural flow rate of 330 kg/hr and the stillage stream entering the WWTP has a furfural flow rate of 230 kg/hr. As a conservative estimate, we also assume a same amount of HAP (i.e., 0.1% of furfural) is emitted as fugitive emissions.

The WWTP consists of anaerobic and aerobic digestion, membrane filtration, reverse osmosis, evaporation, dewatering, and gravity belt thickening. The biogas (rich in CH4) from the anaerobic digester and sludge from both digesters will be sent to the boiler in Area 800 and be burned as a fuel. Estimation of uncontrolled PTE of GHG emissions along with other emissions as products of combustion in the boiler is taken into account in the calculations for Area 800.

Table 10 summarizes the preliminary estimates of uncontrolled PTE for VOC and HAP emissions from the WWTP in Area 600. Detailed calculations can be found in the Worksheet “Area 600 - WWTP” in Appendix I.

Table 10. Preliminary Estimates of Uncontrolled PTE of VOCs and HAPs from WWTP in Area 600

Pollutant	Uncontrolled PTE (tpy)
VOC	5.5
HAP	5.5

Federally Enforceable Limitations

The emissions from the wastewater streams likely would be subject to one of the NESHAP, either the MON (40 CFR 63, Subpart FFFF) or CMAS (40 CFR 63, Subpart VVVVVV), depending on whether the biorefinery is a major or area source of HAP. Therefore, the federally enforceable limitations in the rules could apply to the emissions from WWTP, depending on whether the emission streams meet certain applicability criteria. For more discussion, refer to Section 5.

4.2.7 *Area 700 – Storage and Loading Operations*

4.2.7.1 Storage Tanks

Maximum Capacity to Emit and Physical/Operational Limitations

Area 700 in the design case (Davis et al. 2013) includes tanks for storing the RDB product as well as process chemicals. Regulated air pollutants are expected to be emitted from the RDB storage tank, the H_2SO_4 storage tank, and the NH_3 storage tank. Because NH_3 emissions from the NH_3 storage tank are taken into consideration in Area 200, this subsection only addresses emissions from the RDB, H_2SO_4, and SO_2 storage tanks.

The EPA's TANKS emissions estimation software (version 4.09d) is used to estimate VOC emissions from the RDB storage tank (EPA 2006a). TANKS uses chemical, meteorological, roof fitting, and rim seal data to generate emissions estimates for several types of storage tanks, including: vertical and horizontal fixed roof tanks, internal and external floating roof tanks, domed external floating roof tanks and underground tanks (EPA 2006b). The emissions, referred to as standing losses, estimated by TANKS are caused by diurnal temperature changes, which in turn result in changes in the vapor pressure of the liquids. These emissions would be released through rim seal loss, deck fitting loss and deck seam loss. Emissions are also created due to tanks being filled with liquids. As new materials are added to a tank, saturated vapor from the headspace of the tank is forced out into the atmosphere. These emissions, estimated by TANKS, are referred to as working losses. A floating roof reduces the headspace in a tank, thereby reducing the emissions from working losses, as well as standing losses.

The composition of RDB is approximately 50% pentadecane and 50% hexadecane with a minimal amount of other components (Davis et al. 2013). To err on the conservative side, it is assumed that the fuel property of the RDB is similar to that of petroleum diesel product (Davis and McCormick 2014). The storage capacity of the RDB storage tank is 750,000 gallons for 7 days. Based on the total throughput of the biorefinery (31.3 MMgal/yr) and the storage tank's capacity, the turnovers (i.e., estimated number of times per year the tank is emptied and refilled) are estimated to be about 42 per year. As the emissions are also a function of location-specific meteorological data, we assume a sugars-to-HC biorefinery will be located in Dodge City, Kansas. We further assume that the storage tank is an internal floating roof tank with a diameter of 67 ft and a height of 30 ft. The true vapor pressure of RDB is assumed to be the same as that of No.2 diesel (0.011 psia or 0.08 kPa at 77 F based on the TANKS model, EPA 2006a).

To estimate uncontrolled PTE of HAP emissions from the RDB storage tank, we use the material safety data sheet for No.2 diesel (RTI International, 2011). The HAP emissions include napthalene, biphenyl, ethylbenzene, xylenes, cumene among others. The types of HAPs that are expected to be emitted need to be revised once the composition of the RDB is known.

SO_2 emissions from the SO_2 storage tank are not likely to be emitted because the tank is pressurized. A one ton SO_2 storage tank (Davis, 2014b) is expected to have fusible plugs, suggesting that there is no working and breathing losses associated with this type of storage tank (Hydro Instruments 2013).

The H_2SO_4 emissions from the sulfuric acid tank were calculated using the EPA's TANKS Emissions Estimation Software, Version 4.09d (EPA 2006a). Detailed equations and algorithms used by TANKS to calculate emissions are specified in AP-42 Chapter 7 (EPA 2006b). The sulfuric acid tank is assumed to be an internal floating roof tank with a diameter of 12 ft and a height of 15 ft. The storage tank has a design capacity of 12,600 gal and the annual throughput is 2.8 MMgal/yr. The vapor pressure for 93% sulfuric acid (Davis et al. 2013) is estimated at 3.1×10^{-5} psia at 77 F ("Material Safety Data Sheet" 2009).

Estimated uncontrolled PTE of HAPs, VOCs, and H_2SO_4 emissions is shown in Table 11.

4.2.7.2 Loading Operations

Maximum Capacity to Emit and Physical/Operational Limitations

Although the design case (Davis et al. 2013) does not specify product loading operations, the facility will need equipment for loading RDB into tank trucks or railcars, similar to other biofuel facilities (for example, refer to WLA Consulting 2011). Loading operations are expected to emit VOC and HAP emissions.

We estimated a VOC emission factor for truck and railroad loading by using Eq. 2 (AP-42 Chapter 5, EPA 1995b).

$$L = 12.46 * \frac{SPM}{T} \qquad \text{- Eq. 2}$$

Where:

L = loading loss (lb/kgal)
S = a saturation factor (see AP-42, Table 5.2-1)
P = true vapor pressure of the liquid loaded (psia)
M = molecular weight of vapors (lb/lb-mol)
T = temperature of the bulk liquid loaded (degree R = degree F + 460).

While the values for P, M, and T are identical regardless of the type of loading operations, the value for S varies depending on the type of service used (e.g., dedicated normal service, dedicated vapor balance service, clean cargo service) (Chapter 5, AP-42 EPA 1995b), and whether the loading operation uses a submerged or splash loading technique. Loading loss is calculated for six possible types of loading activity (i.e., submerged loading of a clean cargo tank, submerged loading of dedicated normal service, submerged loading of dedicated vapor balance service, splash loading of a clean cargo tank, splash loading of dedicated normal service, splash loading of dedicated vapor balance service); the splash loading of a clean cargo or dedicated normal service has the highest VOC emission factor (4.8×10^{-2} lb/kgal). To reflect the worst-case VOC emissions from loading operations, we used this highest VOC emission factor and the total throughput of the biorefinery (31.3 MMgal/yr) in the uncontrolled PTE calculation.

Following the same approach described in Section 4.2.7.1, we estimate HAP emissions from RDB loading based on the material safety data sheet for No.2 diesel fuel.

Table 11 summarizes the preliminary estimates of uncontrolled PTE for VOC, HAP, and H_2SO_4 emissions from tanks and loading operations in Area 700. Detailed calculations can be found in the Worksheets "Area 700 - Tanks" and "Area 700 - Loading Operations" in Appendix I.

Table 11. Preliminary Estimates of Uncontrolled PTE of VOC, H_2SO_4, and HAP from Storage Tanks and Loading Operations in Area 700

Pollutant	Uncontrolled PTE from storage tanks (tpy)	Uncontrolled PTE from loading operations (tpy)	Total for Area 700
VOC	6.2×10^{-2}	7.5×10^{-1}	8.1×10^{-1}
H_2SO_4	3.5×10^{-5}	Not applicable	3.5×10^{-5}
HAP	5.4×10^{-4}	6.6×10^{-3}	7.2×10^{-3}

Federally Enforceable Limitations

Storage tanks could be subject to control under one of the NESHAP, the MON (40 CFR 63, Subpart FFFF) or CMAS (40 CFR 63, Subpart VVVVVV) depending on whether the facility is a major or area source of HAP and whether the storage tanks meet the applicability criteria (e.g., size and true vapor pressure). If the sugars-to-HC biorefinery is a major source of HAPs, the loading operations could be subject to control under the MON depending on whether the loading operations meet applicability criteria. For more discussion, refer to Section 5.

4.2.8 Area 800 – Combustor, Boiler, and Turbogenerator

Maximum Capacity to Emit and Physical/Operational Limitations

The biorefinery includes a boiler (M-803) that burns lignin from Area 200, exhaust from the hydrotreater in Area 500, biogas from the anaerobic digester at the WWTP in Area 600, and sludge from digesters at the WWTP in Area 600 (Davis et al. 2013). The boiler is expected to have a heat input of 805 MMBtu/hr.

The boiler will emit products of combustion, including PM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, CO_2, VOCs and HAPs, and residual VOCs and HAPs not completely combusted. Because the fuel that is burned in the boiler is unique in terms of fuel properties and compositions, emissions factors are not readily available from existing literature or guidance. After reviewing AP-42 for wood residue combustion in boiler (EPA 2003b), the EPA's emissions database for boilers and process heaters (EPA 2012), Aspen model inputs and outputs, air regulations (NSPS and NESHAP) applicable to the boiler and consulting NREL's biorefinery design team, we identified emissions factors that most closely match the properties of the fuel burned in the boiler. Because no exact emissions factors are directly applicable to the boiler feed used in the design case (Davis et al. 2013), stack testing will likely be required in the air permit to validate site-specific emissions factors once the biorefinery is operating. All emissions factors, along with data sources, used in the PTE calculation for criteria air pollutants, GHGs, HAP, H_2SO_4 mist, NH_3 from the boiler are documented and presented in Worksheet "Area 800 - Boiler (Comb. Emis.)" in Appendix I.

In addition to the emissions related to the fuel combustion, there are non-combustion related CO_2 emissions originating from other sources such as the hydrotreater in Area 500. The non-combustion-related CO_2 emissions are considered in the emission estimates based on the design case and Aspen model outputs (Davis et al. 2013).

Table 12 summarizes the preliminary estimates of uncontrolled PTE of criteria air pollutant emissions, GHG, HAP, H_2SO_4 mist, NH_3 emissions from the boiler in Area 800. Detailed calculations of combustion related emissions and non-combustion related CO_2 emissions can be found in the Worksheets "Area 800 - Boiler (Comb. Emis.)" and "Area 800 - Boiler (CO_2 Process)", respectively, in Appendix I.

Table 12. Preliminary Estimates of Uncontrolled PTE of Criteria air Pollutants, GHGs, HAPs, H_2SO_4 mist, and NH_3 from the Boiler in Area 800

Pollutant	Uncontrolled PTE (tpy)
PM (filterable)	2.0×10^3
PM_{10}	1.8×10^3
$PM_{2.5}$	1.6×10^3
SO_2	1.4×10^3
NO_x	7.8×10^2
CO	2.1×10^3
VOC	6.0×10^1
Lead	1.7×10^{-1}
GHG (CO_2 equivalent)	1.5×10^6
HAP (total) [a]	3.1×10^2
H_2SO_4 mist	1.4×10^1
NH_3	1.5×10^{-1}

[a] Refer to Worksheets "Area 800- Boiler (Comb. Emis.)" for PTE of each individual HAPs expected to be emitted from the boiler.

Federally Enforceable Limitations

In the design case (Davis et al. 2013), the boiler is equipped with 1) a baghouse to control PM emissions, 2) flue gas desulfurization (FGD) to control SO_2 emissions, and 3) selective non-catalytic reduction (SNCR) and overfire air (OFA) system to reduce NO_x emissions. The boiler would be subject to the boiler NSPS, which provides emissions limits on certain air pollutants (e.g., SO_2, filterable PM) depending on the types of fuels and other criteria. The boiler could also be subject to one of the boiler NESHAP, either Subpart DDDDD or Subpart JJJJJJ of 40 CFR 63, depending on whether the biorefinery is a major or area source of HAP. Emissions limits in these rules likely will require the emissions of HAP to be reduced. Given the magnitude of the uncontrolled PTE from the Area 800 boiler as shown in Table 12, emission reductions will be necessary to meet the applicable regulations, BACT requirements under PSD, or as requested by the biorefinery to avoid applicability of one or more of these rules, especially considering that there is already a plan to include the baghouse, FGD, and SNCR and OFA systems. The permitting strategy is discussed in more detail in Section 5.

4.2.9 *Area 900 – Utilities*

Maximum Capacity to Emit and Physical/Operational Limitations

Utility equipment such as emergency generator, emergency fire pump, and cooling tower, is expected to emit regulated pollutants. While the design case does not include any emergency equipment (Davis et al. 2013), it is common for a facility such as a biorefinery to have a fire pump and/or an emergency generator that is equipped with an internal combustion engine.

We assume that the biorefinery will have an emergency generator, which has an internal combustion the engine rated at 300hp. The combustion products, which could be emitted, include PM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, CO_2, and residual VOCs and HAPs. It is also assumed that the engine is not equipped with any air emission controls. Based on the EPA's guidance, uncontrolled PTE of air pollutants is estimated based on an average usage of 500 hrs/yr for which an emergency generator could be expected to operate under the worst case scenario (EPA 1995a). Emissions factors for criteria air pollutants, HAPs, and GHG emissions are derived from several sources, including Standards of Performance for Stationary Compression Ignition Internal Combustion Engines,[36] emissions factors from AP-42 (Chapter 3, EPA 1996), and the Mandatory Greenhouse Gas Reporting Rule. Data used for calculating emissions can be found in Worksheet "Area 900 -Emergency Generator" in Appendix I.

The design case (Davis et al. 2013) does not specify an emergency fire pump. It is assumed that the emergency fire pump will be identical to that in the design case for a cellulosic ethanol facility per Humbird et al. (2011). The fire pump in Humbird et al. (2011) is rated at 125 hp, and uses diesel fuel during operation. Similar to the emergency generator, the fire pump is expected to emit criteria air pollutants, HAPs, and GHG emissions. Based on the EPA's guidance (EPA 1995a), PTE of air pollutants are estimated based on an average usage of 500 hours/year that an emergency fire pump could be expected to operate under the worst case scenario. Data sources for all emissions factors are identical to those used to estimate PTE for the emergency generator. Emissions factors, along with data sources, can be found in the Worksheet "Area 900 - Emergency Fire Pump" in Appendix I.

A cooling tower is included in the design case (Davis et al. 2013) to handle chilled water and process water. The water that will be used in the biorefinery includes fresh water mixed with treated recycled water. Because the cooling tower provides direct contact between the cooling water and the air passing through the tower, some of the liquid water may be entrained in the air stream and carried out of the tower as drift droplets (EPA 1995b). The particulate matter constituent of the drift droplets may be classified as an air emission. Because the drift droplets generally contain the same chemical impurities as the water circulating through the tower, there purities can be converted to air emissions (EPA 1995b).

The cooling tower is capable of handling 44,000 gallons per minute (gpm) of water (Davis et al. 2013). We assume that the cooling tower is similar to the one used by ABBK, which is equipped with high efficiency drift eliminator (physically integral to the cooling tower). The drift loss of circulating water (ηDrift) is 0.0005% (i.e., 0.0005% of water is lost in the form of mist carried

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[36] Manufacturers of Internal Combustion engines must produce engines that meet the requirements of 40 CFR 60, Subpart IIII; therefore, the regulatory emission rate standards in the rule should reflect how newly purchased engines perform.

out of the tower by an air drift), and that the concentration of total dissolved solids in circulating water is 1,575 ppm (by weight), both of these assumptions are based on ABBK's air permit application (Kansas Department of Health and Environment 2011; WLA 2011). The PM emission factor (EFPM) from the cooling tower is estimated using Eq 3 (AP-42 Chapter 13, EPA 1995b). PM10 and PM2.5 emissions factors are estimated to be 70% and 42%, respectively, of PM emissions based on the methodology developed by South Coast Air Quality Management District (2006a).

$$EF_{PM} = \frac{TDS * \eta_{Drift} * \rho_{H2O}}{1000} \qquad \text{- Eq. 3}$$

Where:

EF_{PM} = Emission factor for total PM (lb/kgal)
TDS = Concentration of total dissolved solids in circulating water (ppm by weight)
η_{Drift} = Drift loss of circulating water (%)
ρ_{H2O} = Water density (lb/gal)

Due to potential leaks in the process that can come in contact with the cooling water through cooling tower heat exchange systems, VOCs and HAPs are expected to be emitted from the cooling tower. Although the sugars-to-HC biorefinery is not a petroleum refinery, the South Coast Air Quality Management District (2006b) provides guidance which treats VOC emissions from cooling towers at chemical manufacturing facilities the same as those from petroleum refineries. As such, we use the default emission factor (6 lb/MMgal of cooling water) for uncontrolled VOCs from cooling towers in petroleum refineries provided in AP-42 (Chapter 5, EPA 1995b) to estimate the uncontrolled PTE of VOC for the sugars-to-HC biorefinery. We further assume 50% of VOC emissions are HAPs; there is not sufficient information available from the design case (Davis et al. 2013) to determine the speciated HAPs emitted from the cooling tower.

Table 13 summarizes the preliminary estimates of uncontrolled PTE of criteria air pollutants and HAP emissions from the emergency generator, emergency fire pump, and cooling tower in Area 900. Detailed calculations of emissions from emergency generator, emergency fire pump, and cooling tower can be found in the Worksheets "Area 900 - Emergency Generator", "Area 900 - Emergency Fire Pump", and "Area 900 - Cooling Tower", respectively, in Appendix I.

Table 13. Preliminary Estimates of Uncontrolled PTE of Criteria Air Pollutants, GHGs, and HAP Emissions from Area 900

Pollutant	Uncontrolled PTE (tpy)			
	Emergency generator	Emergency fire pump	Cooling tower	Subtotal for Area 900
PM	2.5×10^{-2}	1.5×10^{-2}	7.6×10^{-1}	8.0×10^{-1}
PM_{10}	2.5×10^{-2}	1.5×10^{-2}	5.3×10^{-1}	5.7×10^{-1}
$PM_{2.5}$	2.5×10^{-2}	1.5×10^{-2}	3.2×10^{-1}	3.6×10^{-1}
SO_2	8.2×10^{-4}	3.4×10^{-4}	Not applicable	1.2×10^{-3}
NO_x	5.0×10^{-1}	2.1×10^{-1}	Not applicable	7.1×10^{-1}
CO	4.3×10^{-1}	2.5×10^{-1}	Not applicable	6.8×10^{-1}
VOC	5.0×10^{-1}	2.1×10^{-1}	6.9×10^{1}	7.0×10^{1}
GHG (CO_2 equivalent)	8.7×10^{1}	3.6×10^{1}	Not applicable	1.2×10^{2}
HAP	2.1×10^{-3}	8.5×10^{-4}	3.5×10^{1}	3.5×10^{1}

Federally Enforceable Limitations

The HAP emissions from the cooling tower likely would be subject to one of the NESHAP, either the MON (40 CFR 63, Subpart FFFF) or CMAS (40 CFR 63, Subpart VVVVVV), depending on whether the facility is a major or area source of HAP and whether the cooling tower meets specific applicability criteria (if any). The permitting strategy for HAPs is further discussed in Section 5.

The emergency generator and fire pump likely would be subject to the NSPS (40 CFR 60, Subpart IIII) and/or the NESHAP (40 CFR 63, Subpart ZZZZ) for engines, depending on the size and type. The emergency generator and fire pump in a new sugars-to-HC biorefinery are expected to meet the emission limits and work practice standards in the NSPS and/or NESHAP if they meet the applicability criteria specified in the rules.

4.2.10 *Emissions from Leaking Equipment*

Maximum Capacity to Emit and Physical/Operational Limitations

VOCs and HAPs could be released to the atmosphere as fugitive emissions through leaking equipment located in Areas 200, 300, 400, 500, and 600 of the design plant. These VOC and HAP emissions factors are estimated using the EPA's Protocol for Leak Emission Estimates published (1995d). The EPA's approach requires a count of equipment by type (e.g., valves, pumps, connectors). Because the design case (Davis et al. 2013) is a feasibility-level analysis rather than an actual engineering design for a specific facility, we are unable to develop a detailed inventory of each type of equipment. Instead, the component count is estimated based on counts obtained from ABBK's air permit application (Kansas Department of Health and Environment 2011; WLA 2011), and a scaling ratio of the design biorefinery's capacity to ABBK's capacity. For a preliminary conservative estimate, we assume 50% of VOC emissions are emitted as HAP. No details on speciation are available.

Table 14 summarizes preliminary estimates of uncontrolled PTE of VOC and HAP emissions from equipment leads in Areas 200, 300, 400, 500, and 600. Detailed calculations of emissions for each type of equipment can be found in the "Equipment Leaks" worksheets in Appendix I.

Table 14. Preliminary Estimates of Uncontrolled PTE of VOC and HAP emissions from equipment leaks in Areas 200, 300, 400, 500, and 600

Pollutant	Uncontrolled PTE (tpy)
VOC	1.5×10^1
HAP	7.6

Federally Enforceable Limitations

If the sugars-to-HC biorefinery is a major source of HAPs, the HAP emissions from leaking equipment likely would be subject to control under the MON (40 CFR 63, Subpart FFFF). In this case, federally enforceable limitations would apply to emissions from equipment leaking, which would make the PTE lower than the uncontrolled emissions. The permitting strategy for VOC and HAP emissions is discussed in more detail in Section 5.

4.2.11 *Emissions from Truck Traffic*

Maximum Capacity to Emit and Physical/Operational Limitations

Truck traffic for the delivery of feedstock and other raw materials, the removal of waste from the site, and the transfer of products offsite is expected to generate fugitive PM, PM_{10}, and $PM_{2.5}$ emissions from road dust. Internal combustion engine exhaust from trucks is not regulated in stationary source regulations and permits, and therefore, is not included in the PTE estimation.

Without site-specific information in the design case (Davis et al. 2013), we assume that half of the throughput of biomass received, RDB product, and chemicals and supplies are hauled on unpaved roads and the other half on paved roads. Emissions factors for PM, PM_{10} and $PM_{2.5}$ on paved and unpaved roads are calculated based on Eqs 4 and 5, respectively, based on methodologies developed by the EPA (2011b and 2006c).

$$E_{paved\_road} = k * (sL)^{0.91} * (W)^{1.02} * \left(1 - \frac{P}{(4*365)}\right) \qquad \text{- Eq. 4}$$

Where:

E_{paved_road} = Annual emissions from paved roads per vehicle mile travelled (lb/vehicle mile traveled)
k = Particle size multiplier for specific particle size range in lb/vehicle mile travelled (0.011 for PM, 0.0022 for PM_{10} and 0.00054 for $PM_{2.5}$)
sL = Road surface silt loading (g/m^2)
W = Average weight of the vehicles traveling the roads (tons)
P = Number of days with at least 0.01 inch of precipitation (days/yr) (default = 90)

$$E_{unpaved\_road} = k * \left(\frac{sC}{12}\right)^{a} * \left(\frac{W}{3}\right)^{b} * \left(1 - \frac{P}{365}\right) \qquad \text{- Eq. 5}$$

Where:

$E_{unpaved\_road}$ = Annual emissions from unpaved roads per vehicle mile travelled (lb/vehicle mile traveled)

k, a, b = constants (varying by specific particle size range, see Table 13.2.2-2 for Industrial Roads in EPA 2006b)
sC = silt content of unpaved road surface (%)
W = average weight of the vehicles traveling the roads (tons)
P = Number of days with at least 0.01 inch of precipitation (days/yr) (default = 90)

The annual feedstock requirement is 720,000 dry tons (or 900,000 tons including moisture). In order to satisfy the production and storage requirements, the refinery biomass receiving must operate 24 hours per day, six days per week (i.e., 7,488 hr/yr), and receive 12 trucks of biomass per hour (Davis et al. 2013). On an annual basis, it is assumed that half of the biomass is hauled on paved road and the other half on unpaved road. The maximum throughput of RDB is estimated to be 100,000 tons. The estimate of maximum throughput for chemicals and supplies is based on the consumption of various chemicals and supplies in the design case (Davis et al. 2013). The distance traveled (per year) is estimated based on maximum throughput and average truck capacity for biomass feedstock, the RDB product, and chemicals and supplies. We further assume a round trip length of 1,300 feet within the facility boundary for each truck delivery. PTE of PM, PM_{10} and $PM_{2.5}$ generated from truck traffic is calculated by multiplying the emission factors (estimated from eqs 4 and 5) and vehicle miles travelled at the biorefinery. Details can be found in the Worksheet "Truck Traffic" in Appendix I. Table 15 summarizes the preliminary estimates of uncontrolled PTE for PM, PM_{10} and $PM_{2.5}$ emissions from truck traffic for the entire biorefinery. Detailed calculations for each pollutant can be found in the Worksheets "Truck Traffic" in Appendix I.

Table 15. Preliminary Estimates of Uncontrolled PTE of PM, PM_{10}, and $PM_{2.5}$ from Truck Traffic

Pollutant	Uncontrolled PTE (tpy)
PM	6.2×10^1
PM_{10}	1.7×10^1
$PM_{2.5}$	2.1

Federally Enforceable Limitations

There are no currently-known federal regulations that would apply to the fugitive dust emissions from the vehicle traffic. However, if reduction in emissions of PM, PM_{10}, and $PM_{2.5}$ were desirable, dust suppression techniques could be used to reduce emissions and federally enforceable limitations on these fugitive dust emissions could be requested to be included in the permit. The request for federally enforceable limitations should be made after considering all emitting sources at the facility. The permitting strategy for PM, PM_{10}, and $PM_{2.5}$ is discussed in Section 5.

5 Results of Facility-Wide PTE of Regulated Air Pollutants and Discussion of Implications and Limitations

5.1 Preliminary Estimates of Facility-Wide Uncontrolled PTE of Regulated Air Pollutant Emissions

Table 16 summarizes preliminary estimates of facility-wide uncontrolled PTE for all regulated air pollutants potentially emitted from the entire biorefinery, including criteria air pollutants and their precursors, HAP emissions, GHG emissions (in CO_2 equivalent), NH_3, and H_2SO_4 mist. Detailed facility-wide uncontrolled PTE estimates on criteria air pollutants and GHG emissions can be found in Worksheet “PTE Summary (criteria and GHG)” and estimates on HAPs (including individual HAP when available) in Worksheet “ Uncontrolled PTE Summary (HAP)” in Appendix I.

Table 16. Preliminary Estimates of Facility-wide Uncontrolled PTE of Criteria air Pollutants (and precursors), HAPs, GHGs, NH_3, and H_2SO_4 Emissions from the Design Biorefinery (tpy)

Process	PM[a]	PM_{10}[a]	$PM_{2.5}$[a]	VOC	NO_x	CO	Lead	SO_2	H_2SO_4 mist	NH_3	HAP	GHG (CO_2 eq.)
Feedstock handling (Area 100)	7.7×10^{2}	7.7×10^{2}	1.3×10^{2}									
Pretreatment and conditioning (Area 200)				2.3×10^{1}					7.8	1.1×10^{-1}		
Enzymatic hydrolysis, conditioning and bioconversion (Area 300)				1.8×10^{3}							1.8×10^{2}	1.8×10^{5}
Enzyme production (Area 400)								8.2×10^{-1}		1.9		1.2×10^{4}
Pre-heater (Area 500)	$1.9\ \text{x}10^{-2}$	$7.4\ \text{x}10^{-2}$	$7.4\ \text{x}10^{-2}$	$5.4\ \text{x}10^{-2}$	1.6	$3.9\ \text{x}10^{-1}$	$4.9\text{x}10^{-6}$	$5.9\ \text{x}10^{-3}$			$1.8\ \text{x}10^{-2}$	4.1×10^{3}
WWTP (Area 600)				5.5							5.5	
Storage tanks and loading operations (Area 700)				$8.1\ \text{x}10^{-1}$					3.5×10^{-5}		7.2×10^{-3}	
Boiler (Area 800)	2.0×10^{3}	1.8×10^{3}	1.6×10^{3}	6.0×10^{1}	7.8×10^{2}	2.1×10^{3}	1.7×10^{-1}	1.4×10^{3}	1.4×10^{1}	$1.5\ \text{x}10^{-1}$	3.1×10^{2}	1.5×10^{6}
Emergency generator (Area 900)	$2.5\text{x}10^{-2}$	$2.5\text{x}10^{-2}$	$2.5\text{x}10^{-2}$	$5.0\text{x}10^{-1}$	$5.0\text{x}10^{-1}$	$4.3\text{x}10^{-1}$		8.2×10^{-4}			$2.1\ \text{x}10^{-3}$	8.7×10^{1}
Emergency fire pump (Area 900)	$1.5\text{x}10^{-2}$	$1.5\text{x}10^{-2}$	$1.5\text{x}10^{-2}$	$2.1\text{x}10^{-1}$	$2.1\text{x}10^{-1}$	$2.5\text{x}10^{-1}$		3.4×10^{-4}			8.5×10^{-4}	3.6×10^{1}
Cooling tower (Area 900)	$7.6\text{x}10^{-1}$	$5.3\text{x}10^{-1}$	$3.2\text{x}10^{-1}$	6.9×10^{1}							3.5×10^{1}	
Equipment leaks (Areas 200, 300, 400, 500, and 600)				1.5×10^{1}							7.6	
Truck traffic	6.2×10^{1}	1.7×10^{1}	2.1									

Process	PM[a]	PM_{10}[a]	$PM_{2.5}$[a]	VOC	NO_x	CO	Lead	SO_2	H_2SO_4 mist	NH_3	HAP	GHG (CO_2 eq.)
Facility-wide total [b]	2.8×10^3	2.6×10^3	1.7×10^3	2.0×10^3	7.8×10^2	2.1×10^3	$1.7x10^{-1}$	1.4×10^3	2.2×10^1	2.2	5.3×10^2 (All HAP) 2.4×10^2 (Single largest HAP – HCl)	1.7×10^6
Major Source for NSR and Title V	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	2.5×10^1[c] (All HAP) 1.0×10^1 (Any single HAP)	NA[d]
PSD Significance Emission Rate (SER)	2.5×10^1	1.5×10^1	1.0×10^1	4.0×10^1	4.0×10^1	1.0×10^2	6.0×10^{-1}	4.0×10^1	7	NA[c]	NA[c]	Pending[e]

[a] PM is regulated as filterable PM, while PM_{10} and $PM_{2.5}$ are regulated as the total of filterable PM in the size fraction (i.e., PM_{10} or $PM_{2.5}$) and condensable PM. Specifically, PM is regulated as measured using EPA Method 5, which only measures filterable PM. PM_{10} and $PM_{2.5}$ are regulated as measured using EPA Method 201A, which measures the filterable PM at the size fraction, and Method 202, which measures condensable PM. All condensable PM is included in the $PM_{2.5}$ and PM_{10} size fractions.

[b] Due to rounding and the use of two significant digits, numbers may not add up.

[c] Not subject to NSR, although HAP that are also VOC are included in the VOC total and are considered when determining the applicability of PSD review for VOC.

[d] GHGs alone do not determine applicability of Title V or NSR.

[e] Currently the PSD significance level for GHG is not defined. For pollutants with no significance level, any amount of emissions is considered significant. The EPA is expected to publish a significance level in the future. In the meantime, some states are using 75,000 tpy of carbon dioxide equivalents as PSD significant level.

Because the sugars-to-HC biorefinery examined (as described in Davis et al.2013) is a chemical production facility, which is one of the 28 listed source categories (see Appendix C), fugitive emissions are included in the facility-wide uncontrolled PTE estimation (refer to Section 4.1.4). While efforts are made to estimate speciated HAP emissions for the pre-heater, boiler, RDB storage tank, loading operations, emergency generator, and emergency fire pump when possible, sufficient information is not readily available from the design case (Davis et al. 2013) to estimate speciated HAPs for other HAP emitting sources, including enzymatic hydrolysis and bioconversion, WWTP, cooling tower, and equipment leaks.

The uncontrolled PTE for several criteria air pollutants [i.e., CO, NO_x, PM, SO_2, VOC (ozone precursor)], as currently estimated, suggests that the biorefinery would exceed the 100 tpy NSR major source threshold if the biorefinery is to be located in an attainment area. (The NNSR major source thresholds could be lower depending on the nonattainment classifications, see Appendix E). If an actual sugars-to-HC biorefinery seeking an air permit had PTE of the regulated air pollutants at the same levels as the estimated uncontrolled PTE, the biorefinery then would be required to conduct a PSD review for each pollutant, which has PTE equal to or greater than the SER (see Table 16) for the pollutant. For example, the PSD significance threshold for sulfuric acid mist is 7 tpy. If the facility's PTE for sulfuric acid mist is 22 tpy, a PSD review then would be required for sulfuric acid mist. For the sugars-to-HC biorefinery, the uncontrolled PTE level suggests that PSD review would be required for CO, NO_x, PM, SO_2, VOCs, GHGs,[37] and H_2SO_4 (because at least one of the non-GHG pollutants exceeds 100 tpy and the other pollutants either exceed 100 tpy or exceed the SER). In addition, the biorefinery would be required to apply for a Title V operating permit if it is determined to be a major source under NSR. Furthermore, the estimated uncontrolled PTE of HAP suggests that the biorefinery exceeds the 25 tpy major source threshold for the sum of HAP and the 10 tpy major source threshold for several individual HAPs (e.g., hydrogen chloride [HCl], formaldehyde). Refer to Uncontrolled PTE Summary (HAP) in Appendix I.

However, the types of permits required under the NSR and Title V programs are determined based on the PTE rather than the uncontrolled PTE. Federally enforceable limitations will apply to this source and can be taken into account in determining PTE and permitting requirements. As discussed in Sections 3 and 4, the biorefinery will likely be subject to several NESHAPs and NSPS. These regulations provide federally enforceable limitations that will reduce the uncontrolled PTE. Also, the biorefinery can request federally enforceable limits to be included in the permit to reduce the uncontrolled PTE.

In developing the permitting strategy, a facility would prefer to be a minor source under NSR and Title V. If it is not possible to be a minor source, the facility would like the PTE to be less than the SER for as many pollutants as possible because the facility then can avoid conducting a PSD analysis for a regulated pollutant if the PTE of the pollutant is lower than the SER.

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[37] In July 2011, the EPA deferred biogenic CO_2 emissions from permitting requirements for three years in order to develop an accounting framework for biogenic CO_2 emissions (EPA 2011a). The final rule on biogenic CO_2 accounting is still pending; it is unclear whether and how the CO_2 emissions from biogenic sources will be counted towards permit applicability in the future. However, the deferral expired July 21, 2014 pursuant to 40 CFR 65.166(b)(48)(ii)(*a*) and without the accounting framework, it must be assumed that biogenic CO_2 sources must be counted in the same way anthropogenic CO_2 is counted. This may change in the future when an accounting framework is published.

Based on the discussion in Section 3, the regulations that are likely to apply to the sugars-to-HC biorefinery are summarized in Table 17. The boiler NSPS and NESHAP could provide emission limits to reduce uncontrolled PTE of SO_2, NO_x, PM, and HAP emissions if the boiler meets applicability criteria in these rules. The chemical manufacturing NESHAP could reduce emissions of HAPs from several emission sources at the facility (e.g., equipment leak, cooling tower, storage tank) if the specific emission sources meet certain applicability criteria. The NSPS and NESHAPs that could apply to the fire pump and emergency generator depending on the size of these units may provide federally enforceable limitations that reduce the PM, VOC, NO_x and HAP emissions from the emergency equipment. It is assumed that the fire pump and emergency generator purchased by a new biorefinery will meet the NSPS and NESHAP if applicable.

Table 17. Federal Air Regulations Potentially Applicable to the Sugars-to-HC Biorefinery

Plant Area	Affected Sources	Federal Rule	Target Pollutant(s)
Area 800	Boiler	NSPS - 40 CFR 60, Subpart Db	SO_2, PM, and NO_x
		If the sugars-to-HC biorefinery is a major source of HAP, the boiler would be subject to boiler NESHAP - 40 CFR Part 63, Subpart DDDDD.	HAPs
Areas 200 through 900	Emission Release Points: Process vents, equipment leaks, storage tanks, wastewater, heat exchange system (including cooling tower)	If the sugars-to-HC biorefinery is a major source of HAPs, the affected sources at the biorefinery would be subject to NESHAP - 40 CFR Part 63, Subpart FFFF (MON).	HAPs
Area 900	Fire pump and emergency generator	Depending on the size and design, the fire pump and emergency generator may be subject to Subpart IIII.	PM, VOCs, NO_x
Area 900	Fire pump and emergency generator	Depending on the size and design, the fire pump and emergency generator may be subject to Subpart ZZZZ.	HAPs

5.2 Development of Preliminary PTE

5.2.1 *PTE of Hazardous Air Pollutants (HAPs)*

The uncontrolled PTE of HAPs is estimated at 530 tpy from the entire sugars-to-HC biorefinery; the boiler (Area 800) is the largest emitting source accounting for 310 tpy, followed by the enzymatic hydrolysis and bioconversion (in Area 300), which is estimated to emit 180 tpy (refer to Table 18). Due to a lack of detailed information in the design case (Davis et al. 2013), the HAP species are only available for the pre-heater (Area 500), RDB storage tank and loading operations (Area 700), and the boiler, emergency fire pump, and emergency generator (Area 900). HCl with an uncontrolled PTE of 240 tpy (from the boiler) is estimated to be the single largest HAP among all known HAP species.

When PTE of total HAPs is greater than 25 tpy or PTE of any individual HAP greater than 10 tpy, the source would be considered a major source of HAPs and would be required to have a

Title V permit. HAP emissions are not subject to NSR permitting requirements (unless the HAP is lead, which is also a criteria pollutant, or an organic HAP that is also a VOC). The estimated uncontrolled PTE for total HAP or individual HAP from the entire biorefinery indicates the sugars-to-HC biorefinery would be subject to the major source NESHAP for chemical manufacturing (40 CFR 63, Subpart FFFF, or MON) and boilers (40 CFR 63, Subpart DDDDD). If a source elects to avoid being a major source of HAPs, the PTE of HAPs would need to be reduced to less than 25 tpy for total HAP and less than 10 tpy for any individual HAP.

The boiler major source NESHAP (40 CFR 63, Subpart DDDDD) limits HCl to 0.022 lb/MMBtu of heat input. The HCl limit is meant to be a surrogate for all acid gas emissions from the boiler. HCl and hydrogen fluoride (HF) are the only two acid gases expected to be emitted from the boiler. The acid gas emissions reduction can be achieved by a flue gas desulfurization (FGD) system. The design case (Davis et al. 2013) has included a flue gas desulfurization (FGD) system for the boiler, which can effectively mitigate HCl and HF emissions. Assuming the FGD can achieve about 98% reduction in HCl emissions and 88% reduction in HF emissions based on Staudt (2011), the emission rate can be reduced to 0.0015 and 0.00013 lb/MMBtu, respectively, for HCl and HF (i.e., below the NESHAP limit of 0.022 lb/MMBtu). This would lead to a PTE of 5.2 tpy for HCl and 0.47 tpy for HF from the boiler. For these values to be considered the PTE for the boiler, limits must be included in a permit to make them federally enforceable. No other emission control in the design case (Davis et al. 2013) or emission limits in this rule can reduce PTE of HAPs other than acid gas emissions from the boiler. Therefore, the PTE is identical to uncontrolled PTE for all HAPs other than HCl and HF from the boiler at the biorefinery.

The boiler major source NESHAP (40 CFR 63, Subpart DDDDD) could apply to the pre-heater if the biorefinery is a major source of HAPs. However, to be subject to the emission limits in this rule, the pre-heater needs to have a heat input capacity of 10 MMBtu/hr or greater. Because the heat input capacity of the pre-heater in the design case is 2.3MMBtu/hr (Davis et al. 2013), the emission limits in the boiler major source NESHAP are not expected to be applicable to the pre-heater. As such, the controlled PTE of HAPs is expected to be identical as the uncontrolled PTE for the pre-heater.

Process vents could be subject to the control requirements of the MON (40 CFR 63, Subpart FFFF). However, the specific control requirements (which would reduce the HAP emissions) depend on the specifications of the emission units and the applicability criteria. For example, Subpart FFFF control requirements are only applicable to specific process vents that meet certain flow rate and/or HAP concentration thresholds. Given the size of the uncontrolled HAP emissions from the enzymatic hydrolysis, conditioning, and bioconversion area (180 tpy or 360,000 lb/year), these emissions likely would be subject to control requirements of the MON. (MON requires a 98% reduction if the uncontrolled HAP emissions exceed 3,000 lb/yr for batch process vents.) A 98% reduction in HAP emissions could result in a PTE of 3.6 tpy from the enzymatic hydrolysis, conditioning, and bioconversion area. In order to achieve the reduction, emission controls will need to be installed at the biorefinery.

The MON has leak detection and repair requirements (LDAR) that reduce emissions from leaking equipment. The LDAR requirements reduce emissions based on the number of equipment components (e.g., valves, connectors, pumps) subject to monitoring. Based on the EPA's protocol for equipment leak emissions estimates (EPA 1995c), the equipment leak HAP emissions from the biorefinery could be reduced from 7.6 tpy to 1.2 tpy if the biorefinery is in compliance with a monthly LDAR program.

The MON has cooling tower requirements for HAP that require the source to test the cooling tower water and repair any leaks that are indicated by higher concentrations of HAP in the water. Through minimizing leaks into the cooling water system, VOCs are also expected to be reduced by about 88% (from 6 to 0.7 lb VOC/MMgal of cooling water; refer to Section4.2.9). Because HAPs at the biorefinery are assumed to be 50% of VOCs, the leak monitoring practice could reduce the PTE of HAPs to 4.1 tpy from the cooling tower.

The MON also applies to wastewater treatment, but additional information on HAP concentration and specific stream characteristics are necessary to determine whether this rule would apply and thus limit emissions of HAP from the wastewater operations. Because of the lack of specific information to determine applicability, we assume there is no emission control to reduce HAPs from the WWTP.

The MON also applies to storage tanks. However, because the maximum true vapor pressure of the RDB storage tank is about 0.08 kPa (see Section 4.2.7.1), the storage tank in the sugars-to-HC biorefinery does not meet the applicability criteria of the emission limit in the MON, which applies to storage tanks with a maximum true vapor pressure of HAP equal to or greater than 0.69 kPa.

Depending on the size and design, the fire pump and emergency generator may be subject to the internal combustion engine NSPS (Subpart IIII) and NESHAP (Subpart ZZZZ). It is expected that the fire pump and emergency generator installed in a new sugars-to-HC biorefinery will meet the requirements in this rule. The emission limits specified in engine NSPS (Subpart IIII) are taken into account in calculating PTE for the emergency equipment (fire pump and generator). Although there are work practice standards in the engine NESHAP potentially applicable to the emergency equipment, no specific emission limits in this rule, which apply to the fire pump and generator at the biorefinery.

Based on the discussion above, HAP reductions are taken into account for four emitting sources, i.e., 1) boiler due to the boiler major source NESHAP requirement, 2) the enzymatic hydrolysis, conditioning, and bioconversion (Area 300) due to MON requirements, 3) equipment leaks due to compliance with a LDAR program required by MON, and 4) cooling tower due to leak monitoring and repair requirements in MON. The possible PTE of HAPs, then, would be reduced to 84 tpy for the entire biorefinery (Table 18). The applicable regulations could require further reductions to this value; however, more information is needed to determine any specific reductions. In addition, design changes could be made (before the construction of the biorefinery) to reduce the PTE of HAP emissions to less than the major source threshold of 25 tpy and then the MON NESHAP would not apply (and the CMAS NESHAP would likely apply instead). It should be noted that several of the HAP emission estimates (e.g., for the WWTP) are based on very limited information and using very conservative assumptions. Additional refinement of the HAP estimates could result in a lower PTE.

Table 18. Uncontrolled PTE and Possible PTE for HAPs

Process	Uncontrolled HAP PTE (tpy)	Possible HAP PTE (tpy)
Enzymatic Hydrolysis and Bioconversion (Area 300)	1.8×10^2	3.6
Boiler (Area 800)	3.1×10^2	7.0×10^1
Equipment Leaks (Areas 200 – 600)	7.6	1.2
WWTP (Area 600)	5.5	5.5
Cooling Tower (Area 900)	3.5×10^1	4.1
Others (pre-heater, storage tanks, loading operations, and emergency equipment)	2.9×10^{-2}	2.9×10^{-2}
Total	5.3×10^2	8.4×10^1

5.2.2 *PTE of Particulate Matter (PM)*

The uncontrolled PTE for PM, PM_{10}, and $PM_{2.5}$ is greater than 100 tpy, as shown in Table 19.[38] The primary emission sources of PM emissions at the sugars-to-HC biorefinery are the boiler, feedstock handling operation, truck traffic, and cooling tower. The emissions from the boiler and feedstock handling operation are much larger compared to those from the truck traffic, cooling tower, and other operations (e.g., fire pump); however, the truck traffic generates emissions at a level higher or near the SER (25 tpy for PM and 15 tpy for PM_{10}) (refer to Table 16). Therefore, in order to reduce emissions to less than the SER, the truck traffic emissions would also need to be reduced.

The boiler NSPS (40 CFR 60, Subpart Db) regulates PM emissions to 0.03 lb/MMBtu of heat input for the type of fuels burned in the boiler used in the sugars-to-HC biorefinery. In addition, the boiler major source NESHAP (40 CFR 63, Subpart DDDDD) uses a filterable PM limit of 0.03 lb/MMBtu as a surrogate to regulate metal HAPs. State regulations may also apply to the boiler, but are not examined in this technical report. The design case (Davis et al. 2013) indicates that a baghouse will be used on the boiler to control PM emissions. It is anticipated that the baghouse will achieve at least 99% emissions reduction (EPA 2003c). Based on a 99% emission reduction efficiency, the boiler will achieve an emissions rate of 0.0056 lb/MMBtu of filterable PM (below the level required by the boiler NSPS and boiler major source NESHAP) and is estimated to emit about 20 tpy of filterable PM emissions. The PM_{10} and $PM_{2.5}$ are expected to be reduced to 18 and 16 tpy, respectively (refer to boiler PM, PM_{10}, $PM_{2.5}$ emissions in Table 19). For these values to be considered the PTE for the boiler, limits must be included in a permit to make them federally enforceable.

The feedstock handling operations and truck traffic could be subject to state PM regulations that require emission reductions. The design case (Davis et al. 2013) includes a baghouse for

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[38] PM is regulated as filterable PM while PM_{10} and $PM_{2.5}$ are regulated as the total of filterable PM in the size fraction (i.e., PM_{10} or $PM_{2.5}$) and condensable PM. Specifically, PM is regulated as measured using EPA Method 5, which only measures filterable PM. PM_{10} and $PM_{2.5}$ are regulated as measured using EPA Method 201A, which measures the filterable PM at the size fraction, and Method 202, which measures condensable PM. All condensable PM is included in the $PM_{2.5}$ and PM_{10} size fractions.

feedstock handling. Assuming a 99% emission reduction efficiency (EPA 2003c), the baghouse is estimated to reduce emissions from feedstock handling to 7.7, 7.7, and 1.3 tpy for PM, PM_{10}, and $PM_{2.5}$, respectively.

Table 19 shows the possible PTE for PM assuming that federally enforceable limits are taken in a permit to make the baghouse performance on the boiler and feedstock handling operations federally enforceable. By including the limits on the boiler and feedstock handling operations, the PTE of PM, PM_{10}, and $PM_{2.5}$ from the sugars-to-HC biorefinery would be reduced to less than 100 tpy. However, the possible PTE, as currently estimated, would be greater than the SER for PM and PM_{10}, which means that, if the biorefinery is a PSD major source for pollutants other than PM and PM_{10}, a PSD review would need to be performed for PM and PM_{10}, and BACT would be required. The source could consider other emission reduction options to reduce emissions below the SER, such as watering the roads and paving all roads within the biorefinery boundary to reduce truck traffic emissions.

Table 19. Uncontrolled PTE and Possible PTE for PM, PM_{10}, and $PM_{2.5}$

Process	Uncontrolled PM PTE (tpy)			Possible PM PTE (tpy)		
	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Boiler (Area 800)	$2.0x10^3$	$1.8x10^3$	$1.6x10^3$	$2.0x10^1$	$1.8x10^1$	$1.6x10^1$
Feedstock Handling (Area 100)	$7.7x10^2$	$7.7x10^2$	$1.3x10^2$	7.7	7.7	1.3
Truck Traffic	$6.2x10^1$	$1.7x10^1$	2.1	$6.2x10^1$	$1.7x10^1$	2.1
Cooling Tower (Area 900)	$7.6 x10^{-1}$	$5.3 x10^{-1}$	$3.2 x10^{-1}$	$7.6 x10^{-1}$	$5.3 x10^{-1}$	$3.2 x10^{-1}$
Others (Pre-heater and emergency equipment)	$5.8 x10^{-2}$	$1.1 x10^{-1}$	$1.1 x10^{-1}$	$5.8 x10^{-2}$	$1.1 x10^{-1}$	$1.1 x10^{-1}$
Total	$2.8x10^3$	$2.6x10^3$	$1.7x10^3$	$9.1x10^1$	$4.4x10^1$	$2.0x10^1$

5.2.3 *PTE of Carbon Monoxide (CO)*

Table 16 indicates that the only significant emitting source of CO is the boiler. Given that the estimated facility-wide PTE of HAP is greater than 25 tpy, the sugars-to-HC biorefinery would be subject to the major source boiler NESHAP (Subpart DDDDD). Because CO is controlled under the NESHAP as a surrogate for HAP control, the boiler will be subject to a CO emission limit. There are several CO limits in the rule based on the type of the boiler. The design case (Davis et al. 2013) does not specify the type of boiler, but indicates the boiler will be similar to the one recommended in the design case for biochemical conversion of lignocellulosic biomass to ethanol (Humbird et al. 2011), which is a stoker fired boiler. For this type of boiler burning wet biomass, the CO emissions are limited to 0.58 lb per MMBtu of steam generated by the NESHAP rule. Based on a boiler efficiency of 80% (Davis et al. 2013), this would equate to 0.46 lb of CO per MMBtu of heat input. This limit is expected to be met by a new boiler that is properly designed and tuned, and by following the work practice standards specified in the major source boiler NESHAP. Using this limit would result in PTE of CO emissions of 1,600 tpy from the boiler, which would make the biorefinery major for CO if no further CO emission controls are implemented. Combustion controls or add-on controls are available and can be installed to reduce CO emissions from the boiler. For example, oxidation catalyst could be included on the boiler to reduce CO emissions.

5.2.4 PTE of Volatile Organic Compounds (VOCs)

There are several sources of VOCs at the sugars-to-HC biorefinery as shown in Table 16; the enzymatic hydrolysis, conditioning, and bioconversion area (Area 300) is the single-largest emitting source of VOCs, and is estimated to emit two orders of magnitude more VOCs compared to other emitting sources. In addition, the cooling tower generates VOC emissions at a level exceeding the SER (40 tpy for VOC) and a combination of VOC emissions from the boiler, pretreatment and equipment leaks exceed the SER as well. Therefore, in order to reduce emissions to less than the SER, emissions from cooling tower, boiler, pretreatment, and equipment leaks would also need to be reduced.

As discussed in Section 5.2.1, several processes could be subject to the chemical manufacturing NESHAP, 40 CFR 63, Subpart FFFF (i.e., MON). The MON requires HAP emission reductions for certain operations that meet the applicability criteria. Given the quantity of emissions from the enzymatic hydrolysis, conditioning and bioconversion processes (Area 300) (see Section 5.3.1), the process vents from these processes are expected to be subject to a 98% HAP reduction under the MON. Generally, the same emission reduction can be assumed for VOCs since the expected HAPs are also VOCs. This would mean that the MON requirements would effectively reduce the PTE for VOC emissions to 36 tpy (Table 20). In order to achieve the reductions, emission controls will need to be installed.

The MON has HAP reduction requirements for cooling towers. Through minimizing leaks into the cooling water system, the controlled emission of VOCs is expected to be reduced to 0.7 lb/MM gal of cooling water (as opposed to uncontrolled emissions of 6 lb/MM gal) (EPA 1995b), which result in an estimated PTE of VOC to 8.1 tpy from the cooling tower (Area 900).

The MON has LDAR program that are meant to minimize emissions from leaking equipment. Following the EPA's protocol for equipment leak emissions estimates (EPA 1995c), we estimate a PTE of 2.4 tpy for VOC emissions from equipment leaks assuming the biorefinery is in compliance with an LDAR program based on the EPA's best practices guide (EPA 2007).

The MON also applies to wastewater treatment, but additional information on HAP concentration and specific stream characteristics are necessary to determine whether the rule would limit emissions of HAPs (and therefore VOCs) from WWTP. Without information on design specifics, we assume no VOC reduction for wastewater treatment.

Table 20. Uncontrolled PTE and Possible PTE for VOCs

Process	Uncontrolled VOC PTE (tpy)	Possible VOC PTE (tpy)
Enzymatic hydrolysis, Conditioning and Bioconversion (Area 300)	1.8×10^3	3.6×10^1
Boiler (Area 800)	6.0×10^1	6.0×10^1
Pretreatment and Conditioning (Area 200)	2.3×10^1	2.3×10^1
Equipment leaks (Areas 200 -600)	1.5×10^1	2.4
Cooling Tower (Area 900)	6.9×10^1	8.1
Wastewater Treatment Plant (Area 600)	5.5	5.5
Others (Pre-heater, storage tanks, loading operation, and emergency equipment)	1.6	1.6
Total	2.0×10^3	1.4×10^2

Taking into consideration the assumed emission reduction for the enzymatic hydrolysis, conditioning and bioconversion operation (Area 300), the cooling tower (Area 900), and equipment leaks due to the requirements in the MON, the possible PTE of VOCs would be reduced to 140 tpy, as shown in Table 20. It is possible other requirements in MON could further reduce this value, although more information is needed to determine specific reductions. Further reductions could apply or design changes could be made to reduce the PTE of VOC emissions. It should be noted that several of the VOC emissions are estimated based on very limited information. Additional refinement of the VOC estimates is needed once more design details are available.

5.2.5 *PTE of Nitrogen Oxides (NO_x)*

Based on estimates of uncontrolled PTE for all NO_x emitting sources at the biorefinery shown in Table 16, the only significant source of NO_x is the boiler (Area 800). The boiler is not subject to the NO_x emission limits in the boiler NSPS (Subpart Db) because the annual capacity factor for natural gas is expected to be less than 10% (natural gas is only used during the startup). Currently, a selective non-catalyst reduction (SNCR) along with overfire air (OFA) system is planned for the boiler to reduce NO_x emissions (Davis et al. 2013; Humbird et al. 2011). Assuming an efficiency of 55% achieved by the SNCR and OFA in reducing NO_x emissions (EPA 1999, 2003a; B&W 2003), the PTE of NO_x is estimated to be 350 tpy. Because the PTE for NO_x exceeds the major source threshold (100 tpy), it would make the biorefinery major for NO_x. The biorefinery could consider using low NO_x burners or a selective catalytic reduction (SCR) unit to reduce emissions of NO_x and request federally enforceable limits be included in the permit to reduce the PTE. Incorporating NO_x reduction technologies could bring the PTE of NO_x to below major source levels or to below the SER for NO_x (40 tpy).

5.2.6 *PTE of Lead*

The uncontrolled PTE of lead is neither above the PSD or NNSR major source level nor the PSD SER for lead. No emission control is currently planned in the design case (Davis et al. 2013) or required to reduce lead emissions to avoid a regulation or a permitting requirement. As such, the

PTE is identical to the uncontrolled PTE for lead. Lead is also a HAP and these emissions are included in the PTE calculation for total HAPs.

5.2.7 *PTE of Sulfur Dioxide (SO_2)*

Estimates of uncontrolled PTE for all SO_2-emitting sources at the biorefinery (Table 16) suggest that the only significant source of SO_2 is the boiler (Area 800). This boiler would be subject to the boiler NSPS (40 CFR 60, Subpart Db), which limits the SO_2 emission to 0.2 lb/MMBtu of heat input. The design case (Davis et al. 2013) includes FGD with an expected emission reduction of 92%, which would reduce SO_2 emissions, potentially to 0.0035 lb/MMBtu which is below the limit required by the boiler NSPS. (Without the FGD, the boiler would emit SO_2 at a rate of about 0.043 lb/MMBtu). The estimated PTE of SO_2 for the boiler is 110 tpy, which is still above 100 tpy after taking into account the emission reduction achieved by the FGD. Additional controls (or higher efficiency FGD) will be needed to reduce the emissions to below the major source and SER levels.

5.2.8 *PTE of Sulfuric Acid (H_2SO_4) Mist*

Estimates of uncontrolled PTE of H_2SO_4 from all emitting sources at the biorefinery indicate that boiler (Area 800) and pretreatment and conditioning (Area 200) are the two primary H_2SO_4 emitting sources (Table 16). The ASPEN model, which accompanies the design case (Davis et al. 2013), indicates that 1% of SO_2 is converted to H_2SO_4 in the boiler, which results in about 14 tpy of H_2SO_4 emissions. In addition, we assume 0.1% of sulfuric acid consumed by the biorefinery will be emitted as H_2SO_4 mist. Because emission control is not currently incorporated in the design case to reduce H_2SO_4 emissions (Davis et al. 2013), the PTE is expected to be identical to the uncontrolled PTE for H_2SO_4 emissions. The estimated PTE of H_2SO_4 emissions from the entire biorefinery (22 tpy) is lower than the major source level (100 tpy), but greater than the PSD SER (7 tpy). The sugars-to-HC biorefinery could consider installing control devices (e.g., mist control devices) to reduce H_2SO_4 emissions.

5.2.9 *PTE of Ammonia (NH_3)*

The uncontrolled PTE of NH_3 is not above the major source level. No emission control is currently planned for NH_3 in the design case (Davis et al. 2013). As such, the PTE is identical to the uncontrolled PTE for NH_3. There are no regulations specifically applicable to NH_3 emissions. The emissions are primarily informational and require no further reductions to avoid a regulation or a permitting requirement.

5.2.10 *PTE of Greenhouse Gases (GHGs)*

The EPA recently announced its plans to propose revisions to the PSD rules to include an exemption of PSD requirements for GHGs from waste-derived feedstocks and feedstocks from sustainable forest or agricultural practices (EPA 2014). The vast majority of GHG emissions from the sugars-to-HC biorefinery likely will fit this exemption and, therefore, would not need to be counted to determine applicability of PSD to GHG emissions. Also, it should be noted that a source is not required to obtain a PSD or Title V permit on the sole basis of its PTE of GHG emissions per the U.S. Supreme Court ruling (U.S. Supreme Court 2014). Other pollutants must be subject to PSD or Title V before the GHG emissions are considered.

The type of the feedstocks will need to be considered to determine what emissions must be counted for GHG emissions. As a conservative assumption, the current uncontrolled PTE estimate for GHG emissions includes all GHG emissions. Without further control, the PTE is expected to be identical to the uncontrolled PTE for GHG emissions. However, the PTE for GHG emissions will need to be revised once the EPA finalizes the rule for biogenic carbon accounting.

5.2.11 *Facility-Wide PTE*

Table 21 shows the preliminary estimate of PTE for the sugars-to-HC biorefinery by taking into account the potential federally enforceable limitations (in a permit or federal air regulations) discussed in this section, which are summarized in Table 22. Table 22 also notes the areas where further emission reduction could be considered and where an emission calculation should be refined when specific design parameters are available. The preliminary estimate of PTE indicates that the biorefinery could be major for NSR and Title V if no additional emissions controls (other than those currently planned) are implemented.

Table 21. Preliminary Estimates of Possible Facility-wide PTE of Criteria Air Pollutants (and precursors), HAPs, GHGs, NH_3, and H_2SO_4 Emissions from the Design Biorefinery (tpy)

Process	PM[a]	PM_{10}[a]	$PM_{2.5}$[a]	VOC	NO_x	CO	Lead	SO_2	H_2SO_4 mist	NH_3	HAP	GHG (CO_2 eq)
Feedstock handling (Area 100)	7.7	7.7	1.3									
Pretreatment and conditioning (Area 200)				$2.3x10^{1}$					7.8	$1.1x10^{-1}$		
Enzymatic hydrolysis, conditioning and bioconversion (Area 300)				$3.6x10^{1}$							3.6	$1.8x10^{5}$
Enzyme production (Area 400)								$8.2x10^{-1}$		1.9		$1.2x10^{4}$
Pre-heater (Area 500)	$1.9x10^{-2}$	$7.4x10^{-2}$	$7.4x10^{-2}$	$5.4x10^{-2}$	1.6	$3.9x10^{-1}$	$4.9x10^{-6}$	$5.9x10^{-3}$			$1.8x10^{-2}$	4.1×10^{3}
WWTP (Area 600)				5.5							5.5	
Storage tanks and loading operations (Area 700)				$8.1\ x10^{-1}$					3.5×10^{-5}		7.2×10^{-3}	
Boiler (Area 800)	$2.0x10^{1}$	$1.8x10^{1}$	$1.6x10^{1}$	$6.0x10^{1}$	$3.5x10^{2}$	$1.6x10^{3}$	$1.7x10^{-1}$	$1.1x10^{2}$	$1.4x10^{1}$	$1.5x10^{-1}$	$7.0x10^{1}$	$1.5x10^{6}$
Emergency generator (Area 900)	$2.5x10^{-2}$	$2.5\ x10^{-2}$	$2.5\ x10^{-2}$	$5.0x10^{-1}$	$5.0x10^{-1}$	$4.3x10^{-1}$		8.2×10^{-4}			$2.1x10^{-3}$	$8.7x10^{1}$
Emergency fire pump (Area 900)	$1.5x10^{-2}$	$1.5x10^{-2}$	$1.5x10^{-2}$	$2.1x10^{-1}$	$2.1\ x10^{-1}$	$2.5x10^{-1}$		3.4×10^{-4}			8.5×10^{-4}	$3.6x10^{1}$
Cooling tower (Area 900)	$7.6x10^{-1}$	$5.3x10^{-1}$	$3.2x10^{-1}$	8.1							4.1	
Equipment Leaks (Areas 200, 300, 400, 500, and 600)				2.4							1.2	

Process	PM[a]	PM$_{10}$[a]	PM$_{2.5}$[a]	VOC	NO$_x$	CO	Lead	SO$_2$	H$_2$SO$_4$ mist	NH$_3$	HAP	GHG (CO$_2$ eq)
Truck traffic	6.2×10^{1}	1.7×10^{1}	2.1									
Facility-wide total[b]	9.1×10^{1}	4.4×10^{1}	2.0×10^{1}	1.4×10^{2}	3.5×10^{2}	1.6×10^{3}	$1.7\mathrm{x}10^{-1}$	$1.1\mathrm{x}10^{2}$	$2.2\mathrm{x}10^{1}$	2.2	$8.4\mathrm{x}10^{1}$ (All HAP) $1.6\mathrm{x}10^{1}$ (Single largest HAP – Formaldehyde)	$1.7\mathrm{x}10^{6}$
Major Source for NSR and Title V	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	1.0×10^{2}	$2.5\mathrm{x}10^{1}$[c] (All HAP) $1.0\mathrm{x}10^{1}$ (Any single HAP)	NA[d]
PSD Significance Emission Rate	2.5×10^{1}	1.5×10^{1}	1.0×10^{1}	4.0×10^{1}	4.0×10^{1}	1.0×10^{2}	6.0×10^{-1}	4.0×10^{1}	7	NA[c]	NA[c]	Pending [e]

[a] PM is regulated as filterable PM, while PM$_{10}$ and PM$_{2.5}$ are regulated as the total of filterable PM in the size fraction (i.e., PM$_{10}$ or PM$_{2.5}$) and condensable PM. Specifically, PM is regulated as measured using EPA Method 5, which only measures filterable PM. PM$_{10}$ and PM$_{2.5}$ are regulated as measured using EPA Method 201A, which measures the filterable PM at the size fraction, and Method 202, which measures condensable PM. All condensable PM is included in the PM$_{2.5}$ and PM$_{10}$ size fractions.

[b] Due to rounding and the use of two significant digits, numbers may not add up.

[c] Not subject to NSR, although HAP that are also VOC are included in the VOC total and are considered when determining the applicability of PSD review for VOC.

[d] GHGs alone do not determine applicability of Title V or NSR.

[e] Currently the PSD significance level for GHG is not defined. For pollutants with no significance level, any amount of emissions is considered significant. The EPA is expected to publish a significance level in the future. In the meantime, some states are using 75,000 tpy of carbon dioxide equivalents as a PSD significant level.

Table 22. Factors Considered for PTE Estimation and Preliminary Determination of Status

Pollutant	Factors Considered in PTE Calculations in Table 21	Status	Additional Consideration and Refinements to PTE Calculation
PM, PM_{10}, and $PM_{2.5}$	1) Boiler NSPS and boiler major source NESHAP limits 2) Planned feedstock handling and boiler baghouses per the design case (Davis et al. 2013) 3) Permit limits will be needed to make the PTE federally enforceable.	PM, PM_{10} and $PM_{2.5}$: below major level for NSR, but above or at SER	Further emission controls to reduce the PTE to below the SER for PM, PM_{10}, and $PM_{2.5}$ or controls that would be considered BACT.
VOC	Assumed emission reduction requirements under MON (40 CFR 63, Subpart FFFF) for enzymatic hydrolysis, conditioning and bioconversion operation (Area 300), cooling tower (Area 900), and equipment leaks (Areas 200 to 600). Additional control device may be needed to meet the MON requirements.	Major for NSR	1) Conservative assumptions are used for estimating PTE due to a lack of information in the design case (Davis et al. 2013). Assumptions need to be revisited and refined when design specifics are available. 2) Further emission controls to reduce PTE to below the major source level for NSR or PSD SER; or controls that would be considered BACT.
NO_x	1) Planned SNCR and OFA for emission control from the boiler per the boiler quote for the design report (Davis et al. 2013; Humbird et al. 2011) 2) Permit limits will be needed to make the PTE federally enforceable.	Major for NSR	Further emission controls to reduce the PTE to below the major source level for NSR or PSD SER; or controls that would be considered BACT
CO	CO limit in boiler major source NESHAP	Major for NSR	Further emission controls to reduce the PTE to below major source level for NSR or PSD SER; or controls that would be considered BACT.
SO_2	1) 1) Boiler NSPS limit 2) Planned flue gas desulfurization system in the design case (Davis et al. 2013) 3) Permit limits will be needed to make the PTE federally enforceable.	Major for NSR	Higher efficiency flue gas desulfurization system or additional emission control to reduce the PTE to below major source level for NSR or PSD SER; or controls that would be considered BACT.
H_2SO_4	No currently applicable regulatory limitation; No planned emission control in the design case (Davis et al. 2013).	Below major source level, but above SER	1) Conservative assumptions are used for estimating PTE; assumptions should be revisited and refined when design information is available. 2) Further emission control to reduce the PTE to below the SER; or installation of emission control device that would be considered BACT.

Pollutant	Factors Considered in PTE Calculations in Table 21	Status	Additional Consideration and Refinements to PTE Calculation
GHG	No currently applicable regulatory limitation and planned emission control in the design case (Davis et al. 2013).	Pending	Refine PTE by determining what portion of the GHG emissions are exempt from being counted once regulation is finalized.
HAP (including lead)	1) Boiler major source NESHAP limits and planned flue gas desulfurization in the design case (Davis et al. 2013) 2) Assumed emission reduction from the enzymatic hydrolysis, conditioning and bioconversion (Area 300) due to MON requirements 3) Assumed emission reduction from equipment leaks due to compliance with a LDAR program required by MON 4) Assumed emission reduction due to leak monitoring and repair requirements for cooling tower in MON.	Major for Title V	Further reductions to below major source level for HAPs.
NH_3	No currently applicable regulatory limitation and planned emission control in the design case (Davis et al. 2013).	Not Major	None

6 Concluding Notes

As the sugars-to-HC design report indicates, the design case is a feasibility-level analysis for a plausible conversion pathway to RDB to meet a cost target of $5/gallon gasoline equivalent by 2017 (Davis et al. 2013). As such, the design case is not intended to optimize the process to minimize air pollutant emissions. It is reasonable to expect that emissions from the biorefinery likely will be reduced as the technology matures and the entire process continues to be optimized (Jones 2010).

Caution is advised in using the preliminary estimates of PTE for decision making because there are significant uncertainties inherent in the analysis due to a lack of many specific design parameters required for PTE estimates and the subsequent use of general procedures for estimating emissions (e.g., the EPA's AP-42, approaches to estimating emissions from analogous unit operations in existing air permits, etc.).

The preliminary estimates of PTE represent the maximum capacity of the biorefinery to emit pollutants after taking into account potential federally enforceable limits. Therefore, the estimates may not reflect the actual emissions from the biorefinery. Due to the nascent stage of the design conversion technology, no emission data from facilities, which use the same or similar technology, exists. The estimates from this analysis should be considered preliminary and need to be verified once test results are available from facilities or unit operations using similar technology being built and in full operation. It is expected that some emission data from first-generation cellulosic biofuel facilities could be available in the near future because source performance tests are generally required by most permits within the first year of startup (see e.g., ABBK's permit [Kansas Department of Health & Environment 2011]). These data can help improve the fidelity of the PTE estimates to the designed unit processes of the sugars-to-HC biorefinery and validate estimated emissions.

Last but not least, this PTE analysis is for a standalone biorefinery based on the design case documented in Davis et al. (2013) with feedstock delivered to the biorefinery in trucks or railcar. It is likely that the biomass feedstock will be conveyed within a minimal distance from a biomass preprocessing facility to the cellulosic biorefinery through conveyors as envisioned in Kenney et al. (2013). There are air permitting implications for choosing one design scenario over the other. If the preprocessing design plant is not collocated with the biorefinery, air permitting for the biorefinery and the preprocessing design plant then could be completed separately. However, if these two facilities are considered collocated, then the air permitting analyses would be conducted as if the two facilities were only one facility (i.e., emissions from each facility would be added together, and only one air permit would be issued). Given that the biorefinery likely would be a major source for NSR and Title V without implementing further emission controls (other than those currently planned), permitting the biomass preprocessing facility and biorefinery together as one facility (i.e., co-located) increases the possibility that both operations would be considered a major source for NSR and Title V.

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Appendix A. PSD Significant Emission Rate[39]

Pollutant	PSD Significant Emission Rate (tpy)
CO	100
NO_x	40
SO_2	40
PM	25
PM_{10}	15
$PM_{2.5}$	10
VOC	40
Lead	0.6
Fluorides	3
Sulfuric acid mist	7
H_2S	10
Total reduced sulfur (including H_2S)	10
Reduced sulfur compounds (including H_2S)	10
GHG	75,000 (CO_2 equivalents)
Municipal waste combustor organics[a]	3.5×10^6
Municipal waste combustor metals[b]	15
Municipal waste combustor acid gases[c]	40
Municipal solid waste landfill emissions[d]	50

[a] Measured as total tetra-through octachlorinated dibenzo-p-dioxins and dibenzofurans.
[b] Measured as PM.
[c] Measured as SO_2 and HCL.
[d] Measured as nonmethane organic compounds.

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[39] For any PSD regulated pollutant that is not listed, such as CFC and Halon compounds, any increase in actual emissions at a major PSD source is considered significant. For complete rule context, refer to 40 CFR 51.166(b)(23).

Appendix B. Regulated Pollutant List

Disclaimer: This list may not be current (or complete) after publication date of this paper. Please refer to the U.S. EPA's, Air Toxics website at http://www.epa.gov/ttn/atw/ for current information.

Pollutant	CAS #	Type of Regulated Pollutant[b]
Acenaphthene[a]	83329	HAP
Acenaphthylene[a]	203968	HAP
Acetaldehyde [Ethanal]	75070	HAP, 112(r)
Acetamide [Ethanamide]	60355	HAP
Acetonitrile [Methyl cyanide]	75058	HAP
Acetophenone [1-Phenyl-ethanone]	98862	HAP
2-Acetylaminofluorene [N-9H-Fluoren-2-yl-acetamide]	53963	HAP
Acetylene [Ethyne; Ethine]	74862	112(r)
Acetylene tetrachloride [1,1,2,2-Tetrachloroethane]	79345	HAP
Acrolein [2-Propenal]	107028	HAP, 112(r)
Acrylamide [2-Propenamide]	79061	HAP
Acrylic acid [Propenoic acid]	79107	HAP
Acrylonitrile [2-Propenenitrile]	107131	HAP, 112(r)
Acrylyl chloride [2-Propenoyl chloride]	814686	112(r)
Allyl alcohol [2-Propen-1-ol; Propenyl alcohol]	107186	112(r)
Allylamine [2-Propen-1-amine]	107119	112(r)
Allyl chloride [3-Chloro-1-propene]	107051	HAP
p-Aminobiphenyl [4-Aminobiphenyl; p-Biphenyl amine]	92671	HAP
Ammonia (anhydrous)	7664417	112(r)
Ammonia (conc 20% or greater)	7664417	112(r)
Aniline [Amino benzene; Phenyl amine; Cyanol]	62533	HAP
o-Anisidine [2-Methoxy-benzenamine]	90040	HAP
Anthracene[a]	120127	HAP
Antimony Compounds	N/A	HAP
Arsenic Compounds (inorganic including arsine)	N/A	HAP
Arsenic pentoxide	1303282	HAP
Arsenous trichloride	7784341	HAP, 112(r)
Arsine	7784421	HAP, 112(r)
Asbestos	1332214	HAP
Benz(a)anthracene[a]	56553	HAP
Benzene (including benzene from gasoline) [Benzol;Phynyl hydride; Cyclohexatriene[a]	71432	HAP
Benzidine [(1,1'-Biphenyl)-4,4'-diamine]	92875	HAP
Benzo(a)pyrene[a]	50328	HAP
Benzo(b)fluoranthene[a]	205992	HAP
Benzo(g,h,i)perylene[a]	191242	HAP
Benzo(k)fluoranthene[a]	207089	HAP
Benzotrichloride [Phenyl chloroform]	98077	HAP
Benzyl chloride [w-Chlorotoluene]	100447	HAP
Beryllium Compounds	N/A	HAP
Beryllium oxide [Bromollite]	1304569	HAP
Beryllium sulfate	13510491	HAP
Biphenyl [1,1'-Biphenyl; Diphenyl]	92524	HAP
Bis (chloromethyl) ether [BCME; Chloromethyl ether; Oxybis (chloromethane)]	542881	HAP

Bis (2-ethylhexyl) phthalate [DEHP; 1,2-Benzenedicarboxylic acid; bis (2-thylhexyl) ester	117817	HAP
Boron trichloride [Trichloroborane]	10294345	112(r)
Boron trifluoride [Trifluoroborane]	7637072	112(r)
Boron trifluoride compound with methyl ether (1:1)	353424	112(r)
Bromine	7726956	112(r)
Bromoform [Tribromomethane]	75252	HAP
Bromotrifluorethylene [Bromotrifluoroethene]	598732	112(r)
1,3-Butadiene [Erythrene]	106990	HAP, 112(r)
Butane [n-Butane; Diethyl]	106978	112(r)
Butene	25167673	112(r)
1-Butene [1-Butylene]	106989	112(r)
2-Butene [2-Butylene]	107017	112(r)
cis-2-Butene [(Z)-2-Butene]	590181	112(r)
trans-2-Butene [(E)-2-Butene]	624646	112(r)
Cadmium Compounds	N/A	HAP
Cadmium oxide	1306190	HAP
Cadmium sulfate [Soluble anhydrite]	10124364	HAP
Calcium cyanamide	156627	HAP
Captan [3a,4,7,7a-Tetrahydro-2-{(trichloromethyl)thio}-1H-isoindole-1,3(2H)-dione	133062	HAP
Carbaryl [Methylcarbamate 1-naphthalenol]	63252	HAP
Carbon disulfide [Carbon bisulfide]	75150	HAP, 112(r)
Carbon monoxide [Carbon oxide]	630080	Criteria, NSPS
Carbon oxysulfide [Carbonyl sulfide; Carbon oxide sulfide]	463581	HAP, 112(r)
Carbon tetrachloride [Tetrachloromethane]	56235	HAP, Ozone-Depleting
Catechol [1,2-Benzenediol; Pyrocatechol]	120809	HAP
Chloramben [3-Amino-2,5-dichloro-benzoic acid]	133904	HAP
Chlordane [1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-mehano-1H-indene]	57749	HAP
Chlorine	7782505	HAP, 112(r)
Chlorine dioxide	10049044	112(r)
Chlorine monoxide [Chlorine oxide]	7791211	112(r)
Chloroacetic acid [b-Chloroacetic acid]	79118	HAP
2-Chloroacetophenone [w-Chloroacetophenone;2-chloro-1-pheyl-ethanone]	532274	HAP
Chlorobenzene	108907	HAP
Chlorobenzilate [Chlorobenzylate]	510156	HAP
Chlorofluorocarbon-l l (CFC-l l)	75694	Ozone-Depleting
Chlorofluorocarbon-12 (CFC-12)	75718	Ozone-Depleting
Chlorofluorocarbon-13 (CFC-13)	75729	Ozone-Depleting
Chlorofluorocarbon-l l l (CFC-l l l)	354563	Ozone-Depleting
Chlorofluorocarbon-112 (CFC-112)	76120	Ozone-Depleting
Chlorofluorocarbon-113 (CFC-113)	76131	Ozone-Depleting
Chlorofluorocarbon-114 (CFC-114)	76142	Ozone-Depleting
Chlorofluorocarbon-115 (CFC-115)	76153	Ozone-Depleting
Chlorofluorocarbon-211 (CFC-211)	422786	Ozone-Depleting
Chlorofluorocarbon-212 (CFC-212)	3182261	Ozone-Depleting
Chlorofluorocarbon-213 (CFC-213)	2354065	Ozone-Depleting
Chlorofluorocarbon-214 (CFC-214)	29255310	Ozone-Depleting
Chlorofluorocarbon-215 (CFC-215)	4259432	Ozone-Depleting
Chlorofluorocarbon-216 (CFC-216)	661972	Ozone-Depleting
Chlorofluorocarbon-217 (CFC-217)	422866	Ozone-Depleting

Chloroform [Trichloromethane]	67663	HAP, 112(r)
Chloromethyl Ether	542881	112(r)
Chloromethyl methyl ether [Chloromethoxymethane]	107302	HAP, 112(r)
Chloroprene [2-Chloro-1,3-butadiene]	126998	HAP
1-Chloropropylene [1-Chloro-1-propene]	590216	112(r)
2-Chloropropylene [2-Chloro-1-propene]	557982	112(r)
Chromium Compounds	N/A	HAP
Chromium (+6) Compounds	N/A	HAP
Chrysene[a]	218019	HAP
Cobalt Compounds	N/A	HAP
Coke Oven Emissions	N/A	HAP
Cresols/Cresylic acid (isomers and mixture)	1319773	HAP
m-Cresol [3-Methyl-phenol]	108394	HAP
o-Cresol [2-Methyl phenol]	95487	HAP
p-Cresol [4-Methyl phenol]	106445	HAP
Crotonaldehyde [2-Butenal]	4170303	112(r)
(E)-Crotonaldehyde [trans-Crotonaldehyde; (E)-2-Butenal]	123739	112(r)
Cumene [1-Methylethyl benzene, Isopropylbenzene]	98828	HAP
Cyanamide [Cyanogenamide]	420042	HAP
Cyanic acid [Hydrogen cyanate]	420053	HAP
Cyanide Compounds [1]	N/A	HAP
Cyanoacetamide [2-Cyanoacetamide]	107915	HAP
Cyanogen [Ethanedinitrile]	460195	HAP, 112(r)
Cyanogen chloride [Chlorine cyanide]	506774	HAP, 112(r)
Cyclohexylamine [Cyclohexanamine]	108918	112(r)
Cyclopropane [Trimethylene]	75194	112(r)
2,4- D [(2,4-Dichlorophenoxy)acetic acid], (including salts and esters)	94757	HAP
DDE [1,1'-Ethylidenebis(4-chloro-benzene); 1,1-Bis(4-chloropheny)ethane]	3547044	HAP
Diazomethane	334883	HAP
Dibenzo(a,h)anthracene[a]	53703	HAP
Dibenzofurans [2,2'-Biphenylene oxide]	132649	HAP, NSPS
Diborane	19287457	112(r)
1,2-Dibromo-3-chloropropane [Dibromochloropropane]	96128	HAP
Dibutylphthalate [Dibutyl ester 1,2-benzenedicarboxylic acid]	84742	HAP
Dichlorobenzene[a]	25321226	HAP
1,4-Dichlorobenzene [p-Dichlorobenzene]	106467	HAP
3,3-Dichlorobenzidene	91941	HAP
Dichloroethyl ether [bis(2-chloroethyl)ether; 1,1'-oxybis{2-chloroethane}]	111444	HAP
Dichloromethane [Methylene chloride]	75092	HAP
1,3-Dichloropropene	542756	HAP
Dichlorosilane	4109960	112(r)
Dichlorvos [2,2-Dichloroethenyl dimethyl ester phosphoric acid]	62737	HAP
Diethanolamine [2,2'-Iminobisethanol]	111422	HAP
N,N-Diethylaniline [N,N-Dimethylbenzenamine]	121697	HAP
Diethyl sulfate [Diethyl ester sulfuric acid]	64675	HAP
Difluoroethane [1,1-Difluoroethane; Ethylidenedichloride]	75376	112(r)
3,3'-Dimethoxybenzidine [3,3'-Dimethoxy-(1,1'-biphenyl)-4,4'-diamine; o-Dianisdine	119904	HAP
Dimethylamine [N-Methylmethanamine]	124403	112(r)

Dimethyl aminoazobenzene [N,N-Dimethyl-4-(phenylazo)-benzenamine; 4-(Dimethylamino)azobenzene]	60117	HAP
7,12-Dimethylbenz(a)anthracene[a]		HAP
3,3'-Dimethyl benzidine [3,3'-Dimethyl-(1,1'-biphenyl)- 4,4'-diamine; 0-Tolidine]	119937	HAP
Dimethyl carbamoyl chloride [Dimethylcarbamic chloride]	79447	HAP
Dimethyldichlorosilane [Dichlorodimethylsilane]	75785	112(r)
Dimethyl formamide [N,N-Dimethyl formamide]	68122	HAP
1,1-Dimethyl hydrazine	57147	HAP, 112(r)
Dimethyl phthalate [Dimethyl ester 1,2-benzenedicarboxylic acid]	131113	HAP
2,2-Dimethylpropane	463821	112(r)
Dimethyl sulfate [Dimethyl ester sulfuric acid]	77781	HAP
4,6-Dinitro-o-cresol, and salts	534521	HAP
2,4-Dinitrophenol	51285	HAP
2,4-Dinitrotoluene [1-Methyl-2,4-dinitrobenzene]	121142	HAP
1,4-Dioxane [Dioxane; 1,4-Dioxacyclohexane]	123911	HAP
Dioxins and furans (total tetra through octachlorinated dibenzo-p-dioxins)	N/A	NSPS, HAP
1,2-Diphenylhydrazine [N,N'-Diphenylhydrazine]	122667	HAP
Epichlorohydrin [Chloromethyloxirane; 1-Chloro-2,3-epoxypropane]	106898	HAP, 112(r)
1,2-Epoxybutane [Ethyloxirane]	106887	HAP
Ethane	74840	112(r)
Ethyl acetylene [1-Butyne]	107006	112(r)
Ethyl acrylate [Ethyl ester 2-propenoic acid]	140885	HAP
Ethylamine [Ethanamine]	75047	112(r)
Ethylbenzene	100414	HAP
Ethyl carbamate [Urethane; Ethyl ester carbamic acid]	51796	HAP
Ethyl chloride [Chloroethane]	75003	HAP, 112(r)
Ethyl ether [1,1'-Oxybis-ethane]	60297	112(r)
Ethyl mercaptan [Ethanethiol]	75081	112(r)
Ethyl nitrite [Ethyl ester nitrous acid]	109955	112(r)
Ethylene [Ethene]	74851	112(r)
Ethylene dibromide [Dibromoethane]	106934	HAP
Ethylene dichloride [1,2-Dichloroethane]	107062	HAP
Ethylene glycol [1,2-Ethanediol]	107211	HAP
Ethyleneimine [Aziridine]	151564	HAP, 112(r)
Ethylene oxide [Oxirane]	75218	HAP, 112(r)
Ethylene thiourea [2-Imidazolidinethione]	96457	HAP
Ethylenediamine [1,2-Ethanediamine]	107153	112(r)
Ethylidene dichloride [1,2-Dichloroethane]	75343	HAP
Fine mineral fibers [3]	N/A	HAP
Fluoranthene[a]	206440	HAP
Fluorene[a]	86737	HAP
Fluorides	N/A	NSPS
Fluorine	7782414	112(r)
Formaldehyde [Methanal] [a]	50000	HAP, 112(r)
Furans (total tetra through octachlorinated dibenzofurans)	110009	112(r), NSPS, HAP
Glycol ethers [2](excludes sufactant alcohol ethoxylates)	N/A	HAP
Greenhouse Gases [c]	N/A	GHG
Halon-1211	353593	Ozone-Depleting
Halon-1301	75638	Ozone-Depleting
Halon-2402	124732	Ozone-Depleting

Heptachlor [1,4,5,6,7,8,8-Heptachlor-3a,4,7,7a-tetrahydro-4,7-methano-1H-indene]	76448	HAP
Hexachlorobenzene [HCB]	118741	HAP
Hexachlorobutadiene	87683	HAP
Hexachlorocyclopentadiene [Perchlorocyclopentadiene]	77474	HAP
Hexachloroethane	67721	HAP
Hexamethylene-1,6-diisocyanate [1,6-Diisocyantohexane]	822060	HAP
Hexamethylphosphoramide [Tris(dimethylamino)phosphine oxide]	680319	HAP
Hexane[a]	110543	HAP
Hydrazine	302012	HAP, 112(r)
Hydrobromofluorocarbons	N/A	Ozone-Depleting
Hydrochloric acid [Hydrogen chloride]	7647010	HAP, 112(r), NSPS
Hydrochloric acid [Hydrogen chloride](con. 37% or greater)	7647010	112(r)
Hydrochlorofluorocarbon-21 (HCFC-21)	75434	Ozone-Depleting
Hydrochlorofluorocarbon-22 (HCFC-22)	75456	Ozone-Depleting
Hydrochlorofluorocarbon-31 (HCFC-31)	593704	Ozone-Depleting
Hydrochlorofluorocarbon-121 (HCFC-121)	354143	Ozone-Depleting
Hydrochlorofluorocarbon-122 (HCFC-122)	354212	Ozone-Depleting
Hydrochlorofluorocarbon-123 (HCFC-123)	306832	Ozone-Depleting
Hydrochlorofluorocarbon-124 (HCFC-124)	2837890	Ozone-Depleting
Hydrochlorofluorocarbon-131 (HCFC-131)	359284	Ozone-Depleting
Hydrochlorofluorocarbon-132-b (HCFC-132-b)	1649087	Ozone-Depleting
Hydrochlorofluorocarbon-133-a (HCFC-133-a)	75887	Ozone-Depleting
Hydrochlorofluorocarbon-141-b (HCFC-141-b)	1717006	Ozone-Depleting
Hydrochlorofluorocarbon-142-b (HCFC-142-b)	75683	Ozone-Depleting
Hydrochlorofluorocarbon-221 (HCFC-221)	422264	Ozone-Depleting
Hydrochlorofluorocarbon-222 (HCFC-222)	422491	Ozone-Depleting
Hydrochlorofluorocarbon-223 (HCFC-223)	422526	Ozone-Depleting
Hydrochlorofluorocarbon-224 (HCFC-224)	422548	Ozone-Depleting
Hydrochlorofluorocarbon-225-ca (HCFC-225-ca)	422560	Ozone-Depleting
Hydrochlorofluorocarbon-225-cb (HCFC-225-cb)	507551	Ozone-Depleting
Hydrochlorofluorocarbon-226 (HCFC-226)	431878	Ozone-Depleting
Hydrochlorofluorocarbon-231 (HCFC-231)	421943	Ozone-Depleting
Hydrochlorofluorocarbon-232 (HCFC-232)	460899	Ozone-Depleting
Hydrochlorofluorocarbon-233 (HCFC-233)	7125840	Ozone-Depleting
Hydrochlorofluorocarbon-234 (HCFC-234)	425945	Ozone-Depleting
Hydrochlorofluorocarbon-235 (HCFC-235)	460924	Ozone-Depleting
Hydrochlorofluorocarbon-241 (HCFC-241)	666273	Ozone-Depleting
Hydrochlorofluorocarbon-242 (HCFC-242)	460639	Ozone-Depleting
Hydrochlorofluorocarbon-243 (HCFC-243)	460695	Ozone-Depleting
Hydrochlorofluorocarbon-244 (HCFC-244)	N/A	Ozone-Depleting
Hydrochlorofluorocarbon-251 (HCFC-251)	421410	Ozone-Depleting
Hydrochlorofluorocarbon-252 (HCFC-252)	819001	Ozone-Depleting
Hydrochlorofluorocarbon-253 (HCFC-253)	460355	Ozone-Depleting
Hydrochlorofluorocarbon-261 (HCFC-261)	420973	Ozone-Depleting
Hydrochlorofluorocarbon-262 (HCFC-262)	4210203	Ozone-Depleting
Hydrochlorofluorocarbon-271 (HCFC-271)	430557	Ozone-Depleting
Hydrogen	1333740	112(r)
Hydrogen cyanide [Hydrocyanic acid]	74908	HAP, 112(r)
Hydrogen fluoride [Hydrofluoric acid]	7664393	HAP
Hydrogen fluoride [Hydrofluoric acid] (con. 50% or greator)	7664393	112(r)
Hydrogen selenide	7783075	112(r)

Hydrogen sulfide	7783064	112(r), NSPS
Hydroquinone [p-Hydroquinone; 1,4-Benzenediol]	123319	HAP
Indeno(1,2,3-cd)pyrene[a]	193395	HAP
Iron,pentacarbonyl-(Iron carbonyl)	13463406	112(r)
Isobutane (2-Methyl propane)	75285	112(r)
Isobutyronitrile (2-Methyl-propanenitrile)	78820	112(r)
Isopentane (2-Methyl-butane)	78784	112(r)
Isophorone (3,5,5-Trimethyl-2-cyclohexane-1-one)	78591	HAP
Isoprene (2-Methyl-1,3-butadiene)	78795	112(r)
Isopropylamine (2-Propamine)	75310	112(r)
Isopropyl chloride (2-chloro-propane)	75296	112(r)
Isopropyl chloroformate (1-Methylethyl ester carbonochloridic acid)	108236	112(r),
Lead	7439921	Criteria, NSPS
Lead arsenate	7645252	HAP
Lead (+2) arsenate	7784409	HAP
Lead Compounds	N/A	HAP
Lindane (All isomers)	58899	HAP
Maleic anhydride [2,5-Furandione]	108316	HAP
Manganese Compounds	N/A	HAP
Mercury Compounds	N/A	HAP
Methacrylonitrile [2-Methyl-2-propenenitrile]	126987	112(r)
Methane [c]	74828	112(r)
Methanol [Methyl alcohol]	67561	HAP
Methoxychlor [1,1'-(2,2,2-Trichloroethylidene)bis(4-methoxy benzene)]	72435	HAP
Methylamine [Methanamine]	74895	112(r)
Methyl bromide [Bromomethane]	74839	HAP, Ozone-Depleting
3-Methylchloranthrene[a]	56495	HAP
Methyl chloride [Chloromethane]	74873	HAP, 112(r)
Methyl chloroform [1,1,1-Trichloroethane]	71556	HAP, Ozone-Depleting
Methyl chloroformate [Methyl ester carbonochloridic acid]	79221	112(r)
Methyl ether [Oxybismethane]	115106	112(r)
Methyl formate [Methyl ester formic acid]	107313	112(r),
Methyl hydrazine	60344	HAP, 112(r)
Methyl iodide [Iodomethane]	74884	HAP
Methyl isobutyl ketone [Hexone][MIBK]	108101	HAP
Methyl isocyanate [Isocyanato-methane]	624839	HAP, 112(r)
2-Methyl-l-butene	563462	112(r)
3-Methyl-l-butene	563451	112(r)
2-Methylnaphthalene[a]	91576	HAP
Methyl mercaptan [Methanethiol]	74931	112(r)
Methyl methacrylate [Methyl ester 2-methyl-2-propenoic acid]	80626	HAP
2-Methylpropene [2-Methyl-1-propene]	115117	112(r)
Methyl tert-butyl ether [2-Methoxy-2-methyl propane]	1634044	HAP
Methyl thiocyanate [Methyl ester thiocyanic acid]	556649	112(r)
4,4'-Methylene bis(2-chloroaniline)	101144	HAP
Methylene chloride [Dichloromethane]	75092	HAP
4,4,-Methylenedianiline [4,4'-Methylenebis(2-chlorobenzenamine)]	101779	HAP
4,4'-Methylenediphenyl diisocyanate [MDI; Methylene biphenyl isocyanate]	101688	HAP
Methyltrichlorosilane [Trichloromethylsilane]	75796	112(r)

Municipal waste combustor organics (measured as total tetra- thru octa-chlorinated dibenzo-p-dioxins and dibenzofurans)	N/A	NSPS
Municipal waste combustor metals (measured as particulate matter)	N/A	NSPS
Municipal waste combustor acid gases (measured as sulfur dioxide and hydrogen chloride)	N/A	NSPS
Municipal solid waste landfill emissions (measured as non-methane organic compounds)	N/A	NSPS
Naphthalene[a]	91203	HAP
Nickel Compounds	N/A	HAP
Nickel carbonyl	13463393	HAP, 112(r)
Nickel oxide [Nickel mono-oxide; Bunsenite]	1313991	HAP
Nickel sulfate	7786814	HAP
Nitric acid (conc. 80% or greater)	7697372	112(r)
Nitric oxide [Nitrogen oxide (NO)]	10102439	112(r)
Nitrobenzene	98953	HAP
4-Nitrobiphenyl [4-Nitro-1,1'-biphenyl]	92933	HAP
Nitrogen dioxide	10102440	Criteria, NSPS
Nitrogen oxides (NO; NO_2; NO_3; N_2O; N_2O_3; N_20_4; N_20_5)	N/A	NSPS
4-Nitrophenol [p-Nitrophenol]	100027	HAP
2-Nitropropane	79469	HAP
N-Nitrosodimethylamine [N-Methyl-N-nitrosomethanamine]	62759	HAP
N-Nitroso-N-rnethylurea [Methylnitrosourea]	684935	HAP
N-Nitrosomorpholine	59892	HAP
Oleum (Fuming Sulfuric acid) [Sulfuric acid, mixture with sulfur trioxide]	8014957	112(r)
Ozone	N/A	Criteria
Parathion [O,O-diethyl O-(4-nitrophenyl) ester phosphorothioic acid	56382	HAP
Particulate matter [PM]	N/A	NSPS
Particulate matter with an aerodynamic diameter less than 10 microns [PM_{10}]	N/A	Criteria
Particulate matter with an aerodynamic diameter less than 2.5 microns [$PM_{2.5}$]	N/A	Criteria
Pentachloronitrobenzene [PCNB; Quintobenzene]	82688	HAP
Pentachlorophenol	87865	HAP
1,3-Pentadinene	504609	112(r)
Pentane	109660	112(r)
1-Pentene [a-Amylene]	109671	112(r)
trans-2-Pentene[(E)-2-Pentene]	646048	112(r)
sis-2-Pentene [(Z)-2-Pentene]	627203	112(r)
Peracetic acid [Ethaneperoxoic acid]	79210	112(r)
Perchloroethylene [Tetrachloroethylene]	127184	HAP
Perchloromethylmercaptan [Trichloromethanesulfenyl chloride]	594423	112(r)
Phenanathrene[a]	85018	HAP
Phenol [Hydroxybenzene]	108952	HAP
p-Phenylenediamine [1,4-Benzenediamine]	106503	HAP
Phosgene [Carbonyl chloride; Carbonic dichloride]	75445	HAP, 112(r)
Phosphine	7803512	HAP, 112(r)
Phosphorus	7723140	HAP
Phosphorus oxychloride [Phosphoryl chloride]	10025873	112(r)
Phosphorus trichloride [Phosphorous trichloride]	7719122	112(r)

Phthalic anhydride [1,3-Isobenzofurandione]	85449	HAP
Piperidine [Azacyclohexane]	110894	112(r)
Polychlorinated biphenyls [PCB’s, Aroclors]	1336363	HAP
Polycyclic Organic Matter [4]	N/A	HAP
Propadiene [1,2-Propadiene]	463490	112(r)
Propane	74986	112(r)
1,3-Propane sultone [Propane sultone; 2,2-Dioxide 1,2-oxathiolane]	1120714	HAP
b-Propiolactone [2-Oxetanone]	57578	HAP
Propionaldehyde [Propanal]	123386	HAP
Propionitrile [Propanenitrile]	107120	112(r)
Propoxur [Baygon]	114261	HAP
Propyl chloroformate [Propyl ester carbonochloridic acid]	109615	112(r)
Propylene [1-Propene]	115071	112(r)
Propylene dichloride [1,2-Dichloropropane]	78875	HAP
Propylene oxide [Methyl oxirane]	75569	HAP, 112(r)
1,2-Propylenimine [2-Methylaziridine; Propyleneimine]	75558	HAP, 112(r)
Propyne [1-Propyne]	74997	112(r)
Pyrene[a]	129000	HAP
Quinoline [1-Azanapthalene]	91225	HAP
Quinone [p-Benzoquinone; 2,5-Cyclohexadiene-1,4-dione]	106514	HAP
Radionuclides (including radon) [5]	N/A	HAP
Selenium Compounds	N/A	HAP
Silane	7803625	112(r)
Styrene [Ethenylbenzene]	100425	HAP
Styrene oxide [Phenyloxirane; Phenylethylene oxide]	96093	HAP
Sulfur dioxide	7446095	Criteria, NSPS
Sulfur dioxide (anhydrous)	7446095	112(r)
Sulfur tetrafluoride [T4-Sulfur fluoride]	7783600	112(r)
Sulfur trioxide	7446119	112(r)
Sulfuric acid mist	7664939	NSPS
2,3,7,8-Tetrachlorodibenzo-p-dioxin [Tetrachlorinated Dibenzo-p-dioxins]	1746016	HAP, NSPS
Tetrachloroethylene (Perchloroethylene)	127184	HAP
1,1,2,2-Tetrachloroethane [Acetylene tetrachloride]	79345	HAP
Tetrafluoroethylene [Tetrafluoroethene]	116143	112(r)
Tetramethyllead [Tetramethyl plumbane]	75741	112(r)
Tetramethylsilane	75763	112(r)
Tetranitromethane	509148	112(r)
Titanium tetrachloride (TiCl4) [T4- Titanium chloride]	7550450	HAP, 112(r)
Toluene [Methylbenzene] [a]	108883	HAP
2,4-Toluenediamine [4-Methyl-1,3-benzenediamine; Toluene-2,4-diamine]	95807	HAP
Toluene diisocyanate (unspecified isomer) [1,3-Diisocyanatomethylbenzene]	26471625	112(r)
2,4-Toluene diisocyanate [TDI, 2,4-diisocyanato-1-methylbenzend]	584849	HAP, 112(r)
Toluene 2,6-diisocyanate [1,3-diisocyanato-2-methylbenzene]	91087	112(r)
o-Toluidine [2-Methylbenzenamine]	95534	HAP
Total fluorides	N/A	NSPS
Total organic compounds (TOC)	N/A	NSPS
Total suspended particulate matter (TSP) [Particulate Matter]	N/A	NSPS

Total reduced sulfur (TRS) and reduced sulfur compounds	N/A	NSPS
Toxaphene [Chlorinated camphene]	8001352	HAP
1,2,4-Trichlorobenzene	120821	HAP
1, 1, 1-Trichloroethane [Methyl chloroform]	71556	HAP, Ozone-Depleting
1,1,2-Trichloroethane	79005	HAP
Trichloroethylene	79016	HAP
Trichloromethane [Chloroform]	67663	HAP, 112(r)
2,4,5-Trichlorophenol	95954	HAP
2,4,6-Trichlorophenol	88062	HAP
Trichlorosilane	10025782	112(r)
Triethylamine [N,N-Diethylethanamine]	121448	HAP
Trifluorochloroethylene [Chlorotrifluoroethene]	79389	112(r)
Trifluralin	1582098	HAP
Trimethylamine [N,N dimethylmethanamine]	75503	112(r)
Trimethylchlorosilane [Chlorotrimethylsilane]	75774	112(r)
2,2,4-Trimethylpentane [Isooctane]	540841	HAP
Urethane (Carbamic acid ethyl ester)	51796	HAP
Vinyl acetate [Acetic acid ethenyl ester]	108054	HAP, 112(r)
Vinylacetylene [I-Buten-3-yne]	689974	112(r)
Vinyl bromide [Bromoethene]	593602	HAP
Vinyl chloride [Chloroethene]	75014	HAP, 112(r)
Vinyl ethyl ether [Ethyl vinyl ether, Ethoxyethene, EVE]	109922	112(r)
Vinyl fluoride [Fluoroethene]	75025	112(r)
Vinylidene chloride [1,1-Dichloroethylene]	75354	HAP, 112(r)
Vinylidene fluoride [1,1-Difluoroethylene]	75387	112(r)
Vinyl methyl ether [Methyl vinyl ether, Methoxyethene, MVE]	107255	112(r)
Volatile organic compounds [VOC's] [d]	N/A	Criteria, NSPS
Xylenes (isomers and mixtures)	1330207	HAP
m-Xylene [1,3-Dimethylbenzene]	108383	HAP
o-Xylene [1,2-Dimethylbenzene]	95476	HAP
p-Xylene [1,4-Dimethylbenzene]	106423	HAP

[a] These pollutants are also considered to be polycyclic organic matter (POM).

[b] There is no significance to the order the types are listed in this table. Refer to the following sections of the main report for more information regarding each type of regulated pollutant:
For “Criteria” refer to Section 2.1.1.
For “NSPS” refer to Section 2.1.2.
For “HAP” refer to Section 2.1.3.
For “Ozone-Depleting” refer to Section 2.1.4.
For “112(r)” refer to Section 2.1.5.
For “GHG” refer to Section 2.1.6.

[c] One of the pollutants listed in this table (i.e., methane) is a specific GHG; however, it is not identified as such in this table because this table is not intended to be an exhaustive list of <u>all</u> GHGs. Refer to Section 2.1.6 for a definition of GHG.

[d] Some of the pollutants listed in this table are specific VOC; however, they are not identified as such in this table because this table is not intended to be an exhaustive list of <u>all</u> VOCs. Refer to Section 2.1.1 for a definition of VOC.

Appendix C. Source Categories for which Fugitives are Counted in PTE (and for which 100 tpy PSD Major Source Threshold is Applicable)[40]

1. Fossil fuel-fired steam electric plants of more than 250 million Btu/hr heat input
2. Coal cleaning plants (with thermal dryers)
3. Kraft pulp mills
4. Portland cement plants
5. Primary zinc smelters
6. Iron and steel mill plants
7. Primary aluminum ore reduction plants
8. Primary copper smelters
9. Municipal incinerators capable of charging more than 250 tons of refuse per day
10. Hydrofluoric acid plants
11. Sulfuric acid plants
12. Nitric acid plants
13. Petroleum refineries
14. Lime plants
15. Phosphate rock processing plants
16. Coke oven batteries
17. Sulfur recovery plants
18. Carbon black plants (furnace plants)
19. Primary lead smelters
20. Fuel conversion plants
21. Sintering plants
22. Secondary metal production plants
23. Chemical process plants (The term chemical processing plant shall not include ethanol production facilities that produce ethanol by natural fermentation included in NAICS codes 325193 or 312140)
24. Fossil fuel boilers (or combinations thereof) totaling more than 250 million Btu/hr heat input
25. Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels

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[40] For complete rule context, refer to 40 CFR 51.165(a)(1)(iv)(C).

26. Taconite ore processing plants

27. Glass fiber processing plants

28. Charcoal production plants.

29. Any other stationary source category which, as of August 7, 1980, is being regulated under section 111 or 112 of the Act.

Appendix D. Major Source Thresholds for Title V Operating Permit[41]

A major source, for the purposes of Title V, is a source that meets any one or more of the following:

- Has the potential-to-emit (PTE) of a regulated pollutant (See Appendix B) at 100 tons per year (tpy) or more
- Has the PTE of an individual HAP of 10 tpy or more or the PTE of 25 tpy or more for the sum of HAP
- Is located in a serious, severe, or extreme nonattainment area and has the PTE of NO_x or VOC of greater than or equal to 50, 25, or 10 tpy, respectively
- Is located in a serious CO nonattainment area, and the Administrator has determined that stationary sources contribute significantly to the CO ambient levels in the area, and has the PTE of CO of 50 tpy or more
- Is located in a serious particulate matter (PM_{10}) nonattainment area that has the PTE of PM_{10} of 70 tpy or more
- Is located within an ozone transport region (OTR) and has the PTE of VOC of greater than or equal to 50 tpy, or a PTE of NO_x of greater than or equal to 100 tpy.

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[41] For complete rule context, refer to 40 CFR 70.2 and the "major source" definition.

Appendix E. Major NSR Thresholds for Nonattainment Areas (NNSR)[42]

Pollutant	**Nonattainment Classification**	**Major NNSR Source Threshold (tpy)**
Ozone (VOC or NO_x)	Marginal	100
	Moderate	100
	Serious	50
	Severe	25
	Extreme	10
PM (10μm)	Moderate	100
	Serious	70
CO	Moderate	100
	Serious	50
SO_2, NO_x and Lead	Nonattainment	100

[a] Current attainment status for each state can be found in EPA's "Green Book"
http://www3.epa.gov/airquality/greenbook/astate.html

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[42] For complete rule context, refer to 40 CFR 51.165(a)(1)(iv)(A).

Appendix F. NSPS that are Applicable to Equipment at the Design Plant

Table F-1. NSPS Subpart Db. Standards of Performance for Industrial-Commercial-Institutional Steam-Generating Units[a]

Applicability	• Steam generating units with a design rate greater than 100 MMBtu/hr (29 MW). [60.40b(a)]
Assumptions	• Design plant has a boiler used to produce steam that burns lignin and the unconverted cellulose and hemicellulose from the feedstock, biogas from anaerobic digestion, biomass sludge from WWT, and PSA offgas from the hydrotreating unit. It is assumed that a biomass stoker boiler will be used at the biorefinery and the biorefinery has an annual capacity factor greater than 30% for wood.
SO_2 Standards	• SO_2 emission rate of 87 ng/J (0.20 lb/MMBtu) heat input or less. [60.42b(k)(1)]
PM Standards	• PM emission rate of 0.10 lb/MMBtu.
NO_x Standards	• The boiler is not subject to the NOx emission limits in the boiler NSPS because the annual capacity factor for natural gas is expected to be less than 10% (natural gas is only used during startup)
Compliance	• Must maintain at the affected facility fuel receipts (such as a current, valid purchase contract, tariff sheet, or transportation contract) from the fuel supplier that certify that the oil meets the definition of distillate oil and gaseous fuel meets the definition of natural gas as defined in §60.41b and the applicable sulfur limit. [60.49b(r)] • Develop and submit a site-specific fuel analysis plan to the Administrator of the EPA (or his authorized representative) for review and approval no later than 60 days before the date you intend to demonstrate compliance. Each fuel analysis plan shall include a minimum initial requirement of weekly testing. [60.49b(r)]
Design Plant Area	• Area 800: Combustor, Boiler, and Turbogenerator
Specific Design Plant Equipment	• M-803; one boiler at design plant sized at 300 MMBtu/hour.

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?SID=850c40f563bbbd28fe98e5d0f3d88668&mc=true&node=sp40.7.60.d_0b&rgn=div6

Table F-2. NSPS Subpart IIII. Standards of Performance for Stationary Compression Ignition (CI) Internal Combustion Engines (ICE)[a]

Applicability	• Stationary compression ignition internal combustion engines [60.4200(a)]
Assumptions	• Although the design report does not mention emergency engines, it is assumed the design plant will have an emergency stationary compression ignition engine that is <300 HP with a displacement of less than 30 liters per cylinder. As such, this rule is applicable to the biorefinery.
PM Standards	• 0.15 g/hp-hr [60.4205(c)]
NMHC + NO_x Standards	• 3.0 g/hp-hr [60.4205(c)]
Compliance	• The sulfur content of the diesel fuel combusted in the emergency fire water-pump engine shall not exceed 15 ppm. [60.4207(b)] • The diesel fuel combusted in the emergency fire water-pump engine shall have a minimum centane index of 40 or a maximum aromatic content of 35 volume percent. [60.4207(b)]
Design Plant Area	• Area 900: Emergency Engines
Specific Design Plant Equipment	• Not included in design report.

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?SID=850c40f563bbbd28fe98e5d0f3d88668&mc=true&node=sp40.7.60.iiii&rgn=div6

Appendix G. Clean Air Act HAPs Used to Determine Applicability of Chemical Manufacturing Operations to Chemical Manufacturing Area Sources NESHAP (40 CFR 63, Subpart VVVVVV)[a]

Type of HAP	Chemical Name	CAS #
1. Metal compounds	Arsenic compounds	-
	Cadmium compounds	-
	Chromium compounds	-
	Lead compounds	-
	Manganese compounds	-
	Nickel compounds	-
2. Organic compounds	Chloroform	67-66-3
	Acetaldehyde	75-07-0
	Methylene chloride (Dichloromethane)	75-09-2
	Quinoline	91-22-5
	1,3-Butadiene	106-99-0
	Ethylene dichloride (1,2-Dichloroethane)	107-06-2
	Hexachlorobenzene	118-74-1
	1,3-Dichloropropene	542-75-6
3. Others	Hydrazine	302-01-2

[a] The following website provides an electronic copy of the most updated HAP list to determine the applicability of this rule: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr;rgn=div6;view=text;node=40%3A15.0.1.1.1.35;idno=40;sid=fd3b12eb6d0178cbf50139f96d7e9fad;cc=ecfr

Appendix H. Specific NESHAPs that may be Applicable to the Design Plant

Table H-1a. NESHAP Subpart FFFF. National Emission Standards for HAPs for Miscellaneous Organic Chemical Manufacturing (MON)[a]

Applicability	• In order to be subject to Subpart FFFF a facility must meet the following four (4) conditions: [63.2435] 1. The facility is a major source of HAPs; [63.2435(a)] 2. Manufactures any material or family of materials described in paragraphs 63.2435(b)(1)(i) through (v); [63.2435(b)(1)] 3. Processes, uses, or generates any of the organic HAP listed in section 112(b) of the CAA or hydrogen halide and halogen HAP, as defined in §63.2550; [63.2435(b)(2)] 4. Not an affected source or part of an affected source under another subpart of this part 63, except for process vents from batch operations within a chemical manufacturing process unit (CMPU), as identified in §63.100(j)(4). [63.2435(b)(3)]
Assumptions	• This rule would be applicable to the biorefinery **IF** the biorefinery has the potential to emit of any single HAP at a rate **>10 tpy**, and any combination of HAP at a rate **>25 tpy**. • Design plant produces acetaldehyde (or another HAP listed in Table 1 of the regulation) as a byproduct of the pretreatment and conditioning process (Area 200), the Enzymatic Hydrolysis, Hydrolysate Conditioning, Bioconversion process (Area 300), the Product Recovery and Upgrading process (Area 500), and/or the Wastewater Treatment (Area 600). • No halogenated streams.
	A. Batch process vents
Assumptions	• Data to determine HAP content in all batch process vents do not exist for design plant; therefore, assume each of the batch process vents in a process for which the collective uncontrolled organic HAP emissions from batch process vents is equal to or greater than 3,000 lb/yr, which designates batch process vents as Group 1 (which is worst case scenario for batch process vent rule requirements). • Although the design report states that it is unlikely that “the hydrocarbon product targeted here has much lower volatility so there is nearly no FFA product in the vent gas and a scrubber is not required”, the HAP concentrations that may be emitted from any of the process vents at this design plant are unknown; therefore, assume worst case that HAP is emitted in large enough quantities to require control.
HAP Standards	• Reduce collective uncontrolled organic HAP emissions from the sum of all batch process vents within the process by ≥98 percent by weight by venting emissions from a sufficient number of the vents through one or more closed-vent systems to any combination of control devices (except a flare). [63.2460(a)]

	• Reduce collective uncontrolled organic HAP emissions from the sum of all batch process vents within the process by ≥95 percent by weight by venting emissions from a sufficient number of the vents through one or more closed-vent systems to any combination of recovery devices or a biofilter, except you may elect to comply with the requirements of Subpart WW of this part for any process tank. [63.2460(a)] • Reduce uncontrolled organic HAP emissions from one or more batch process vents within the process by venting through a closed-vent system to a flare or by venting through one or more closed-vent systems to any combination of control devices (excluding a flare) that reduce organic HAP to an outlet concentration ≤20 ppmv as TOC[b] or total organic HAP. [63.2460(a)]
Design Plant Area	• Area 300: Enzymatic Hydrolysis, Hydrolysate Conditioning, and Bioconversion
Specific Design Plant Equipment	• F-300B Aerobic Bioreactor
B. Continuous process vents	
Assumptions	• Flow rate is greater than or equal to 0.005 standard cubic meter per minute. • Data to allow TRE[c] calculations do not exist for design plant; therefore, assume TRE ≤5.0 which designates continuous process vents as Group 1 (which is worst case scenario for process vent rule requirements). • Although the design report states that it is unlikely that "the hydrocarbon product targeted here has much lower volatility so there is nearly no FFA product in the vent gas and a scrubber is not required", the HAP concentrations that may be emitted from any of the process vents at this design plant are unknown; therefore, assume worst case that HAP is emitted in large enough quantities to require control.
HAP Standards	• Reduce emissions of total organic HAP by ≥98 percent by weight or to an outlet process concentration ≤20 ppmv as organic HAP or TOC by venting emissions through a closed-vent system to any combination of control devices (except a flare). [63.2455(a)] • Reduce emissions of total organic HAP by venting emissions through a closed vent system to a flare. [63.2455(a)] • Use a recovery device to maintain the TRE above 5.0. [63.2455(a)]
Design Plant Area	• Area 200: Pretreatment and Conditioning • Area 300: Enzymatic Hydrolysis, Hydrolysate Conditioning, and Bioconversion
Specific Design Plant Equipment	• M-207 Pretreatment Reactor • F-300 Enzymatic Hydrolysis Reactor
C. Storage tanks	
Assumptions	• Design plant will have storage tanks meeting only Group 2 storage tank thresholds. Although there may be tanks with capacity greater than or equal to 10,000 gallons, these tanks will not store material that have a maximum true vapor pressure of total HAP greater than or equal to 0.69 kilopascals.

	• Although the Product Storage Tank (T-701) located in Area 700 meets the capacity threshold of this rule, it is unlikely that it would meet the maximum true vapor pressure of the rule because it is storing “diesel-range paraffinic product suitable as a diesel blendstock”.
HAP Standards	• No specific control requirements.
Design Plant Area	• None, see assumptions.
Specific Design Plant Equipment	• None, see assumptions.
D. Wastewater	
Assumptions	• Design plant will have wastewater meeting applicability Group 2 wastewater thresholds as follows: - Total annual organic HAP concentration <10,000 ppm by weight at all flow rates, <1000 ppm by weight annual average concentration, and <2000 lb/yr in the total annual load as specified in 63.2485(c); OR - The annual average flow rate is less than 0.02 liter per minute or the annual average concentration for each individual Table 8 compound is less than 10 parts per million by weight as specified in 63.132(d)(2)) - There are more requirements (not shown here) if the partially soluble HAP (listed in Table 8 of NESHAP Subpart FFFF) concentration in a wastewater stream is equal to or greater than 10,000 parts per million by weight (ppmw) AND the wastewater stream contains a separate organic phase; however, this is **not** possible to determine with the information provided in the design report.]
HAP Standards	• No specific control requirements. • Submit certain information in the Notification of Compliance Status Report. [63.2485(a) and 63.146(b)(1)] • Keep certain records for each wastewater stream. [63.2485(a) and 63.147(b)(8)]
Design Plant Area	• Area 600: Wastewater Treatment
Specific Design Plant Equipment	• Any wastewater stream meeting applicability thresholds from any Areas of design plant.
E. Heat exchange system	
Assumptions	• Design plant will have a cooling tower system (capable of handling 44,200 gallons per minute) that does not meet any of the criteria specified in 63.104(a)(1) through (6). [Note: it is possible that the cooling tower system would meet 63.104(a)(2) (which says if the intervening cooling fluid between the process and the cooling water contains <5% by weight of total HAPs listed in Table 4 of 40 CFR 63, Subpart F, the cooling tower system is excluded from any requirements under this rule); however, this is **not** possible to determine with the information provided in the design report.]
HAP Standards	• Work practice standards to minimize HAP emissions apply. • Monitor the cooling water for the presence of one or more organic hazardous air pollutants or other representative substances whose presence in cooling water indicates a leak. Requires samples to be monitored for certain HAPs dependent on whether heat exchanger system is recirculating or once-through design. [63.2490(a) and 63.104(b)]

	• Monitor using a surrogate indicator of heat exchange system leaks. Prepare and implement a monitoring plan that documents the procedures that will be used to detect leaks of process fluids into cooling water. The plan shall require monitoring of one or more surrogate indicators or monitoring of one or more process parameters or other conditions that indicate a leak. Surrogate indicators that could be used to develop an acceptable monitoring program are ion specific electrode monitoring, pH, conductivity or other representative indicators. [63.2490(a) and 63.104(c)] • Leak repair requirements in §63.104(d) and (e), and the recordkeeping and reporting requirements in §63.104(f). Leak shall be repaired as soon as practical but not later than 45 calendar days and confirmed to not be leaking after repair or startup. [63.2490(a)].
Design Plant Area	• Area 900: Cooling Tower
Specific Design Plant Equipment	• M-902 Cooling Tower System

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?SID=4b90cbfb4762f2efba8a51a30f01f8e6&mc=true&node=sp40.13.63.ffff&rgn=div6

[b] TOC means Total Organic Compounds measured according to the procedures in Method 18—Measurement of gaseous organic compound emissions by gas chromatography (refer to Appendix A-6 to Part 60 here: http://www.ecfr.gov/cgi-bin/text-idx?SID=eb7e7415623c327a122a78e441223d4d&node=40:8.0.1.1.1&rgn=div5#40:8.0.1.1.1.0.1.1.6). TOC is frequently used as a surrogate for organic HAP because of the available test method for measuring TOC. It is usually taken as synonymous with organic HAP.

[c] TRE means Total Resource Effectiveness. It is a measure of the supplemental total resource requirement per unit reduction of organic HAP associated with a process vent stream, based on vent stream flow rate, emission rate of organic HAP, net heating value, and corrosion properties (whether or not the vent stream contains halogenated compounds), as quantified by an equation (see 63.2455(b)) developed from current characteristics of process vents. TRE was developed by the EPA as a cost cut-off concept that when equal to or higher than a given number of a federal rule, the facility is not required to install control.

Table H-1b. NESHAP Subpart VVVVVV. National Emission Standards for HAPs for Chemical Manufacturing Area Sources (CMAS)[a]

Applicability	• In order to be subject to Subpart VVVVVV a facility must meet the following three (3) conditions: [63.11193] 1. The facility is an area (minor) source of HAPs; [63.11494(a)(1)] 2. Use a feedstock or produce a product or byproduct containing any HAP listed in Table 1 of the regulation; and [63.11494(a)(2)] *Refer to Appendix G of this report for chemical list.* 3. One of the following is met: - The HAP(s) in feedstock have levels greater than 1.0% (for quinoline, manganese, and/or trivalent chromium), or 0.1% for any other HAP listed in Table 1 of the regulation; - Quinoline is generated as byproduct and is present in the CMPU in any liquid stream (process or waste) at a concentration greater than 1.0 percent by weight; - Hydrazine and/or Table 1 organic HAP other than quinoline are generated as byproduct and are present in the CMPU in any liquid stream (process or waste), continuous process vent, or batch process vent at an individual concentration greater than 0.1 percent by weight; or - Hydrazine or any HAP listed in Table 1 of the regulation is produced as a product of the CMPU. [63.11494(a)(2)]
Assumptions	• Design plant is an area source of HAP (i.e., it has the potential to emit any single HAP at a rate **<10 tpy**, and any combination of HAP at a rate **<25 tpy**). • Design plant produces acetaldehyde (or another HAP listed in Table 1 of the regulation) as a byproduct of the pretreatment and conditioning process (Area 200), the Enzymatic Hydrolysis, Hydrolysate Conditioning, Bioconversion process (Area 300), the Product Recovery and Upgrading process (Area 500), and/or the Wastewater Treatment (Area 600). • No metal HAPs. • No halogenated streams.
A. Batch process vents	
Assumptions	• Total organic HAP emissions from batch process vents are equal to or greater than 10,000 lb/yr (which is worst case scenario for batch process vent rule requirements). • Although the design report states that it is unlikely that "the hydrocarbon product targeted here has much lower volatility so there is nearly no FFA product in the vent gas and a scrubber is not required", the HAP concentrations that may be emitted from any of the process vents at this design plant are unknown; therefore, assume worst case that HAP is emitted in large enough quantities to require control.
HAP Standards	• Reduce collective uncontrolled total organic HAP emissions from the sum of all batch process vents by ≥90 percent by weight or to ≤20 ppmv by routing emissions from a sufficient number of the batch process vents through a closed vent system to any combination of control devices (except a flare) in accordance with the requirements of §63.982(c). [63.11496(a)]

	• Route emissions from batch process vents containing at least 90 percent of the uncontrolled total organic HAP through a closed-vent system to a flare in accordance with the requirements of §63.982(b). [63.11496(a)] • Comply with the alternative standard specified in §63.2505. [63.11496(a)]
Design Plant Area	• Area 300: Enzymatic Hydrolysis, Hydrolysate Conditioning, and Bioconversion
Specific Design Plant Equipment	• F-300B Aerobic Bioreactor
B. Continuous process vents	
Assumptions	• Data to allow TRE[b] calculations do not exist for design plant; therefore, assume TRE ≤1.0 which designates continuous process vents as Group 1 (which is worst case scenario for process vent rule requirements). • Although the design report states that it is unlikely that “the hydrocarbon product targeted here has much lower volatility so there is nearly no FFA product in the vent gas and a scrubber is not required”, the HAP concentrations that may be emitted from any of the process vents at this design plant are unknown; therefore, assume worst case that HAP is emitted in large enough quantities to require control.
HAP Standards	• Reduce emissions of total organic HAP by ≥95 percent by weight (≥85 percent by weight for periods of startup or shutdown) or to ≤20 ppmv by routing emissions through a closed vent system to any combination of control devices (except a flare) in accordance with §63.982(c). [63.11496(b)] • Reduce emissions of total organic by HAP by routing all emissions through a closed-vent system to a flare in accordance with §63.982(b). [63.11496(b)] • Comply with the alternative standard specified in §63.2505. [63.11496(b)]
Design Plant Area	• Area 200: Pretreatment and Conditioning • Area 300: Enzymatic Hydrolysis, Hydrolysate Conditioning, and Bioconversion
Specific Design Plant Equipment	• M-207 Pretreatment Reactor • F-300 Enzymatic Hydrolysis Reactor
C. Storage tanks	
Assumptions	• Design plant will have storage tanks but they do not meet any of the rule's applicability criteria. Although there are tanks with capacity greater than or equal to 40,000 gallons, that may store liquid that contains organic HAP listed in Table 1 of this rule, these tanks do not store material that has a maximum true vapor pressure of total HAP at the storage temperature greater than or equal to 5.2 kilopascals. • Although the Product Storage Tank (T-701) located in Area 700 meets the capacity threshold of this rule, it is unlikely that it would meet the maximum true vapor pressure of the rule because it is storing “diesel-range paraffinic product suitable as a diesel blendstock”.
HAP Standards	• No specific control requirements.
Design Plant Area	• None, see assumptions.
Specific Design Plant Equipment	• None, see assumptions.

D. Wastewater	
Assumptions	• Design plant will have wastewater that contains at least 5 ppmw of any HAP listed in Table 9 to 40 CFR part 63, Subpart G and has an annual average flow rate of 0.02 liters per minute. [Note: there are more requirements (not shown here) if the partially soluble HAP (listed in Table 7 of NESHAP Subpart VVVVVV) concentration in a wastewater stream is equal to or greater than 10,000 parts per million by weight (ppmw) and the wastewater stream contains a separate organic phase; however, this is not possible to determine with the information provided in the design report.]
HAP Standards	• Discharge to onsite or offsite wastewater treatment or hazardous waste treatment. [63.11498(a)] • Maintain records identifying each wastewater stream and documenting the type of treatment that it receives. Multiple wastewater streams with similar characteristics and from the same type of activity in a CMPU may be grouped together for recordkeeping purposes. [63.11498(a)]
Design Plant Area	• Area 600: Wastewater Treatment
Specific Design Plant Equipment	• Any wastewater stream meeting applicability thresholds from any areas of design plant.
E. Heat exchange system	
Assumptions	• Design plant will have a cooling tower system (capable of handling 44,200 gallons per minute) that does not meet any of the criteria specified in 63.104(a)(1) through (6). [Note: it is possible that the cooling tower system would meet 63.104(a)(2) (which says if the intervening cooling fluid between the process and the cooling water contains <5% by weight of total HAPs listed in Table 4 of 40 CFR 63, Subpart F, the cooling tower system is excluded from any requirements under this rule); however, this is not possible to determine with the information provided in the design report.]
HAP Standards	• Work practice standards to minimize HAP emissions apply. • Monitor using a surrogate indicator of heat exchange system leaks. Prepare and implement a monitoring plan that documents the procedures that will be used to detect leaks of process fluids into cooling water. The plan shall require monitoring of one or more surrogate indicators or monitoring of one or more process parameters or other conditions that indicate a leak. Surrogate indicators that could be used to develop an acceptable monitoring program are ion specific electrode monitoring, pH, conductivity or other representative indicators. [63.11499(a) and 63.104(c)] • Leak repair requirements in §63.104(d) and (e), and the recordkeeping and reporting requirements in §63.104(f). Leak shall be repaired as soon as practical but not later than 45 calendar days and confirmed to not be leaking after repair or startup. [63.11499(a)].
Design Plant Area	• Area 900: Utilities
Specific Design Plant Equipment	• M-902 Cooling Tower System

[a] The following website provides an electronic copy of the most recent version of the rule:
http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr;rgn=div6;view=text;node=40%3A15.0.1.1.1.35;idno=40;sid=fd3b12eb6d0178cbf50139f96d7e9fad;cc=ecfr

[b] TRE means Total Resource Effectiveness. It is a measure of the supplemental total resource requirement per unit reduction of organic HAP associated with a process vent stream, based on vent stream flow rate, emission rate of organic HAP, net heating value, and corrosion properties (whether or not the vent stream contains halogenated compounds), as quantified by an equation (see 63.11496(b)(1)) developed from current characteristics of process vents. TRE was developed by the EPA as a cost cut-off concept that when equal to or higher than a given number of a federal rule, the facility is not required to install control.

Table H-2a. NESHAP Subpart DDDD. National Emission Standards for HAPs for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters[a]

Applicability	• Industrial, commercial, or institutional boiler that is located at, or is part of, a major source of HAP. [63.7485]
Assumptions	• Design plant uses a preheater to increase the temperature of the process stream prior to hydrotreating. This heater is referred to as a "PREHEATER" in PFD-005 of the design report. The preheater burns tailgas and natural gas. • Design plant has a boiler used to produce steam that burns lignin and the unconverted cellulose and hemicellulose from the feedstock, biogas from anaerobic digestion, biomass sludge from WWT, and PSA offgas from the hydrotreating unit. The design case does not specify the type of boiler. It is assumed it is a stoker boiler. • Boiler does not meet the definition of limited-use boiler. • Design plant has the potential to emit any single HAP at a rate **>10 tpy**, and/or any combination of HAP at a rate **>25 tpy**.
Standards and Compliance for Preheater	• Process heaters designed to burn gas 1 fuels subcategory (which includes burning only natural gas) are not subject to the emission limits under this rule, but must complete a tune-up once every 2 (or 5) years depending on the size of the process heater. [63.7500(e)]
HCL Standard for Boiler	• 2.2E-02 lb per MMBtu of heat input [63.7500(a)(1)]
CO Standards for Boiler	• 0.58lb per MMBtu of steam output
PM (filterable) Standards for Boiler	• 3.0E-02 lb per MMBtu of heat input.
Compliance for Boiler	• Performance stack testing, fuel analysis, continuous emission monitoring system (CEMS), continuous parameter monitoring system (CPMS), and/or particulate matter continuous parameter monitoring system (PM CPMS). [63.7505(c)]
Design Plant Area	• Area 500: Product Recovery and Upgrading • Area 800: Combustor, Boiler, and Turbogenerator
Specific Design Plant Equipment	• PREHEATER • M-803; one boiler at design plant sized at 300 MMBtu/hour

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?SID=4b81502efef17c46f6a556befde43fbe&mc=true&node=sp40.14.63.ddddd&rgn=div6

Table H-2b. NESHAP Subpart JJJJJJ. National Emission Standards for HAPs for Industrial, Commercial, and Institutional Boilers Area Sources[a]

Applicability	• Industrial, commercial, or institutional boiler that is located at, or is part of, an area source of HAP. [63.11193]
Assumptions	• Design plant has a boiler used to produce steam that burns lignin and the unconverted cellulose and hemicellulose from the feedstock, biogas from anaerobic digestion, biomass sludge from WWT, and PSA offgas from the hydrotreating unit. • Boiler does not meet the definition of seasonal boiler or limited-use boiler. • Design plant has the potential to emit any single HAP at a rate **<10 tpy**, and any combination of HAP at a rate **<25 tpy**.
PM (filterable) Standards	• 3.0E-02 lb per MMBtu of heat input. [63.11201(a)]
Compliance	• Minimize the boiler's startup and shutdown periods and conduct startups and shutdowns according to the manufacturer's recommended procedures. If manufacturer's recommended procedures are not available, you must follow recommended procedures for a unit of similar design for which manufacturer's recommended procedures are available. [63.11201(b)] • Conduct a tune-up of the boiler biennially (if boiler does not use an oxygen trim system that maintains an optimum air-to-fuel ratio). [63.11201(b)] • Conduct a tune-up of the boiler every 5 years (if boiler has an oxygen trim system that maintains an optimum air-to-fuel ratio that would otherwise be subject to a biennial tune-up). [63.11201(b)]
Design Plant Area	• Area 800: Combustor, Boiler, and Turbogenerator
Specific Design Plant Equipment	• M-803; one boiler at design plant sized at 53.1 MW.

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?node=sp40.15.63.jjjjjj

Table H-3a. NESHAP Subpart ZZZZ. National Emission Standards for HAPs for Stationary Reciprocating Internal Combustion Engines (RICE)[a]

Applicability	• Stationary reciprocating internal combustion engines at a major or area source of HAP emissions.
Assumptions	• Although the design report does not mention emergency engines, it is assumed the design plant will have an emergency stationary RICE that is black start stationary and <300HP. Black start engine means an engine whose only purpose is to start up a combustion turbine. • Design plant has the potential to emit any single HAP at a rate **<10 tpy**, and any combination of HAP at a rate **<25 tpy**.
Work Practice Standards	• Work practice standards to minimize HAP emissions apply. (see compliance)
Compliance	• Change oil and filter every 500 hours of operation or annually, whichever comes first. [63.6603(a)] • Inspect air cleaner every 1,000 hours of operation or annually, whichever comes first, and replace as necessary. [63.6603(a)] • Inspect all hoses and belts every 500 hours of operation or annually, whichever comes first, and replace as necessary. [63.6603(a)]
Design Plant Area	• Area 900: Emergency Engines
Specific Design Plant Equipment	• Not included in design report.

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?SID=5e24fb7117bef7cb5c760e7c00866c99&mc=true&node=sp40.14.63.zzzz&rgn=div6

Table H-3b. NESHAP Subpart ZZZZ. National Emission Standards for HAPs for Stationary RICEs[a]

Applicability	• Stationary reciprocating internal combustion engines at a major or area source of HAP emissions.
Assumptions	• Although the design report does not mention emergency engines, it is assumed the design plant will have an emergency stationary RICE that is black start stationary and <300HP. Black start engine means an engine whose only purpose is to start up a combustion turbine. • Design plant has the potential to emit any single HAP at a rate **>10 tpy**, and/or any combination of HAP at a rate **>25 tpy**.
Work Practice Standards	• Work practice standards to minimize HAP emissions apply. (see compliance)
Compliance	• Change oil and filter every 500 hours of operation or annually, whichever comes first. [63.6602] • Inspect air cleaner every 1,000 hours of operation or annually, whichever comes first, and replace as necessary. [63.6602] • Inspect all hoses and belts every 500 hours of operation or annually, whichever comes first, and replace as necessary. [63.6602] • During periods of startup, you must minimize the engine's time spent at idle and minimize the engine's startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes, after which time the non-startup emission limitations apply. [63.6602]
Design Plant Area	• Area 900: Emergency Engines
Specific Design Plant Equipment	• Not included in design report.

[a] The following website provides an electronic copy of the most recent version of the rule: http://www.ecfr.gov/cgi-bin/text-idx?SID=5e24fb7117bef7cb5c760e7c00866c99&mc=true&node=sp40.14.63.zzzz&rgn=div6

Appendix I. Preliminary Estimates of Uncontrolled PTE and PTE of Regulated Air Pollutants from Sugars to Hydrocarbons Biorefinery

Link to Appendix I Excel Worksheet