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Plan Approval No. 23-0119J
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Sunoco Partners Marketing & Terminals, L.P.—Marcus Hook
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I. Introduction

Sunoco Partners Marketing & Terminals, L.P. (SPMT) owns and operates a natural gas liquids (NGLs) processing, storage, and distribution facility located at the Marcus Hook Industrial Complex (MHIC) in Marcus Hook Borough, Delaware County (hereinafter referred to as "the facility"). SPMT operates the facility under Title V Operating Permit (TVOP) No. 23-00119 and the original Plan Approval No. 23-0119E. The facility is an existing major facility for Prevention of Significant Deterioration of Air Quality (PSD) and New Source Review (NSR) purposes.

On July 29, 2019, DEP received a Plan Approval application package (in triplicate) for Project Phoenix, as described in the *Project Phoenix Description* section, below, from SPMT. The Plan Approval application package included the Plan Approval application, general information form, compliance review form [25 Pa. Code § 127.12(a)(11)], and copies of the notifications to the municipality and county [71 P.S. § 510-5 (Act 14 of 1984); 25 Pa. Code § 127.43a],[1] and monies for the application fee of $7,000 [25 Pa. Code § 127.702(c)(3) and (d)(3)]. All applicable sections of the Plan Approval application were completed. Therefore, DEP considers the Plan Approval application administratively complete as of the same date. Coordination with other programs is not required.

Due to the long lead time involved with the construction of the refrigerated ethane storage tanks under Project Phoenix, SPMT has requested that DEP issue the initial Plan Approval for a term of 36 months. DEP consents to SPMT's request.

[1] On August 2, 2019, DEP received proofs of delivery for the notifications to the municipality and county.

II. Project Phoenix Description

SPMT has proposed to receive approximately 140,000 barrels per day of ethane feedstock by installing equipment to upgrade the ethane to meet the applicable specifications; chill, and store the ethane; and, ultimately, transfer the product off-site. To this end, SPMT has proposed the following (hereinafter collectively referred to as "Project Phoenix"):

- The installation of the following sources and equipment:
  - Two new 600,000-*bbl* refrigerated ethane storage tanks (Source IDs 124–125).
  - One new amine treatment system to remove excess carbon dioxide [CO_2] from ethane feedstock prior to fractionation.
  - One new dehydration train system to remove water from ethane feedstock prior to fractionation.
  - Two new refrigeration systems, each consisting of a closed-loop propane system followed by an open-loop ethane system, for the cooling of dry ethane.
  - Two new fractionation towers (demethanizers) and associated equipment for the removal of methane from dry ethane.
  - Two new wet surface air cooling (WSAC) systems (Source ID 141), one associated with each new refrigeration system, to process cooling water for the refrigeration systems.
  - One new elevated, air-assisted Project Phoenix Cold Flare (Source ID C04), equipped with high- and low-pressure (HP and LP) cold flare tips for flaring refrigerated streams that do not contain water.
  - All associated piping and components for the refrigerated ethane process.
- The use of two existing marine vessel loading docks (1A and 2A; part of Source ID 104 under Title V Operating Permit (TVOP) No. 23-00119) for the loading of liquified ethane into marine vessels.
- The increased use of steam (36,300 *lbs/hr*) from three auxiliary boilers (1 and 3–4; Source IDs 031 and 033–034 under TVOP No. 23-00119) by the amine treatment system and dehydration train system.
- Incremental flows from the amine treatment system and dehydration train system to the West Warm Flare (Source ID C03 under TVOP No. 23-00119).

While other equipment associated with previous projects at the facility process, chill, and store ethane, SPMT has indicated that Project Phoenix involves a specific process design for the ethane feedstock, and that no other feedstocks are proposed to be sent to the sources and equipment associated with Project Phoenix. The respective sources and equipment of or associated with Project Phoenix are discussed in further detail, below:

A. Refrigerated ethane storage tanks: The refrigerated ethane storage tanks are proposed to be double-walled and employ boil-off gas management systems (comprised of a series of compressors) to return ethane vapors to the ethane refrigeration system. The ethane is proposed be stored at approximately 1.0 *psig* and between approximately –125 °*F* to –135 °*F*.

   The refrigerated ethane storage tanks are proposed to have operational, maintenance, and emergency connections to the Project Phoenix Cold Flare.

   SPMT has indicated that the ethane will contain up to 3.6*%, by weight*, propane and 0.5*%, by weight*, methane. While the refrigerated ethane storage tanks are designed to have zero emissions, fugitive emissions of volatile organic compounds [VOCs] and greenhouse gases (GHGs), in units of carbon dioxide equivalents [CO_2e], are expected from the associated piping and components in ethane service.

B. Amine treatment system: SPMT has indicated that the ethane feedstock is expected to contain CO_2 at varying concentrations up to 1000 *ppm*. The amine treatment system is proposed to remove excess CO_2 from ethane

feedstock with CO_2 concentrations equal to or greater than 100 *ppm*. (Ethane feedstock with lower CO_2 concentrations is considered to meet product specifications; therefore, SPMT has proposed that such ethane feedstock bypass the amine treatment system and be routed to the dehydration train system.) The amine treatment system is proposed to be connected to existing amine equipment for reliability.

The amine stripper tower reboiler of the amine treatment system is proposed to use 9,300 *lbs/hr* of steam from the existing auxiliary boilers.

The amine treatment system is proposed to have maintenance and emergency connections to the Project Phoenix Cold Flare, and maintenance connections to the existing West Warm Flare.

SPMT has indicated that the amine will consist of 90*%, by weight*, water and 10*%, by weight*, diethanolamine, a VOC. Therefore, fugitive emissions of VOCs are expected from the associated piping and components in amine service.

C. Dehydration train system: The molecular sieve desiccant dehydration train system is proposed to remove water entrained in the ethane feedstock. Periodically, superheated dry ethane is proposed to be run through the system to regenerate (i.e., remove the water from) the dehydration beds.

The dehydration regenerator vaporizer of the dehydration train system is proposed to use 27,000 *lbs/hr* of steam from the existing auxiliary boilers.

The dehydration train system is proposed to have maintenance and emergency connections to the Project Phoenix Cold Flare, and operational connections to the existing West Warm Flare.

As with the refrigerated ethane storage tanks, fugitive emissions of VOCs and GHGs are expected from the associated piping and components in ethane service.

D. Refrigeration systems and demethanizers: The refrigeration systems, each comprised of a closed-loop propane system followed by an open-loop ethane system, are proposed to cool dry ethane feed. Propane and ethane are proposed to be compressed, then cooled and condensed by the WSAC systems, for use as the refrigerants in the propane and ethane refrigeration systems, respectively. The demethanizers are proposed to remove methane from the methane-rich off gases generated in the ethane refrigeration systems for routing to the fuel gas system at the facility. Refrigerated ethane product is proposed to be routed from the transfer pumps to either one of the two refrigerated ethane storage tanks under Project Phoenix or one of two functionally-equivalent existing refrigerated ethane tanks (Source IDs 101 or 117 under TVOP No. 23-00119).

The refrigeration systems are proposed to have operational, maintenance, and emergency connections to the Project Phoenix Cold Flare. The demethanizers are proposed to have maintenance and emergency connections to the Project Phoenix Cold Flare.

As with the refrigerated ethane storage tanks and dehydration train system, fugitive emissions of VOCs and GHGs are expected from the associated piping and components in ethane service. In addition, fugitive emissions of VOCs are expected from the associated piping and components in propane service. Lastly, fugitive emissions of GHGs are expected from the associated piping and components of the methane/ethane system, which transports methane rich off-gases to the demethanizer.

E. WSAC Systems: The WSAC systems are proposed to process 21,000 *gals/min* of cooling water (a mixture of potable water and steam condensate) for the refrigeration systems, and be equipped with high-efficiency drift eliminators (maximum drift of 0.0005*%*) to minimize particulate matter [PM] emissions. The WSAC systems are proposed to rely on evaporative cooling to transfer heat from the propane and ethane refrigerants in the refrigeration systems, which requires an open design of the heat exchange system akin to an air-cooled fin fan-type heat exchange system. As such, VOCs from the process are not expected to accumulate in the water basins of the WSAC systems.

F. Project Phoenix Cold Flare: The Project Phoenix Cold Flare is proposed to be elevated, air-assisted, and equipped with HP and LP cold flare tips for flaring refrigerated streams (i.e., those less than –20 °*F*) that do

not contain water. The Project Phoenix Cold Flare is proposed to be manufactured by John Zink Company, LLC, or equivalent, and meet the equipment specifications and operating parameters listed in Table 1, below:

Table 1
Proposed Project Phoenix Cold Flare Equipment Specifications and Operating Parameters

	HP Cold Flare Tip	LP Cold Flare Tip
Design Volume (*scfm*)	77,120	5,270
Stack Height (*ft*)	195	195
Stack Diameter (*ft*)	2.00	1.33
Smokeless Operation?	Yes	Yes
Pilot & Purge Gas Flow Rate (*scfh*)	500	500
Sweep Gas Flow Rate (*scfh*)	6,875	1,576

Continuous flows of pilot and purge gases (natural gas; based on 8,760 *hrs/yr*) are proposed to be introduced directly into the stack of the Project Phoenix Cold Flare to ensure its safe and reliable operation. In addition, continuous flows of sweep gas (natural gas) are proposed to be introduced into the header of the Project Phoenix Cold Flare to prevent explosive conditions within the piping.

Operational, maintenance, and/or emergency flows from the refrigerated ethane storage tanks, amine treatment system, dehydration train system, refrigeration systems, and demethanizers are proposed to be sent to the Project Phoenix Cold Flare. Operational flows occur on a regular, routine, or continuous basis. Maintenance flows occur at various intervals depending on maintenance and operational schedules and the condition of the respective equipment. Emergency flows are not expected during normal operations. However, as the Project Phoenix Cold Flare is also proposed to provide safe and reliable control and destruction of gases during emergency situations, SPMT has considered emergency flows in the design of the Project Phoenix Cold Flare.

The expected/proposed pilot and purge, sweep, operational, and maintenance flows to the Project Phoenix Cold Flare, as provided by SPMT, are listed in Table 2, below:

Table 2
Expected/Proposed Flows to the Project Phoenix Cold Flare (*lbs/yr*)

Flare Tip	Flow Type(s)	Methane	Ethane	Propane	Fuel Gas	**Totals**
High-Pressure	Pilot & Purge	192,420	0	0	0	**192,420**
	Sweep	2,645,820	0	0	0	**2,645,820**
	Operational	51,100	82,913	114,488	0	**248,501**
	Maintenance	0	37,967	12,197	1	**50,165**
Low-Pressure	Pilot & Purge	192,420	0	0	0	**192,420**
	Sweep	606,492	0	0	0	**606,492**
	Operational	7,300	3,196,750	168,250	0	**3,372,300**
	Maintenance	0	488,204	25,695	0	**513,899**
Totals		**3,695,552**	**3,805,834**	**320,630**	**1**	**7,822,017**

G. Piping and components: The proposed piping and components associated with the refrigerated ethane storage tanks, amine treatment system, dehydration train system, refrigeration systems, demethanizers, and existing marine vessel loading include valves, pump seals, compressor seals, pressure relief valves, and/or flanges/ Connectors associated with this equipment and the natural gas system, methane/ethane system, ethane system, flare sweep system, and acid gas system. Based on preliminary engineering designs plus a margin of 20%, SPMT has estimated a component count for these sources (see *Attachment #1*). Fugitive emissions of VOCs and GHGs, as applicable, are expected from the proposed piping and components.

H. Marine vessel loading: Ethane is proposed to be off-loaded using existing marine vessel loading docks 1A and 2A without any modifications. Each marine vessel loading dock is equipped with two loading arms for the loading of liquified ethane into marine vessels, as well as a vapor return line to return the ethane back to the refrigerated ethane storage tanks. Thus, as with the refrigerated ethane storage tanks, the marine vessel loading is designed to have zero emissions.

I. Auxiliary boilers: Steam from the three existing auxiliary boilers is proposed to be used for the amine stripper tower reboiler of the amine treatment system (9,300 *lbs/hr*) and the dehydration regeneration vaporizer of the dehydration train system (27,000 *lbs/hr*). Therefore, the total steam demand for Project Phoenix is 36,300 *lbs/hr*.

J. West Warm Flare: For safety reasons, any flaring streams that (potentially) contain water cannot be directed to the proposed Project Phoenix Cold Flare. Along these lines, the amine treatment system and dehydration train system are proposed to include maintenance and emergency connections to the existing West Warm Flare. Due to the distance to the West Warm Flare header, incremental sweep gas flow (natural gas) is proposed to be used. The expected/proposed incremental flows of amine and natural gas to the West Warm Flare, as provided by SPMT, are 159 *lbs/yr* (maintenance) and 136,656 *lbs/yr* (sweep), respectively.

III. Emissions/Regulatory Analysis

A. Piping and components: SPMT has determined the VOC potential to emit[2] (PTE), and GHG PTE, in units of carbon dioxide equivalents [CO_2e], from the proposed piping components (see *Attachment #1*) using the calculation methodologies presented in the United States Environmental Protection Agency's (EPA's) Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017 (hereinafter referred to as "the EPA Protocol"), a component count corresponding to the preliminary engineering design plus a margin of 20*%*, and assuming continuous operation (i.e., 8,760 *hrs/yr*), as follows:

- Based on the VOC contents of the amine and propane proposed for them, the piping and components associated with the proposed amine treatment system and propane refrigeration systems are in VOC service.[3] Therefore, they are subject to the Standards of Performance for New Stationary Sources (NSPS) for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006 [40 CFR Part 60, Subpart VVa]. The applicable requirements for these piping components, including leak detection and repair (LDAR), are discussed in DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, page 19 [*Piping and components* sub-section]). For these piping components, SPMT applied a screening methodology using screening value emission factors from Tables 2-10, 2-12, and 2-14 of the EPA Protocol, average leak concentration values (based on over 2 years of leak concentration data from the facility's LDAR program), and respective component counts for each component type to obtain leak rates. Then, SPMT multiplied the leak rates by the VOC contents of the amine and propane to obtain the VOC PTE for the proposed amine treatment system and propane refrigeration systems, respectively (see *Attachment #3*).

- For the rest of the proposed components (i.e., those not in VOC service), SPMT multiplied emission factors from Table 2-1 of the EPA Protocol (without any LDAR control efficiency reduction) and respective component counts for each component type by the VOC and GHG (i.e., methane/natural gas) contents of the respective gas in each proposed system (and, for methane, the global warming potential from 40 CFR Part 98, Table A-1) to obtain the associated VOC and CO_2e PTEs (see *Attachment #4*).

DEP does not have any specific objections to the gas speciation information presented by SPMT for the methane/ethane system in Appendix D, Table D-6, of the application for Plan Approval No. 23-0119J, which

[2] As the term is defined in 25 Pa. Code § 121.1.

[3] As the term is defined in 40 CFR § 60.481a (i.e., "contains or contacts a process fluid that is at least 10[*%*] VOC by weight").

SPMT's "engineering contractor has confirmed … [is] not expected to have a VOC component." However, DEP does not concur with the gas speciation information for the natural gas system (and flare system). Based on the 2019 daily average gas chromatograph (GC) data for the MHIC from Williams Pipeline Co., the natural gas supplier for the MHIC (see *Attachment #5*), which SPMT provided as part of DEP's review of the application for Plan Approval No. 23-0119J, the average methane/GHG and VOC contents for the natural gas used at the facility are 97.43% and 0.08%, respectively (versus 90% and 0%, respectively, from the gas speciation information in Table D-6). Based on the differences between these GHG and VOC contents amount to increases in total emissions from the natural gas system and flare system of less than 2.7 *tons/yr* CO_2e and less than 0.0012 *tons/yr* VOCs, respectively.

B. WSAC Systems: SPMT has determined the PM, PM less than 10 μm in aerodynamic diameter [PM_{10}], and PM less than 2.5 μm in aerodynamic diameter [$PM_{2.5}$] PTEs for the proposed WSAC systems using the calculation methodology developed by Messrs. Joel Reisman and Gordon Frisbie in their paper titled "Calculating Realistic PM_{10} Emissions from Cooling Towers" (see *Attachment #6*, page 2 [first two full paragraphs] (i.e,. Equation 1 with a source-specific total dissolved solids content)) and based on continuous operation (i.e., 8,760 *hrs/yr*). The PM, PM_{10}, and $PM_{2.5}$ PTEs for the proposed WSAC systems are 0.552 *tons/yr*, 0.429 *tons/yr*, and 0.00133 *tons/yr*, respectively.

C. Project Phoenix Cold Flare: SPMT has determined the carbon monoxide [CO], CO_2e, nitrogen oxides [NO_x],[4] sulfur dioxide [SO_2], and VOC PTEs for the proposed Project Phoenix Cold Flare, as follows:

- CO, NO_x, and SO_2: By multiplying the total mass flows to the Project Phoenix Cold Flare, as listed in Table 2, above, by the higher heating values of the respective materials (i.e., methane/natural gas, ethane, propane, and fuel gas), and the CO, NO_x, and SO_2 emission factors for flares (0.31 *lbs/mmBtu*, 0.068 *lbs/mmBtu* and 0.0006 *lbs/mmBtu*, respectively) from EPA's AP-42, Volume I, Fifth Edition (AP-42), Table 13.5-1.

- CO_2e: Using the calculation methodology specified in 40 CFR § 98.233.

- VOCs: By multiplying the total mass flows of methane/natural gas and propane to the Project Phoenix Cold Flare, as listed in Table 2, Sub-section F. (*Project Phoenix Cold Flare*), of the *Project Phoenix Description* section, above, by their higher heating values (and, for methane/natural gas, an assumed VOC content of 1%[5]), and a proposed VOC destruction and removal efficiency (DRE) of 98% for the Project Phoenix Cold Flare.

However, as discussed in DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, pages 20 [last two paragraphs]–21 [second bullet]), the proposed Project Phoenix Cold Flare is subject to the design and operating requirements of 40 CFR § 60.18 (including maximum exit velocity, visible emissions, and a minimum net heating value for gas streams combusted in flares), except that DEP considers a VOC DRE restriction of 99.0% to be appropriate. Therefore, DEP has recalculated the VOC PTE for the proposed Project Phoenix Cold Flare using the higher VOC DRE. The

[4] All NO_x is also treated as nitrogen dioxide [NO_2].

[5] Though, based on the aforementioned 2019 daily average GC data for the MHIC (see *Attachment #5*), the maximum daily VOC content of the pipeline natural gas supplied to the MHIC was 0.158%.

CO, CO_2e, NO_x, SO_2, and VOC PTEs for the proposed Project Phoenix Cold Flare are listed in Table 3, below:

Table 3
CO, CO_2e, NO_x, SO_2, and VOC PTEs for the Proposed Project Phoenix Cold Flare (*tons/yr*)

Cold Flare Tip	Flow Type(s)	CO	CO_2e	NO_x	SO_2	VOCs
HP	Pilot & Purge	0.70	295	0.15	0.001	0.01
	Sweep	9.23	4,061	2.02	0.02	0.13
	Operational & Maintenance	1.03	418	0.23	8.1×10^{-9}	0.64
LP	Pilot & Purge	0.70	295	0.15	0.001	0.01
	Sweep	2.12	931	0.46	0.004	0.03
	Operational & Maintenance	13.35	5,280	2.93	–	0.97
	Totals	**27.12**	**11,281**	**5.95**	**0.02**	**1.79**

D. Auxiliary boilers: As discussed in DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, pages 12 [last bullet and Footnote 21] and 16 [penultimate bullet]), the auxiliary boilers did not undergo a modification.[2] Therefore, in the same manner as discussed therein, SPMT has calculated the "incremental emissions" of CO, CO_2e, sulfuric acid mist [H_2SO_4], NO_x, lead [Pb], SO_2, and VOC associated with the additional steam demand for Project Phoenix. The incremental emissions for the auxiliary boilers associated with Project Phoenix are listed in Table 4, below:

Table 4
Incremental Emissions for the Auxiliary Boilers Associated with Project Phoenix (*tons/yr*)

CO	CO_2e	H_2SO_4	NO_x	Pb	$PM/PM_{10}/PM_{2.5}$	SO_2	VOCs
1.20	30,050	0.00892	5.95	0.00107	0.218	0.660	0.434

E. West Warm Flare: As discussed in DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, pages 12 [last paragraph]–13 [remainder of paragraph] and 17 [first non-bullet paragraph]), the physical change from the Ethylene Complex Flare to the West Warm Flare is not a modification. Therefore, in the same manner as discussed therein, SPMT has calculated the incremental emissions associated with the additional flows to the West Warm Flare from Project Phoenix. The incremental emissions for the West Warm Flare associated with Project Phoenix are listed in Table 5, below:

Table 5
Incremental Emissions for the West Warm Flare Associated with Project Phoenix (*tons/yr*)

CO	CO_2e	NO_x	SO_2	VOCs
0.477	210.23	0.105	0.0984	0.0153

Based on the PTEs and incremental emissions* for the respective sources and equipment of or associated with Project Phoenix, DEP has determined the emissions increases due to Project Phoenix. The emissions increases of CO, CO_2e, H_2SO_4, NO_x, Pb, PM, PM_{10}, $PM_{2.5}$, SO_2, and VOCs due to Project Phoenix are listed in Table 6, below:

Table 6
Emissions Increases Due to Project Phoenix (*tons/yr*)

Source/Equipment	CO	CO_2e	H_2SO_4	NO_x	Pb	PM	PM_{10}	$PM_{2.5}$	SO_2	VOCs
Piping and Components	0	5,521	0	0	0	0	0	0	0	36.17
WSAC Systems	0	0	0	0	0	0.552	0.429	0.001	0	0
Project Phoenix Cold Flare	27.12	11,281	0	5.95	0	0	0	0	0.02	1.79
Auxiliary Boilers*	1.20	30,050	0.00892	5.95	0.00107	0.218	0.218	0.218	0.660	0.434
West Warm Flare*	0.477	210.23	0	0.105	0	0	0	0	0.001	0.015
Totals	**28.80**	**47,062**	**0.00892**	**12.01**	**0.00107**	**0.770**	**0.647**	**0.219**	**0.681**	**38.41**

IV. PSD/NSR Analysis

DEP typically evaluates a project for which a Plan Approval application has been submitted as a stand-alone project. However, in this case, in accordance with the remand of Plan Approval No. 23-0119E by Judge Bernard A. Labuskes, Jr., of the Environmental Hearing Board, DEP has also evaluated Project Phoenix, along with the other sources and equipment at the facility that relate to the NGLs processing, storage, and distribution operations, as part of a single aggregated project to determine the applicability of PSD and NSR requirements (see DEP's technical review memo for Plan Approval No. 23-0119E (revised) dated February 5, 2021 (*Attachment #2*) for further discussion).

Since Project Phoenix does not cause a significant emissions increase[2,6] of a regulated NSR pollutant,[2,6] pursuant to 40 CFR § 52.21(a)(2)(iv)(*a*), Project Phoenix is not a major modification[2,6] and is not subject to PSD requirements by itself. As discussed in DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, page 14 [Table 2 and second paragraph]), the single aggregated project is also not subject to PSD requirements. Therefore, Project Phoenix is not subject to any PSD requirements.

DEP typically performs the NSR analysis for a stand-alone project in accordance with 25 Pa. Code § 127.203(b)(1)(i)–(ii), which requires DEP to determine whether the emissions increases of NO_x or VOCs due to the stand-alone project, aggregated with other increases (or increases and decreases) in net emissions occurring over different look-back periods, exceed 25 *tons/yr*. However, as discussed in DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, page 18 [Table 3 and second paragraph]), the aggregated emissions increases of both NO_x and VOCs for the single aggregated project exceed 25 *tons/yr*. Therefore, the aggregated emissions increases are significant[2] for both pollutants, and Project Phoenix (along with the rest of the single aggregated project) is subject to the NSR requirements of 25 Pa. Code Chapter 127, Subchapter E, for both NO_x and VOCs.

These NSR requirements, including requirements to implement Lowest Achievable Emission Rate (LAER) and obtain NO_x and VOC emissions offsets for the single aggregated project and Project Phoenix, are discussed in the *NSR Requirements* section of DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, pages 18–22). Since the emissions increase of VOCs due to Project Phoenix exceeds 25 *tons/yr* by itself, DEP considers it appropriate for the portion of VOC Emission Reduction Credits (ERCs) required for the single aggregated project that is attributable to Project Phoenix (i.e., 49.93 *tons/yr*, or 38.41 *tons/yr* multiplied by the required offset ratio of 1.3:1) to be obtained and surrendered under pending Plan Approval No. 23-0119J. To this end, Plan Approval No. 23-0119J includes a requirement (i.e., Condition # 001,

[6] As the term is defined in 40 CFR § 52.21(b).

Section C) for SPMT to obtain and surrender these VOC ERCs prior to the commencement of operation of the sources and equipment of Project Phoenix.

As indicated in Sub-section C. (25 Pa. Code § 127.205(3)–(4)) of the *NSR Requirements* section of DEP's technical review memo for Plan Approval No. 23-0119E (revised), dated February 5, 2021 (*Attachment #2*, pages 21–22), SPMT currently (i.e., as of the date of this technical review memo) holds 89.62 tons of VOC ERCs. However, after accounting for the 59.07 tons of VOC ERCs that SPMT is required to surrender under Plan Approval No. 23-0119E (revised), SPMT does not hold sufficient VOC ERCs to satisfy the amount it is required to surrender under pending Plan Approval No. 23-0119J. SPMT has indicated that it intends to surrender the remaining balance of VOC ERCs (i.e., 30.55 tons), as well as obtain and surrender additional VOC ERCs, under pending Plan Approval No. 23-0119J prior to the commencement of operation of the sources and equipment of Project Phoenix.

V. Additional Regulatory Analysis

As the refrigerated ethane storage tanks store volatile organic liquids and have storage capacities of greater than 75 m^3, they are subject to the NSPS for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) For Which Construction, Reconstruction, or Modification Commenced After July 23, 1984 [40 CFR Part 60, Subpart Kb]. However, because of the high vapor pressure of the liquified ethane stored (108 *kPa*), the VOC standards specified in 40 CFR § 60.112b are not applicable.

VI. Recommendations

Based on a review of the previously-issued Plan Approvals and associated applications for the facility, TVOP No. 23-00119, the applications for Plan Approval Nos. 23-0119E (revised) and 23-0119J, and EPA's RACT/ BACT/LAER Clearinghouse, I recommend that DEP issue Plan Approval No. 23-0119J to SPMT for Project Phoenix.

Table 3-1: Potential Fugitive VOC and CO_2e Emissions

Project Phoenix Units	New Fugitive Components	Number of Components	VOC Emissions[1] (TPY)	CO_2e Emissions (TPY)
Refrigeration System Components	Valves	2,071	3.25	0.00
	Pump Seals	2	0.02	0.00
	Compressor Seals	12	0.04	0.00
	Pressure Relief Valves	77	0.04	0.00
	Flanges/Connectors	6,745	3.15	0.00
Amine Treatment System Components	Valves	1,397	0.22	0.00
	Pump Seals	6	0.01	0.00
	Pressure Relief Valves	30	0.00	0.00
	Flanges/Connectors	3,862	0.18	0.00
Ethane System Components	Valves	5,375	9.30	32.28
	Pump Seals	10	0.07	0.23
	Compressor Seals	14	1.14	3.96
	Pressure Relief Valves	212	7.68	26.66
	Flanges/Connectors	17,410	11.08	38.47
Methane/Ethane System Components	Valves	1,322	0	952.92
	Pressure Relief Valves	38	0	482.04
	Flanges/Connectors	3,198	0	706.40
Natural Gas System Components	Valves	445	0	577.46
	Others	10	0	216.92
	Flanges/Connectors	1,134	0	450.87
Flare Sweep System Components	Valves	815	0	1,044.88
	Flanges/Connectors	2,484	0	987.63
Acid Gas System Components	Valves	40	0	0.55
	Flanges/Connectors	48	0	0.20
Total Fugitive Emissions			**36.17**	**5,521**

[1] Potential fugitive emissions are estimated based on USEPA guidance correlations ("Protocol for Equipment Leak Emission Estimates", EPA-453/R-95-017).

COMMONWEALTH OF PENNSYLVANIA
Department of Environmental Protection
Southeast Regional Office
February 5, 2021
484.250.5920

Subject: Technical Review Memo
Revision of Plan Approval No. 23-0119E
APS ID 880945, AUTH ID 1282410
Sunoco Partners Marketing & Terminals, L.P.—Marcus Hook
100 Green Street
Marcus Hook, PA 19061

To: James D. Rebarchak 2/12/21
Regional Air Quality Program Manager
Air Quality Program
Southeast Region

From: David S. Smith DSS 2/5/21
Engineering Specialist
Facilities Permitting Section
Air Quality Program

Through: Janine Tulloch-Reid, P.E. JET 2/11/2021
Environmental Engineer Manager
Facilities Permitting Section
Air Quality Program

I. Introduction/Purpose of Authorization

Sunoco Partners Marketing & Terminals, L.P. (SPMT) owns and operates a natural gas liquids (NGLs) processing, storage, and distribution facility located at the Marcus Hook Industrial Complex (MHIC) in Marcus Hook Borough, Delaware County (hereinafter referred to as "the facility"). SPMT operates the facility under Title V Operating Permit (TVOP) No. 23-00119 and Plan Approval No. 23-0119E, which the Department of Environmental Protection (DEP) originally issued to SPMT on March 2, 2015, and April 1, 2016, respectively. The facility is an existing major facility for Prevention of Significant Deterioration of Air Quality (PSD) and New Source Review (NSR) purposes (see *PSD Analysis* and *NSR Analysis* sections, below, for further discussion).

On April 29, 2016, Clean Air Council (CAC) appealed Plan Approval No. 23-0119E to the Environmental Hearing Board (EHB; under Docket No. 2016-073-L), arguing, among other things, that DEP erred in considering the sources and equipment permitted under Plan Approval No. 23-0119E as a stand-alone project (i.e., versus as a larger project with the other sources and equipment at the facility that relate to the NGLs processing, storage, and distribution operations and were previously permitted under other Plan Approvals).

On January 9, 2019, Judge Bernard A. Labuskes, Jr., of the EHB, remanded Plan Approval No. 23-0119E to DEP for the reevaluation of the sources and equipment permitted or authorized under Plan Approval Nos. 23-0119 through 23-0119E, Request for Determination of Changes of Minor Significance and Exemption from Plan Approval/Operating Permit (RFD) No. 5236, and future projects related to the NGLs processing, storage, and distribution operations at the facility, as a single aggregated project to determine the applicability of PSD and NSR requirements (see *Single Aggregated Project Description* section, below, for further discussion).

Attachment #2

On July 29, 2019, DEP received a Plan Approval application package (in triplicate) for Plan Approval No. 23-0119E (revised) from SPMT. The Plan Approval application package included the Plan Approval application, general information form, compliance review form [25 Pa. Code § 127.12(a)(11)], and copies of the notifications to the municipality and county [71 P.S. § 510-5 (Act 14 of 1984); 25 Pa. Code § 127.43a].[1] All applicable sections of the Plan Approval application were completed. Therefore, DEP considers the Plan Approval application administratively complete as of the same date. Coordination with other programs is not required.

II. Single Aggregated Project Description

DEP is reevaluating the following authorizations at the facility, listed in chronological order by original issuance/ approval date, as a single aggregated project:

A. Plan Approval No. 23-0119 (issued on February 5, 2013)

The portion of the single aggregated project previously authorized under Plan Approval No. 23-0119 includes the following:

- The installation of the following sources and equipment:
  - A new 300,000-*bbl* refrigerated ethane storage tank.
  - A new 500,000-*bbl* refrigerated propane storage tank.
  - All associated piping and components for the refrigerated product storage.
  - A new elevated, air-assisted West Cold Flare for flaring events.
- The use of three existing marine vessel loading docks (1A, 2A, and 3C), each equipped with two new loading arms and a new vapor return line, for the loading of liquified ethane (2A) and propane (1A and 3C) into marine vessels.[2]
- The use of an existing cavern (5) for the storage of liquified propane.
- Incremental flows from cavern 5[3] to an existing elevated, steam-assisted flare located in the state of Delaware.[4]

The following sources were listed in the original Plan Approval No. 23-0119:

Source ID	Source Name[5]
101	Refrigerated Ethane Tank (300k *bbl*)*
102	Refrigerated Propane Tank (500k *bbl*)*
103	NSPS Subpart VVa Fugitive Equipment Leaks*
104	Marine Vessel Loading (Refrigerated)*

[1] On August 2, 2019, DEP received proofs of delivery for the notifications to the municipality and county.

[2] The application for Plan Approval No. 23-0119 indicated that existing marine vessel loading dock 3A, instead of 1A, would be used for the loading of liquified ethane and propane. The application for Plan Approval No. 23-0119D indicated that existing marine vessel loading dock 3A, in addition to 1A, would be used for the loading of liquified ethane, propane, and butane. As indicated in Sub-section C. [*Plan Approval No. 23-0119B (issued on January 30, 2014)*] within this section, below, marine vessel loading dock 3A is used for the loading of light naphtha.

[3] DEP did not previously evaluate the emissions from this activity as part of its review of the original authorization.

[4] SPMT subsequently replaced this flare, the Ethylene Complex (EC) Flare, with an elevated, steam-assisted West Warm Flare (Source ID C03) under Plan Approval No. 23-0119H.

[5] The source names are those listed in TVOP No. 23-00119 for the facility, for which DEP issued a minor modification on August 25, 2020. The source names indicated with an asterisk (*) have changed from the respective original Plan Approvals, which DEP incorporated into TVOP No. 23-00119 via a significant modification on December 19, 2016, and via administrative amendments on January 26, 2017, and February 1, 2018.

Source ID	Source Name
105	Cavern[6]
C01	West Cold Flare (Modified)*

B. Plan Approval No. 23-0119A (issued on September 5, 2013)

The portion of the single aggregated project previously authorized under Plan Approval No. 23-0119A includes the following:

- The installation of the following equipment and source:[7]
  - A new amine treatment system to remove hydrogen sulfide (H_2S) and carbon dioxide (CO_2) from liquified ethane (with some propane and methane) feedstock prior to fractionation.
  - A new dehydration system to remove water from liquified ethane (with some propane and methane) feedstock prior to fractionation.
  - A new fractionation tower (demethanizer) and associated equipment for the fractionation/removal of liquified methane from liquified ethane (with some propane and methane) feedstock.
  - All associated piping and components for routing liquified ethane to the refrigerated product storage tanks (Source IDs 101–102) installed under Plan Approval No. 23-0119.
- The increased use of steam from three existing auxiliary boilers (1 and 3–4)[8] by the demethanizer.[3]
- Incremental flows from the demethanizer[3] to an existing elevated, steam-assisted flare located in the state of Delaware.[4]

The demethanizer (Source ID 106A)[5,7]* was listed as a source in Plan Approval No. 23-0119A.

C. Plan Approval No. 23-0119B (issued on January 30, 2014)

The portion of the single aggregated project previously authorized under Plan Approval No. 23-0119B includes the following:

- The installation of a new 4-bay loading rack with vapor balance system for the offloading of natural gasoline feedstock and loading of pentane into tanker trucks.
- The use of eight existing internal floating roof storage tanks, as follows:
  - Four tanks (607 and 609–611) for the storage of natural gasoline feedstock prior to fractionation.
  - Four tanks (246, 250, 253, and 527) for the storage of light naphtha prior to loading using an existing marine vessel loading dock (see below) or into tanker trucks.
- The use of an existing fractionation tower (15-2B T-05) and associated equipment for the fractionation of natural gasoline feedstock into pentane and light naphtha.
- The use of three existing spheres (3, 4, and 16) for the storage of pentane.

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[6] The source name and ID originally applied to cavern 5 only. However, as part of the significant modification to the TVOP No. 23-00119 discussed in Footnote 5, above, DEP combined cavern #5 and three additional existing caverns (1–3; see Footnote 13, below, for further discussion) into a source grouping under the same source name and ID.

[7] The equipment and fractionation tower installed under Plan Approval No. 23-0119A were originally used to process a liquified ethane/propane (mixed) feedstock, with the latter originally permitted/operated as a deethanizer (former Source ID 106). However, in September 2019, SPMT made physical changes to the fractionation tower to process a different feedstock (i.e., liquified ethane (with some propane and methane)) and operate it as a demethanizer. DEP reflected these changes in TVOP No. 23-00119 via the minor modification discussed in Footnote 5, above.

[8] As indicated in Footnote 9, below, steam from auxiliary boiler 2 was also used at the facility, but this auxiliary boiler has since been removed.

- The use of an existing marine vessel loading dock (3A, with air emissions routed through a vapor recovery unit on dock 3B) for the loading of light naphtha into marine vessels.[3]
- The increased use of steam from existing auxiliary boilers 1 and 3–4 by fractionation tower 15-2B T-05,[8] and setting new combined carbon monoxide [CO], nitrogen oxides [NO_x], particulate matter [PM], sulfur oxides [SO_x], and volatile organic compound [VOC] potentials to emit (PTEs)/ emission restrictions for the auxiliary boilers.[9]
- The increased use of cooling water (9,200 *gals/min*) from an existing cooling tower (15-2B; Source ID 139) permitted under TVOP No. 23-00001 (and subsequently, TVOP No. 23-00119) by existing fractionation tower 15-2B T-05.
- Incremental flows from the fractionation tower 15-2B T-05,[3] marine vessel loading dock 3A,[3] and spheres[3] to an existing elevated, steam-assisted flare located in the state of Delaware.[4]

The following sources were listed in Plan Approval No. 23-0119B:

Source ID	Source Name[5]
031	Auxiliary Boiler 1
~~032~~	~~Auxiliary Boiler 2~~[8]
033	Auxiliary Boiler 3
034	Auxiliary Boiler 4
111	Natural Gasoline Loading Rack
115	Marine Vessel Loading
133	Tank 246 Int Float 54.4 *mbbl*
136	Tank 250 Int Float 80.4 *mbbl*
178	Tank 527 Int Float 69.7 *mbbl*
188	Tank 607 Int Float 100 *mbbl*
190	Tank 609 Int Float 98.17 *mbbl*
192	Tank 611 Int Float 87.8 *mbbl*
204	Tank 253 Int Float 90.5 *mbbl*
212	Tank 610 Int Float 96.0 *mbbl*
C031	Low NO_x Burners and FGR (Auxiliary Boiler 1)*
~~C032~~	~~Low NO_x Burners and FGR (Auxiliary Boiler 2)~~[8]
C033	Low NO_x Burners and FGR (Auxiliary Boiler 3)
C034	Low NO_x Burners and FGR (Auxiliary Boiler 4)
C111	Natural Gas Loading Rack Vapor Balance System

D. Plan Approval No. 23-0119C (issued on November 19, 2014)

The portion of the single aggregated project previously authorized under Plan Approval No. 23-0119C includes the installation of a new 30,000-*gal/min* recirculating cooling tower for the demethanizer (Source ID 106A) installed under Plan Approval No. 23-0119A to accommodate the refrigeration of propane following fractionation.

[9] The combined PTEs/emission restrictions for the auxiliary boilers have changed twice since DEP originally issued Plan Approval No. 23-0119B. The first instance was as part of the significant modification to TVOP No. 23-00119 discussed in Footnote 5, above. However, based on their removal from service (indicated by ~~strikethrough~~), DEP did not include auxiliary boiler 2 and associated low-NO_x burners and FGR [flue gas recirculation] (former Source IDs 032 and C032, respectively), in TVOP No. 23-00119, and reduced the combined CO, NO_x, PM, SO_x, sulfuric acid mist [H_2SO_4], and VOC emission restrictions for the remaining three auxiliary boilers (i.e., Source IDs 031 and 033–034). The second instance was as part of the minor modification to TVOP No. 23-00119 discussed in Footnote 5, above, in which DEP reduced the combined CO emission restriction for the three auxiliary boilers, as they have actual certified continuous emissions monitoring system (CEMS) data. The current emission restrictions are reflected in the *NSR Analysis* and *PSD Analysis* sections, below.

The cooling tower (Source ID 112)[5]* was listed as a source in Plan Approval No. 23-0119C.[10]

E. Plan Approval No. 23-0119D (issued on February 26, 2015)

The portion of the single aggregated project previously authorized under Plan Approval No. 23-0119D includes the following:

- The installation of the following sources and equipment:
  - A new 300,000-*bbl* refrigerated ethane storage tank (associated with the fractionation of liquified ethane (with some propane and methane) feedstock authorized under Plan Approval No. 23-0119A).
  - Two new refrigerated propane storage tanks, as follows (associated with the fractionation of liquified liquified ethane (with some propane and methane), propane, and propane/butane (transmix) feedstocks authorized under Plan Approval Nos. 23-0119A, 23-0119D, and 23-0119E, respectively):
    - One with a storage capacity of 900,000 *bbl*.
    - One with a storage capacity of 600,000 *bbl*.
  - A new 600,000-*bbl* refrigerated butane storage tank (associated with the fractionation of butane and propane/butane (transmix) feedstocks authorized under Plan Approval Nos. 23-0119D and 23-0119E, respectively).
  - A new elevated, air-assisted East Cold Flare for flaring events.[11]
  - All associated piping and components for the refrigerated product storage.
  - A new dehydration system to remove water from propane and butane feedstocks prior to refrigeration and product storage.
  - A new 50,000-*gal/min* cooling tower to accommodate the refrigeration of propane and butane.
- The use of three existing marine vessel loading docks (1A, 2A, and 3C; Source ID 104) permitted under Plan Approval No. 23-0119 (and subsequently, TVOP No. 23-00119), each equipped with two new loading arms and a new vapor return line, for the loading of liquified ethane (1A and 2A), propane (1A and 3C), and butane (1A and 3C) into marine vessels.[2]
- The redesign/modification and use of the West Cold Flare (Source ID C01) installed under Plan Approval No. 23-0119 to control failures from the refrigerated product storage tanks authorized under Plan Approval Nos. 23-0119 and 23-0119D, respectively.[11]
- The increased throughput for the demethanizer (Source ID C106A) installed under Plan Approval No. 23-0119A.
- The increased use of steam from the auxiliary boilers (Source IDs 031 and 033–034) permitted under Plan Approval No. 23-0119B (and subsequently, TVOP No. 23-00119)[6] by the dehydration system.[3]
- Incremental flows from the deethanizer[3] to an existing elevated, steam-assisted flare located in the state of Delaware.[4]

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[10] The source ID originally applied to the 30,000-*gal/min* cooling tower only. However, on February 26, 2015, DEP issued Plan Approval No. 23-0119D, which authorized the installation of a new 50,000-*gal/min* cooling tower (see Sub-section E. [*Plan Approval No. 23-0119D (issued on February 26, 2015)*] within this section, below, for further discussion). As part of the authorization, DEP combined the cooling towers into a source grouping under the same source ID, but changed the source name to "new cooling towers."

[11] As part of the revision to Plan Approval No. 23-0119E, SPMT has revised the emissions calculations for the East Cold Flare and West Cold Flare under Plan Approval No. 23-0119D to account for the as-built sweep gas flow necessary for safe and reliable operation of the cold flares, and additional operational and maintenance flows based on current and planned operation. The revised emissions are reflected in the PSD and NSR analyses (see *PSD Analysis* and *NSR Analysis* sections, below).

The following sources were listed in Plan Approval No. 23-0119D:

Source ID	Source Name[5]
103	NSPS Subpart VVa Fugitive Equipment Leaks*
112	New Cooling Towers*
117	Refrigerated Ethane Tank (300k *bbl*)*
118	Refrigerated Butane Tank (600k *bbl*)*
119	Refrigerated Propane Tank (900k *bbl*)*
120	Refrigerated Propane Tank (600k *bbl*)*
C01	West Cold Flare (Modified)*
C02	East Cold Flare (New Tanks Project)*

F. RFD No. 5236 (approved August 13, 2015)

The portion of the single aggregated project previously approved under RFD No. 5236 includes the installation of the following sources and equipment:

- Two new 50,000-*bbl* spheres (20 and 21)[12] for the storage of propane and butane.
- All associated piping and components.

G. RFD No. 5340 (approved October 1, 2015)

The portion of the single aggregated project previously approved under RFD No. 5340 includes an increase to the VOC emission restriction for one of the existing internal floating roof storage tanks (609) authorized under Plan Approval No. 23-0119B for the storage of natural gasoline feedstock prior to fractionation. The request was to permit SPMT to continue to operate the storage tank while DEP reviewed the application for Plan Approval No. 23-0119F (see Sub-section I. [*Plan Approval No. 23-0119F (issued on August 15, 2016)*] within this section, below, for further discussion).

H. Plan Approval No. 23-0119E (originally issued on April 1, 2016)

The portion of the single aggregated project previously authorized under the original Plan Approval No. 23-0119E includes the following:

- The redesign/modification and use of three existing fractionation towers, as follows, and associated equipment for the fractionation of propane/butane (transmix) and deethanized natural gas liquid feedstocks:
  - Two fractionation towers (depropanizers; 15-2B T-4 and 15-2S T-4) for fractionation into propane and heavier hydrocarbons.
  - One fractionation tower (debutanizer; 15-2B T-2) for fractionation of the heavier hydrocarbons from the depropanizers into butane and natural gasoline.
- The installation of the following equipment:
  - Meter provers.
  - Additional piping and components, including a flare header, from the fractionation towers and meter provers to an existing flare (as described below).
- The use of refrigerated and internal floating roof storage tanks installed and/or permitted under Plan Approval Nos. 23-0119, 23-0119B, and 23-0119D and/or permitted under the TVOP.

[12] These sources are referenced in Section G, of the TVOP.

- The use of existing caverns (1–3 and 5) for the storage of liquified propane and butane.[13]
- The increased use of steam from the auxiliary boilers (Source IDs 031 and 033–034) permitted under Plan Approval No. 23-0119B (and subsequently, TVOP No. 23-00119)[7] by the fractionation towers[3] and a preheater[3] for the transmix and deethanized natural gas liquid feedstocks.
- The increased use of cooling water (19,500 *gals/min*) from existing cooling tower 15-2B (Source ID 139) permitted under TVOP No. 23-00119 by the fractionation towers.
- Incremental flows from the fractionation towers, meter provers, and caverns[3] to an existing elevated, steam-assisted flare located in the state of Delaware.[4]

The following sources were listed in the original Plan Approval No. 23-0119E:

Source ID	Source Name
090	Depropanizer (15-2S T-4)
091	Depropanizer (15-2B T-4)
092	Debutanizer (15-2B T-2)
103	NSPS Subpart VVa Fugitive Equipment Leaks

I. Plan Approval No. 23-0119F (issued on August 15, 2016)

The portion of the single aggregated project previously authorized under Plan Approval No. 23-0119F includes increases to the VOC emission restrictions for three of the internal floating roof storage tanks (607, 609, and 611) authorized under Plan Approval No. 23-0119B for the storage of natural gasoline feedstock prior to fractionation.[14] No physical changes to these storage tanks occurred as a result of the authorization. The following sources were listed in Plan Approval No. 23-0119F:

Source ID	Source Name[5]
188	Tank 607 Int Float 100 *mbbl*
190	Tank 609 Int Float 98.17 *mbbl*
192	Tank 611 Int Float 87.8 *mbbl*

J. RFD No. 5918 (approved September 26, 2016)

The portion of the single aggregated project previously approved under RFD No. 5918 includes the following:

- The installation of additional equipment to accommodate the offloading of railcars containing propane at existing railcar stations (11–23) of the 15-2B propane rail rack.
- Incremental flows from the propane railcar offloading operation[3] to an existing elevated, steam-assisted flare located in the state of Delaware.[4]

K. RFD No. 5944 (approved September 26, 2016)

The portion of the single aggregated project previously approved under RFD No. 5944 includes a de minimis emission increase, pursuant to 25 Pa. Code § 127.449, from the use of portable flares to vent ethane, propane, or butane from pipelines prior to any maintenance activities.

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[13] When DEP originally issued Plan Approval No. 23-0119E, caverns #1–3 and 5 were included in TVOP No. 23-00119 as part of a source grouping of various "NESHAP fugitive equipment" (Source ID 800). However, as discussed in Footnote 5, above, DEP combined the caverns into their own "cavern" source grouping (Source ID 105).

[14] Plan Approval No. 23-0119F also included changes to the VOC emission restrictions for two internal floating roof storage tanks (23 and 242). However, these storage tanks do not store any materials that relate to the NGLs processing, storage, and distribution operations at the facility. Therefore, DEP does not consider these tanks to be part of the single aggregated project.

L. RFD No. 6484 (approved August 17, 2017)

The portion of the single aggregated project previously approved under RFD No. 6484 includes the following:

- The installation of the following additional equipment to remove alcohols, usually methanol, from feedstocks (potentially added during the winter months to prevent freezing in the pipeline) prior to their being processed at the facility:
  - New methanol analyzer equipment.
  - New molecular sieve dehydration beds.
  - A new regeneration process.
  - A new internal floating roof wastewater storage tank for the temporary storage of methanol-rich wastewater, generated during the regeneration of molecular sieve dehydration beds by the regeneration process, prior to discharge to the process wastewater stream.
  - All associated piping components for the methanol removal.
- The increased use of steam from the auxiliary boilers (Source IDs 031 and 033–034) permitted under Plan Approval No. 23-0119B (and subsequently, TVOP No. 23-00119)[7] by the regeneration process.[3]
- Incremental flows from the regeneration process[3] to the West Warm Flare (Source ID C03) installed under Plan Approval No. 23-0119H (and subsequently permitted under TVOP No. 23-00119).

M. De Minimis Emissions Increase[15] (DEP notified via letter from SPMT dated August 24, 2018)

The portion of the single aggregated project previously authorized under this de minimis emissions increase relates to the refrigerated butane storage tank (Source ID 118) permitted under Plan Approval No. 23-0119D (and subsequently, TVOP No. 23-00119) being temporarily taken out of service.

N. De Minimis Emissions Increase[15] (DEP notified via letter from SPMT dated December 10, 2018)

The portion of the single aggregated project previously authorized under this de minimis emissions increase relates to operational, maintenance, and emergency connections to the West Warm Flare (Source ID C03) installed under Plan Approval No. 23-0119H (and subsequently permitted under TVOP No. 23-00119).

O. De Minimis Emissions Increase[15] (DEP notified via letter from SPMT dated March 22, 2019)

The portion of the single aggregated project previously authorized under this de minimis emissions increase relates to connections to the West Warm Flare (Source ID C03) installed under Plan Approval No. 23-0119H (and subsequently permitted under TVOP No. 23-00119).

P. RFD No. 7944 (approved August 21, 2019)

The portion of the single aggregated project previously approved under RFD No. 7944 includes a de minimis emissions increase, pursuant to 25 Pa. Code § 127.449, from the use of a portable flare during instances where the demethanizer (Source ID 106A) installed under Plan Approval No. 23-0119A (and subsequently, TVOP No. 23-00119) is taken out of service for maintenance activities.

Q. RFD No. 8829 and Determination of Changes of Minor Significance (approved November 3, 2020)

The portion of the single aggregated project previously approved under RFD No. 8829 and a determination of changes of minor significance include the installation of 26 welded valves and three thermal pressure safety valves, respectively, for the 15-2B propane rail rack.

[15] As authorized by DEP pursuant to 25 Pa. Code § 127.449.

R. Plan Approval No. 23-0119J (application currently under technical review by DEP)

The portion of the single aggregated project pending authorization under Plan Approval No. 23-0119J includes the following:

- The installation of the following sources and equipment:
  - Two new 600,000-*bbl* refrigerated ethane storage tanks.
  - One new amine treatment system to remove excess H_2S and CO_2 from ethane feedstock prior to fractionation.
  - One new dehydration train system to remove water from ethane feedstock prior to fractionation.
  - Two new refrigeration systems, each consisting of a closed-loop propane system followed by an open-loop ethane system, for the cooling of dry ethane.
  - Two new fractionation towers (demethanizers) and associated equipment for the removal of methane from dry ethane.
  - Two new wet surface air cooling (WSAC) systems, one associated with each new refrigeration system, to process cooling water for the refrigeration systems.
  - One new elevated, air-assisted Project Phoenix Cold Flare, equipped with high- and low-pressure (HP and LP) cold flare tips for flaring refrigerated streams that do not contain water.
  - All associated piping and components for the refrigerated ethane process.
- The use of two existing marine vessel loading docks (1A and 2A; part of Source ID 104) permitted under Plan Approval No. 23-0119 (and subsequently, TVOP No. 23-00119), each equipped with two loading arms and a vapor return line, for the loading of liquified ethane into marine vessels.
- The increased use of steam (36,300 *lbs/hr*) from the auxiliary boilers (Source IDs 031 and 033–034) permitted under Plan Approval No. 23-0119B (and subsequently, TVOP No. 23-00119) by the amine treatment system and dehydration train system.
- Incremental flows from the amine treatment system and dehydration train system to the West Warm Flare (Source ID C03) installed under Plan Approval No. 23-0119H (and subsequently permitted under TVOP No. 23-00119).

The following sources are proposed to be listed in Plan Approval No. 23-0119J:

Source ID	Source Name
103	NSPS Subpart VVa Fugitive Equipment Leaks
124	Refrigerated Ethane Storage Tank (600,000 *bbl*)
125	Refrigerated Ethane Storage Tank (600,000 *bbl*)
141	Wet Surface Air Cooling Systems (2)
C04	Project Phoenix Cold Flare

III. PSD Analysis

As indicated in 40 CFR § 52.21(a)(2)(i), the provisions of 40 CFR § 52.21 (incorporated by reference at 25 Pa. Code § 127.83) "apply to the construction[16] of any new major stationary source[16] … or any project at an existing major stationary source in an area designated as attainment." As the facility is an existing major stationary source, in accordance with 40 CFR § 52.21(a)(2)(iv), DEP is required to perform a PSD analysis to determine whether the single aggregated project constitutes a major modification[16] for a regulated NSR pollutant[16] and

[16] As the term is defined in 40 CFR § 52.21(b).

subject to PSD requirements. The relevant regulated NSR pollutants for which Delaware County is currently in attainment, and for which DEP has performed the PSD analysis, are CO, H_2SO_4, nitrogen dioxide [NO_2], lead [Pb], PM, PM less than 10 μm in aerodynamic diameter [PM_{10}], PM less than 2.5 μm in aerodynamic diameter [$PM_{2.5}$],[17] and sulfur dioxide [SO_2].

As indicated in 40 CFR § 52.21(a)(2)(iv)(*a*), "a project is a major modification for a regulated NSR pollutant if it causes two types of emissions increases—a significant emissions increase[16] … and a significant[16] net emissions increase.[16] … The project is not a major modification if it does not cause a significant emissions increase. If the project causes a significant emissions increase, then the project is a major modification only if it also results in a significant net emissions increase." In addition, in accordance with 40 CFR § 52.21(b)(49)(iii)–(iv), greenhouse gases (GHGs),[16] in units of carbon dioxide equivalents [CO_2e], are significant and subject to regulation[16] only when a project is already a major modification for a regulated NSR pollutant.

Before beginning the PSD analysis, it is critical to define the project and establish the associated timeframes (i.e., based on the dates that DEP received a complete application, construction actually/is anticipated to commence,[16] and operation actually/is anticipated to commence). DEP has defined the project as the single aggregated project described in the *Single Aggregated Project Description* section, above. While establishing the associated timeframes for a project is normally a straightforward exercise, in this case, the actual and anticipated dates for the commencement of construction and operation for the sources and equipment of the single aggregated project range from calendar years 2013–2024. Since the original Plan Approval No. 23-0119E has been remanded, DEP has chosen to establish the timeframes for the single aggregated project based on the actual dates that DEP received the complete application for, construction commenced under, and operation commenced under the original issuance of Plan Approval No. 23-0119E (i.e., October 6, 2015, April 1, 2016, and August 10, 2017, respectively).

The first step of the PSD analysis is to determine whether a significant emissions increase of a regulated NSR pollutant will occur due to the single aggregated project. This is based on the sum of the emissions increases for each emissions unit,[16] and, as indicated in 40 CFR § 52.21(b)(7)(i)–(ii), is determined differently based on whether the emissions unit is new or existing, respectively, as follows:

- "A new emissions unit is any emissions unit that is (or will be) newly constructed and that has existed for less than 2 years from the date such emissions unit first operated.
- An existing emissions unit is any emissions unit that [is not a new emissions unit]. A replacement unit[16] … is an existing emissions unit."

Since the sources and equipment of the single aggregated project include both new and existing emissions units, DEP has applied the hybrid test indicated in 40 CFR § 52.21(a)(2)(iv)(*f*), as follows:

- For each new emissions unit, the emissions increase of a regulated NSR pollutant is the difference between the potential to emit[16] (PTE) and the baseline actual emissions[16] (BAE), the latter of which is generally zero.
- For each existing emissions unit, the emissions increase of a regulated NSR pollutant is the difference between the projected actual emissions[16] (PAE) and the BAE, except that, pursuant to 25 Pa. Code §§ 127.203a(a)(5)(i)(B) and (a)(4)(i)(A), respectively, these "[i]nclude fugitive emissions to the extent quantifiable, and emissions associated with startups and shutdowns" only, and "[do] not include excess emissions including emissions associated with upsets or malfunctions."

Moreover, as indicated in 40 CFR § 52.21(b)(48)(ii)(*c*), "when a project involves multiple [existing] emissions units, only one consecutive 24-month period must be used to determine the [BAE] for the emissions units being changed[, though a] different consecutive 24-month period can be used for each regulated NSR pollutant."

[17] On September 30, 2019, EPA approved DEP's request for redesignation of the attainment status for Delaware County from nonattainment to attainment of the 2012 annual $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS).

Lastly, though not directly addressed in 40 CFR § 52.21, DEP also considers in the PSD analysis the "incremental emissions increase" of each regulated NSR pollutant for the sources and equipment of the single aggregated project that have not undergone construction (i.e., "any physical change or change in the method of operation"), but which have experienced an increase in utilization. This approach is consistent with U.S. Environmental Protection Agency (EPA) guidance (see *Attachments #1a–1c*, as highlighted).

Since all sources and equipment of the single aggregated project that were newly constructed had not existed for (i.e., commenced operation) 2 years or more prior to the date that construction commenced for sources and equipment authorized under the original issuance of Plan Approval No. 23-0119E (i.e., after April 1, 2014), DEP considers all such sources and equipment to be new emissions units. DEP has determined the respective emissions increases of each regulated NSR pollutant for these sources and equipment by using the PTEs previously calculated under the associated authorizations.

From the existing sources and equipment of the single aggregated project, DEP considers four to have undergone construction: the 15-2B cooling tower and Tanks 607, 609, and 611 (Source IDs 139, 188, 190, and 192, respectively). The only regulated NSR pollutant emitted by the storage tanks is VOCs; therefore, the storage tanks are discussed in the *NSR Analysis* section, below.

The 15-2B cooling tower was previously permitted under TVOP No. 23-00001 (and subsequently, Plan Approval No. 23-0119B and TVOP No. 23-00119) to provide cooling water. While all of the cooling water currently goes to different sources and equipment than it did under TVOP No. 23-00001 (as also authorized under the original Plan Approval No. 23-0119E and RFD No. 5597), this, in and of itself, does not constitute a physical change or a change in the method of operation of the 15-2B cooling tower.[18] Under RFD No. 5597, SPMT installed two pumps on the 15-2B cooling tower to increase its capacity from 25,000 *gals/min* to 28,500 *gals/min* to accommodate the transfer of cooling load from the 15-6 cooling tower for instrument air compressors (IACs) at the MHIC. While the physical change resulted in emissions increases of PM, PM_{10}, and $PM_{2.5}$ for the 15-2B cooling tower and (greater) emissions decreases of PM, PM_{10}, and $PM_{2.5}$ for the 15-6 cooling tower,[19] the IACs are not in VOC service[20] and do not directly relate to the NGLs processing, storage, and distribution operations at the facility. Therefore, for calculation purposes, DEP has evaluated the 15-2B cooling tower as if the physical change did not occur (i.e., DEP has determined the associated incremental emissions increases of PM, PM_{10}, and $PM_{2.5}$ rather than evaluating the 15-2B cooling tower as an existing emissions unit). (It bears mention that this approach results in the determination of greater emissions increases of PM, PM_{10}, and $PM_{2.5}$.) DEP has determined the associated incremental emissions increases of PM, PM_{10}, and $PM_{2.5}$ by summing the following:

- The emissions increases of PM, PM_{10}, and $PM_{2.5}$ indicated in the applications for Plan Approval No. 23-0119E and RFD No. 5597, as determined by SPMT using the calculation methodology developed by Messrs. Joel Reisman and Gordon Frisbie in their paper titled "Calculating Realistic PM_{10} Emissions from Cooling Towers" (see *Attachment #2*, page 2 [first two full paragraphs] (i.e,. Equation 1 with a source-specific total dissolved solids content)) and based on continuous operation (i.e., 8,760 *hrs/yr*).

[18] DEP's technical review memo for the original Plan Approval No. 23-0119E, dated March 31, 2016, indicated that the 15-2B cooling tower experienced a physical change due to the addition of new cooling water lines and demands. This statement was in error, as the addition of new cooling water lines does not constitute a physical change to the cooling tower itself, and the new cooling water demands do not affect the function of the cooling tower (i.e., it still circulates cooling water) or the VOC (only) emission restriction (unchanged from TVOP No. 23-00001).

[19] Since the 15-6 cooling tower was removed from service under RFD No. 5597, and its drift eliminators were not as efficient as those on the 15-2B cooling tower, the project resulted in a net emissions decrease of PM, PM_{10}, and $PM_{2.5}$. DEP has determined the emissions decreases of PM, PM_{10}, and $PM_{2.5}$, respectively, for the 15-6 cooling tower by using the associated 2014–2015 average PM emissions, and multiplying them by the PM_{10} and $PM_{2.5}$ fractions, all as indicated in the application for RFD No. 5597.

[20] As the term is defined in 40 CFR § 60.481a (i.e., "contains or contacts a process fluid that is at least 10[%] VOC by weight").

- The above emissions increases of PM, PM_{10}, and $PM_{2.5}$ prorated by the cooling water demand for fractionation tower 15-2B T-05 authorized under Plan Approval No. 23-0119B.

[Note: DEP has also determined the associated incremental emissions increase of VOCs (see *NSR Analysis* section, below, for further discussion).]

None of the other existing sources and equipment of the single aggregated project have undergone construction, as follows:

- Marine vessel loading (refrigerated and non-refrigerated) and Tanks 246, 253, 250, 527, and 610 (Source IDs 104, 115, 133, 204, 136, 178, and 212, respectively): The only regulated NSR pollutant emitted by these sources is VOCs; therefore, these sources are discussed in the *NSR Analysis* section, below.

- The auxiliary boilers were previously permitted under TVOP No. 23-00001 (and subsequently, Plan Approval No. 23-0119B and TVOP No. 23-00119) to provide steam. While most of the steam currently goes to different sources and equipment than it did under TVOP No. 23-00001 (as also authorized or proposed under Plan Approval Nos. 23-0119A, 23-0119D, (the original) 23-0119E, 23-0119H, and 23-0119J (pending), and RFD No. 6484), this, in and of itself, does not constitute a physical change or a change in the method of operation of the auxiliary boilers.[21] As detailed in the *Additional Information for the Auxiliary Boilers* section, below, DEP has determined the associated incremental emissions increases of CO, CO_2e, H_2SO_4, NO_2, Pb, PM, PM_{10}, $PM_{2.5}$, and SO_2 by multiplying the actual operational steam demand for the sources and equipment of or related to the single aggregated project and the projected operational steam demand for the sources and equipment proposed under Plan Approval No. 23-0119J (pending) by emission factors for these pollutants based on 2018–2019 auxiliary boiler performance, all as provided by SPMT.

  [Note: DEP has also determined the associated incremental emissions increase of NO_x and VOCs (see *NSR Analysis* section, below, for further discussion).]

While flows from various sources and equipment of the single aggregated project proceed to the West Warm Flare, DEP does not consider the West Warm Flare itself to be part of the single aggregated project. The West Warm Flare is effectively a replacement unit for the EC Flare, which had received flows from various sources and equipment at the Braskem America facility at the MHIC since before SPMT began its NGLs processing, storage, and distribution operations there.[22] Moreover, 74.9*%, by weight*, of the VOC flow to the West Warm Flare is from sources and equipment at the Braskem America facility, not SPMT. Therefore, for the PSD analysis, DEP has only considered the incremental emissions increases associated with flows to the West Warm Flare from the

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[21] DEP's technical review memos for Plan Approval Nos. 23-0119A, 23-0119B, and (the original) 23-0119E, dated August 19, 2013, January 21, 2014, and March 31, 2016, respectively, indicated that the auxiliary boilers experienced a physical change or a change in the method of operation, as applicable, due to the addition of a new fuel (i.e., H_2S from the new amine treatment system) and new steam lines and demands. These statements were in error, as the auxiliary boilers were previously permitted to burn refinery fuel gas containing H_2S under TVOP No. 23-00001, the addition of new steam lines does not constitute a physical change to the auxiliary boilers themselves, and the new steam demands do not affect the function of the auxiliary boilers (i.e., they still produce steam) or the emission restrictions (either reduced or unchanged from TVOP No. 23-00001).

[22] However, since SPMT's TVOP with Delaware Department of Natural Resources & Environmental Control (DNREC) did not permit operational and maintenance flows to the EC Flare, SPMT was not permitted to consider the EC Flare as an existing emissions unit. Consequently, under Plan Approval No. 23-0119H, DEP considered the West Warm Flare as a new emissions unit. Notwithstanding this permitting history, based on a decrease in the amount of piping and components associated with the West Warm Flare versus the EC Flare, the physical change resulted in net emissions decreases of CO, CO_2e, NO_2, and SO_2, and aggregated emissions decreases of NO_x and VOCs (see *NSR Analysis* section, below, for further discussion). Therefore, the change does not constitute construction, and the fact that the West Warm Flare otherwise meets the criteria for a replacement unit specified in 40 CFR § 52.21(b)(33)(i)–(iv) does not apply. [Note: This position is consistent with EPA guidance (see *Attachment #4*, as highlighted) and the definition of the term "modification" in 25 Pa. Code § 121.1 (i.e., "a physical change … which would increase the amount of an air contaminant emitted … or which would result in the emission of an air contaminant not previously emitted, except that … replacement [is] not considered [a] physical change").]

various sources and equipment of the single aggregated project. DEP has determined the associated incremental emissions increases of CO, NO_2, and SO_2 by multiplying the total mass flows, the higher heating values of the respective materials (e.g., natural gas, propane, butane, etc.), and the CO, NO_x,[23] and SO_2 emission factors for flares (0.31 *lbs/mmBtu*, 0.068 *lbs/mmBtu*, and 0.0006 *lbs/mmBtu*, respectively) from EPA's AP-42, Volume I, Fifth Edition (AP-42), Table 13.5-1. In addition, DEP has determined the associated incremental emissions increases of CO_2e by summing the emissions increases of CO_2e indicated in the applications for Plan Approval Nos. 23-0119H and 23-0119J (pending), as determined by SPMT using the calculation methodology specified in 40 CFR § 98.233. [Note: DEP has also determined the associated incremental emissions increase of NO_x and VOCs (see *NSR Analysis* section, below, for further discussion).]

Based on the emissions increases of CO, CO_2e, H_2SO_4, NO_2, Pb, PM, PM_{10}, $PM_{2.5}$, and SO_2 for the respective sources and equipment of the single aggregated project, DEP has determined the associated emissions increases due to the single aggregated project (see *Attachment #3*). The emissions increases of CO, CO_2e, H_2SO_4, NO_2, Pb, PM, PM_{10}, $PM_{2.5}$, and SO_2 due to the single aggregated project, as well as the associated significant emissions rates, are listed in Table 1, below:

Table 1
Emissions Increases Due to the Single Aggregated Project & Significant Emissions Rates (*tons/yr*)
40 CFR § 52.21(a)(2)(iv)(*f*) and (b)(3)(i)(*a*), (23), and (40)

	CO	CO_2e	H_2SO_4	NO_2	Pb	PM	PM_{10}	$PM_{2.5}$	SO_2
Emissions Increases[24]	**101.13**	**243,261**	0.0574	**58.89**	6.84×10^{-3}	3.87	3.66	1.82	17.49
Significant Emissions Rates	100	75,000	7	40	0.6	25	15	10	40

As indicated in Table 1, DEP has determined that the single aggregated project causes a significant emissions increase of CO, CO_2e, and NO_2. Therefore, the next step is to conduct a netting analysis to determine whether a significant net emissions increase of CO, CO_2e, and NO_2 also occurs due to the single aggregated project.

As indicated in 40 CFR § 52.21(b)(3)(i)–(ii), the net emissions increase is the sum of "[t]he increase in emissions from a particular physical change or change in the method of operation" (i.e., the significant emissions increases of CO, CO_2e, and NO_2 determined above) and "any other increases and decreases in actual emissions … that are contemporaneous with the particular change and are otherwise creditable," where the contemporaneous period "occurs between: (a) The date five years before construction on the particular change commences; and (b) The date that the increase from the particular change occurs." (If the net emissions increase is a negative value, then zero is entered.) In line with the discussion in the third paragraph of this section, since the original Plan Approval No. 23-0119E has been remanded, DEP has chosen to set the date that construction on the particular change (i.e., the single aggregated project) commenced as the date that construction commenced under the original issuance of Plan Approval No. 23-0119E. Similarly, DEP has chosen to set the date that the increase from the particular change occurs as the date that operation of sources/equipment installed under the original issuance of Plan Approval No. 23-0119E commenced. Therefore, DEP has used the April 1, 2011–August 10, 2017, timeframe as the contemporaneous period for which to determine whether a significant net emissions increase of CO, CO_2e, and NO_2 occurs due to the single aggregated project. (Since the increases and decreases in actual emissions for the contemporaneous period were authorized by DEP via either Plan Approval, ERC application, or de minimis emissions increase, DEP considers them to meet the criteria in 40 CFR § 52.21(b)(3)(iii)–(viii) for being creditable.) In addition, DEP has not truncated the look-back period to consider CO, CO_2e, and NO_2 emissions that were netted out under previous Plan Approvals.

[23] All NO_x is also treated as NO_2.

[24] The emissions increases of CO, CO_2e, H_2SO_4, NO_2, Pb, PM, PM_{10}, $PM_{2.5}$, and SO_2 in Table 1 and, where applicable, Table 2, differ from the values indicated in the previous draft of this technical review memo, dated February 28, 2020, and the *Pa. Bulletin* notice published on February 29, 2020, for Plan Approval No. 23-0119E (revised). The changes are due

Based on the sum of the emissions increases of CO, CO_2e, and NO_2 due to the single aggregated project and the increases and decreases in actual emissions for the contemporaneous period, DEP has determined the associated net emissions increases for the single aggregated project (see *Attachment #3*). The net emissions increases of CO, CO_2e, and NO_2 for the single aggregated project, as well as the associated significant emissions rates, are listed in Table 2, below:

Table 2
Net Emissions Increases for the Single Aggregated Project & Significant Emissions Rates (*tons/yr*)
40 CFR § 52.21(b)(3)(i)(*a*)–(*b*) and (23)

	CO	CO_2e	NO_2
Net Emissions Increases[24]	83.94	**223,200**	31.60
Significant Emissions Rates	100	75,000	40

As indicated in Table 2, DEP has determined that the single aggregated project causes a significant net emissions increase of CO_2e only. Since the single aggregated project is not a major modification for a regulated NSR pollutant, CO_2e is not subject to regulation and SPMT is not subject to PSD requirements.

IV. NSR Analysis

Pursuant to 25 Pa. Code § 127.201(f), the facility is "considered a major facility[25] and … subject to the requirements applicable to a major facility located in a severe nonattainment area[25] for ozone." Therefore, in accordance with 25 Pa. Code §§ 127.203a and 127.203(b)(1)(i)–(ii), DEP is required to perform an NSR analysis to determine whether the aggregated emissions increases of NO_x or VOCs (i.e., the sum of the emissions increases due to the single aggregated project and either of the following) exceed 25 *tons/yr*:

- "[T]he other increases in net emissions occurring over a consecutive 5 calendar-year period, which includes the calendar year of the modification or addition which results in the emissions increase.
- [The] other increases and decreases in net emissions occurring within 10 years prior to the date of submission of a complete Plan Approval application."

As with the PSD analysis, before beginning the NSR analysis, it is critical to define the project and establish the associated timeframes. As with the PSD analysis, DEP has defined the project as the single aggregated project described in the *Single Aggregated Project Description* section, above, and has chosen to establish the timeframes for the single aggregated project based on the actual dates that DEP received the complete application for, construction commenced under, and operation commenced under the original issuance of Plan Approval No. 23-0119E.

First, DEP has determined the emissions increase of NO_x and VOCs due to the single aggregated project. As with the PSD analysis, this is based on the sum of the emissions increases for each emissions unit,[25] and, as indicated in 25 Pa. Code § 127.203a(a)(1)(i)(B) and (A), is determined differently based on whether the emissions unit is new or existing, respectively, as follows:

- "For new emissions units, the emissions increase of a regulated NSR pollutant[16,25] will be the potential to emit[25] [(PTE)] from each new emissions unit."
- "For existing emissions units, an emissions increase of a regulated NSR pollutant is the difference between the projected actual emissions[25] [(PAE)] and the baseline actual emissions[25] [(BAE)] for each unit."

primarily to the application of updated values for the steam demand associated with the sources and equipment of or related to the single aggregated project, and updated emission factors for these pollutants, both as provided by SPMT.

[25] As the term is defined in 25 Pa. Code § 121.1.

As with the PSD analysis, as indicated in 25 Pa. Code § 127.203a(a)(4)(i)(D), "when a project involves multiple [existing] emissions units, the same consecutive 24-month period must be used to determine the [BAE] for the emissions units being changed." However, unlike with the PSD analysis, "[t]he same consecutive 24-month period shall be used for all regulated NSR pollutants, unless … a different 24-month period is more appropriate and [DEP] approves [of its use]."

Lastly, though not directly addressed in 25 Pa. Code §§ 127.203 and 127.203a, DEP also considers in the NSR analysis the "incremental emissions increase" of NO_x and VOCs from the sources and equipment of the single aggregated project that have not undergone a modification,[25] but which have experienced an increase in utilization.

As with the PSD analysis, DEP considers all sources and equipment of the single aggregated project that were newly constructed to be new emissions units, and has determined the respective emissions increases for these sources and equipment by using the PTEs previously calculated under the associated authorizations.

Similar to the PSD analysis, from the existing sources and equipment of the single aggregated project, DEP considers the 15-2B cooling tower and Tanks 607, 609, and 611 (Source IDs 139, 188, 190, and 192, respectively) to have undergone a modification. As all of these sources were permitted under Plan Approval No. 23-0119B, DEP has used the same 2010–2011 timeframe for the BAEs that it used during its original review of the application for Plan Approval No. 23-0119B.[26]

As discussed in the *PSD Analysis* section, above, the physical change to the 15-2B cooling tower did not result in an emissions increase of VOCs and did not relate directly to the NGLs processing, storage, and distribution operations at the facility. Therefore, for calculation purposes, DEP has evaluated the 15-2B cooling tower as if the physical change did not occur. (i.e., DEP has determined the associated incremental emissions increases of VOCs rather than evaluating the 15-2B cooling tower as an existing emissions unit). (Again, it bears mention that this approach results in the determination of a greater emissions increase of VOCs.) DEP has determined the associated incremental emissions increase of VOCs by multiplying the total cooling water demand associated with the affected sources and equipment of the single aggregated project by the controlled VOC fugitive emission factor for petroleum refineries (0.7 *lbs/mmgals*) from EPA's AP-42, Table 5.1-3 (up to the VOC emission restriction in TVOP No. 23-00001 (and subsequently, TVOP No. 23-00119) of 4.60 *tons/yr*).

Tanks 607 and 611 were previously permitted under TVOP No. 23-00001 to store petroleum liquids with a vapor pressure of less than 11 *psia*, and subsequently permitted under Plan Approval Nos. 23-0119B and 23-0119F (and TVOP No. 23-00119), to store petroleum liquids, in particular, natural gasoline, with a vapor pressure of less than 11 *psia*. Tanks 607 and 611, along with Tanks 23, 454, and 619, were subject to a combined VOC emission restriction in TVOP No. 23-00001 of 7.5 *tons/yr*. However, in Plan Approval No. 23-0119F, Tanks 23, 607, and 611 were subject to separate VOC emission restrictions of 1.47 *tons/yr*, 6.75 *tons/yr*, and 6.05 *tons/yr*, respectively, while Tanks 454 and 619 were indicated for removal (and not included). Since the separate VOC emission restrictions for Tanks 23, 607, and 611 exceed the previous combined VOC emission restriction, DEP considers each tank to have undergone "a change in the method of operation of a source which would increase the amount of an air contaminant emitted by the source." Based on the VOC emission restrictions established under Plan Approval No. 23-0119F (1.47 *tons/yr*, 6.75 *tons/yr*, and 6.05 *tons/yr*),[27] and the BAEs previously determined under Plan Approval No. 23-0119B (0.74 *tons/yr*, 1.16 *tons/yr*, and 1.59 *tons/yr*,

[26] DEP's technical review memo for Plan Approval No. 23-0119B, dated January 21, 2014, indicates that the BAEs for Tanks 607, 609, and 611 were based on the 2009–2010 timeframe. However, the values shown are actually for the 2010--2011 timeframe. While a portion of this timeframe is outside of the 5-year period immediately prior to the date that DEP received the complete application for the original Plan Approval No. 23-0119E, pursuant to 25 Pa. Code § 127.203a(a)(4)(i), "[DEP] may approve the use of a different consecutive 24-month period within the last 10 years … that … is more representative of normal source operation." The 2010–2011 timeframe represents the last 2 years that the facility operated as a refinery before shutting down, not operating in a normal manner again until 2015. Therefore, DEP considers the use of the 2010–2011 timeframe appropriate.

[27] Pursuant to 25 Pa. Code § 127.203a(a)(5)(ii), the PTE for an emissions unit may be used in lieu of the PAE.

respectively), DEP has determined the emissions increase of VOCs for Tanks 23, 607, and 611 to be 0.73 *tons/yr*, 5.59 *tons/yr*, and 4.46 *tons/yr*, respectively.

Tank 609 was previously permitted under TVOP No. 23-00001 to store benzene, but subsequently permitted under Plan Approval Nos. 23-0119B and 23-0119F (and TVOP No. 23-00119) to store natural gasoline. In addition, Tank 609 was subject to a VOC emission restriction in TVOP No. 23-00001 of 4,660 *lbs/yr* (i.e., 2.33 *tons/yr*), but VOC emission restrictions of 5.02 *tons/yr* under RFD No. 5340 and 5.40 *tons/yr* under Plan Approval No. 23-0119F. Therefore, DEP considers these to be "a change in the method of operation of a source which would increase the amount of an air contaminant emitted by the source [and] which would result in the emission of an air contaminant not previously emitted." Based on the current VOC emission restriction (5.40 *tons/yr*)[28] and the BAE previously determined under Plan Approval No. 23-0119B (1.775 *tons/yr*), DEP has determined the emissions increase of VOCs for Tank 609 to be 3.63 *tons/yr*.

None of the other existing sources and equipment of the single aggregated project underwent a modification, as follows:

- Marine vessel loading was previously permitted under TVOP No. 23-00001 for the loading of "gasoline and other normally liquid petroleum products" with a Reid vapor pressure of less than 4 *psia,* except if loaded through the vapor recovery unit on dock 3B, and subsequently permitted, as follows:
    - Refrigerated: Under Plan Approval Nos. 23-0119, 23-0119D, and 23-0119J (pending) (and TVOP No. 23-00119) (as all or part of Source 104) for the loading of liquefied ethane, propane, and butane, as applicable. While the associated loading docks were each equipped with two new loading arms and a new vapor return line, no emissions result from their operation. Therefore, the physical change does not constitute a modification.
    - Non-refrigerated: Under Plan Approval No. 23-0119B (and TVOP No. 23-00119) (as Source 115) for the loading of non-refrigerated petroleum products, specifically light naphtha, through the vapor recovery unit on dock 3B. DEP determined whether or not an emissions increase of VOCs is associated with the marine vessel loading based on whether it experienced an increase in utilization. Based on DEP records, the average historical throughput for the marine vessel loading in 2010–2011 (i.e., the same timeframe used to calculate the BAE for Tank 609) was 18.91 *Mbbl/day*. While SPMT indicated in the application for Plan Approval No. 23-0119B that the planned throughput for the marine vessel loading was 10 *Mbbl/day*, the actual average throughput over 2015–2019 was 33.99 *Mbbl/day*. Since the actual average throughput has been greater than the average historical throughput in TVOP No. 23-00001, DEP has based the emissions increase of VOCs on the increase in utilization (i.e., 33.99 *Mbbl/day* – 18.91 *Mbbl/day* = 15.08 *Mbbl/day*). Using the same calculation methodology that SPMT used in its application for Plan Approval No. 23-0119B (i.e., AP-42, Section 5.2, Equation 1, multiplied by an overall reduction efficiency term), DEP has calculated the corresponding emissions increase of VOCs for the marine vessel loading to be 5.59 *tons/yr*.

- As discussed in the *PSD Analysis* section, above, the auxiliary boilers did not experience a physical change or a change in the method of operation, and the total steam demand at the MHIC and associated emissions from the auxiliary boilers do not exceed the total rated steam production and permitted emission restrictions for the auxiliary boilers, respectively. In the same manner as in the PSD analysis, DEP has determined the associated incremental emissions increases of NO_x and VOCs by multiplying the actual operational steam demand for the sources and equipment of or related to the single aggregated project and the projected operational steam demand for the sources and equipment proposed under Plan Approval No. 23-0119J (pending) by emission factors for these pollutants based on 2018–2019 auxiliary boiler performance, all as provided by SPMT.

- Tanks 253 and 610 (Source IDs 204 and 212, respectively) were previously permitted under TVOP No. 23-00001 to store petroleum liquids with a vapor pressure of less than 11 *psia*, and subsequently permitted under Plan Approval Nos. 23-0119B and 23-0119F, as applicable (and TVOP No. 23-00119), to store petroleum liquids, specifically natural gasoline or light naphtha, with a vapor pressure of less than 11 *psia*. Tanks 253 and 610, along with other tank(s) that are not part of the single aggregated project, were

subject to a combined VOC emission restriction in TVOP No. 23-00001 of 47.13 *tons/yr*, and a combined VOC emission restriction in Plan Approval No. 23-0119F of 40.4 *tons/yr*. Since the current combined VOC emission restriction is less than that in TVOP No. 23-00001, DEP considers the emissions increase of VOCs for Tanks 253 and 610 to be zero (i.e., 0 *tons/yr*).

- Tanks 246, 250, and 527 (Source IDs 133, 136, and 178, respectively) were previously permitted under TVOP No. 23-00001 to store petroleum liquids with a vapor pressure of less than 11 *psia*,[28] and subsequently permitted under Plan Approval No. 23-0119B (and TVOP No. 23-00119), to store petroleum liquids, specifically natural gasoline or light naphtha, with a vapor pressure of less than 11 *psia*. DEP determined whether or not an emissions increase of VOCs is associated with the tanks based on whether they experienced a combined increase in utilization. Based on DEP records, the average historical throughput for the three storage tanks in 2010–2011 (i.e., the same timeframe used to calculate the BAE for Tank 609) was 50.40 *Mbbl/day*. While SPMT indicated in its application for Plan Approval No. 23-0119B that the planned throughput for the three storage tanks under Plan Approval No. 23-0119B was 8.76 *Mbbl/day*, the actual average throughput over 2015–2019 was 5.22 *Mbbl/day*.[29] Since the actual throughput for the three storage tanks under Plan Approval No. 23-0119B is less than the average historical throughput in TVOP No. 23-00001, DEP considers the emissions increase of VOCs for Tanks 246, 250, and 527 to be zero (i.e., 0 *tons/yr*).

As discussed in the *PSD Analysis* section, above, DEP does not consider the West Warm Flare itself to be part of the single aggregated project, and has only considered the incremental emissions increases associated with flows to the West Warm Flare from the various sources and equipment of the single aggregated project. DEP has determined the associated incremental emissions increase of NO_x and VOCs by multiplying the total mass flows of the respective materials (e.g., natural gas, propane, butane, etc.) that proceed to the West Warm Flare by the following:

- NO_x: The associated higher heating value and the NO_x emission factor for flares (0.068 *lbs/mmBtu*) from AP-42, Table 13.5-1.
- VOCs: The VOC destruction and removal efficiency (DRE) of 98% for the West Warm Flare (and, for natural gas flows, an assumed VOC content of 1%[30]).

Next, DEP has determined the other increases in net emissions of NO_x and VOCs occurring over a consecutive 5 calendar-year period. Similar to the PSD analysis, since the original Plan Approval No. 23-0119E has been remanded, DEP has chosen to set the date of "the modification or addition which results in the emissions increase" as the date that construction commenced under the original issuance of Plan Approval No. 23-0119E. Therefore, DEP has used the 2012–2016 timeframe as the consecutive 5 calendar-year period for which to determine the other increases in net emissions of NO_x and VOCs. In addition, DEP has not truncated the look-back period to consider the other increases in net emissions of NO_x and VOCs that were netted out under previous Plan Approvals.

Based on the sum of the emissions increases of NO_x and VOCs due to the single aggregated project and the other increases in net emissions of NO_x and VOCs occurring over a consecutive 5 calendar-year period, DEP has determined the associated aggregated emissions increases for the single aggregated project (see *Attachment #6*).

[28] Except for Tank 527, which did not include a vapor pressure restriction.

[29] Though DEP has observed that the highest actual average throughput in a given year was 12.45 *Mbbl/day* (in 2019).

[30] Though, based on 2019 daily average gas chromatograph data from Williams Pipeline Co., the natural gas supplier for the MHIC (*Attachment #5*), the maximum daily VOC content of the pipeline natural gas supplied to the MHIC was 0.158% (on January 31, 2019).

The aggregated emissions increases of NO_x and VOCs for the single aggregated project are listed in Table 3, below:

Table 3
Aggregated Emissions Increases for the Single Aggregated Project (*tons/yr*)
25 Pa. Code § 127.203(b)(1)(i)

	NO_x	VOCs
Aggregated Emissions Increases[31]	**60.89**	**187.48**
Significant Emissions Rates	25	25

Since the aggregated emissions increases of both NO_x and VOCs for the single aggregated project exceed 25 *tons/yr*, the aggregated emissions increases are significant[25] for both pollutants. Therefore, the single aggregated project is subject to the NSR requirements of 25 Pa. Code Chapter 127, Subchapter E, for both NO_x and VOCs, and there is no need to determine the aggregated emissions increase in accordance with 25 Pa. Code § 127.203(b)(1)(ii). SPMT is required to implement Lowest Achievable Emission Rate (LAER) for NO_x and VOCs in accordance with 25 Pa. Code §§ 127.203(b)(2) and 127.205(1), and obtain NO_x and VOC emissions offsets in accordance with 25 Pa. Code §§ 127.201(d) and 127.210(a) (see *NSR Requirements* section, below, for further discussion).

V. NSR Requirements

In accordance with 25 Pa. Code § 127.205(1)–(5), respectively, SPMT is required to meet the following requirements:

- Implement a level of pollution control that meets LAER.
- Certify that each facility located within the Commonwealth that is owned, operated, or controlled by SPMT and subject to NSR requirements and emission restrictions, is in compliance, or are on a schedule of compliance, with all applicable emission restrictions and standards.
- Obtain and surrender the required emission offsets, at the required offset ratio, prior to commencement of operation of the affected source(s), from other sources that impact a nonattainment area in the same or lower nonattainment classification area than the one in which they were generated.
- Demonstrate through an analysis of alternative sites, sizes, production processes, and environmental control techniques that the benefits of the proposed project significantly outweigh the environmental and social costs imposed on the Commonwealth as a result of its location, construction, or modification.

A. 25 Pa. Code § 127.205(1)

SPMT has conducted a LAER evaluation in accordance with EPA's guidance in the October 1990 draft NSR Workshop Manual, and applicable Commonwealth and federal regulations. As indicated in 25 Pa. Code § 127.205(1), "only sources which are new or which are modified shall be required to implement LAER." The following sources and equipment of the single aggregated project, which were (or are proposed to be)

[31] The emissions increases of NO_x and VOCs in Table 3 differ from the values indicated in the previous draft of this technical review memo, dated February 28, 2020, and the *Pa. Bulletin* notice published on February 29, 2020, for Plan Approval No. 23-0119E (revised). The entire change for NO_x and part of the change for VOCs is due to the application of updated values for the steam demand associated with the sources and equipment of or related to the single aggregated project, and updated emission factors for these pollutants, both as provided by SPMT. The rest of the change for VOCs is primarily due to a change in how DEP calculated the emissions increase for the marine vessel loading (non-refrigerated).

newly constructed or were modified, and are in VOC service and/or emit VOCs and/or NO_x, are required to meet LAER:

- The refrigerated storage tanks under Plan Approval Nos. 23-0119, 23-0119D, and 23-0119J (pending).
- The piping and components under Plan Approval Nos. 23-0119, 23-0119A, 23-0119B, 23-0119D, (the original) 23-0119E, and 23-0119J (pending); and RFDs No. 5236 and 6484.
- The elevated, air-assisted cold flares under Plan Approval Nos. 23-0119, 23-0119D, and 23-0119J (pending).
- The following internal floating roof storage tanks:
  - Tank 609 (Source ID 190) under Plan Approval No. 23-0119B.
  - A methanol-rich wastewater tank under RFD No. 6484.
- The cooling towers under Plan Approval Nos. 23-0119B, 23-0119C, 23-0119D, and (the original) 23-0119E.[32]
- The meter provers under the original Plan Approval No. 23-0119E.

1. Refrigerated storage tanks: The refrigerated propane and butane storage tanks are in VOC service. The ethane in the refrigerated ethane storage tanks also contains VOCs. Regardless, as discussed in DEP's technical review memos for Plan Approval Nos. 23-0119, 23-0119D, and 23-0119J, dated February 4, 2013, February 23, 2015, and February 5, 2021, respectively, all of the refrigerated storage tanks are designed to have zero VOC emissions. Therefore, the refrigerated storage tanks meet LAER.

2. Piping and components: Under Plan Approval Nos. 23-0119, 23-0119A, 23-0119B, and 23-0119D (and subsequently, TVOP No. 23-00119), and (the original) Plan Approval No. 23-0119E, the piping and components are subject to the Standards of Performance for New Stationary Sources (NSPS) for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006 [40 CFR Part 60, Subpart VVa], including leak levels and the use of an approved Leak Detection and Repair (LDAR) program. SPMT has proposed that these requirements be extended to the proposed piping and components under Plan Approval No. 23-0119J (pending), and that they constitute LAER. DEP concurs with SPMT's LAER proposal for the piping and components, except that DEP considers the following more stringent LDAR requirements indicated in the Texas Commission on Environmental Quality's (TCEQ's) 28LAER program as LAER, and has incorporated them into SPMT's existing LDAR program for the facility:

   - The leak definition for pumps of 500 *ppm* (instead of 2,000 *ppm*).
   - The leak percentage for valves required for a reduction in monitoring frequency of 0.5% (instead of 2.0%).

   Since SPMT already uses a gas analyzer in conjunction with the repair or maintenance of leaking components, DEP considers SPMT's existing LDAR program as a directed maintenance program. Therefore, DEP has not changed any other LDAR requirements under Source ID 103.

3. Cold flares: SPMT has performed a search of EPA's RACT/BACT/LAER Clearinghouse (RBLC) and other state RBLC databases for NO_x and VOC LAER precedents for flares, as well as a technical

[32] The WSAC systems under Plan Approval No. 23-0119J are proposed to rely on evaporative cooling to transfer heat from the propane and ethane refrigerants in the refrigeration systems, which requires an open design of the heat exchange system akin to an air-cooled fin fan-type heat exchange system. As such, VOCs from the process are not expected to accumulate in the water basins of the WSAC systems.

feasibility analysis, and has presented the following in its applications for Plan Approval Nos. 23-0119E (revised) and 23-0119J (pending) as LAER:

- A NO_x emission rate of 0.068 *lbs/mmBtu* corresponding to that indicated for elevated flares in AP-42, Table 13.5-1.

- Numerous entries for flares subject to a VOC DRE restriction of 98%, and two entries for flares subject to a VOC DRE restriction of 99%. In all cases, the higher VOC DRE restriction is indicated for flows with hydrocarbons containing no more than three carbons (i.e., propane or lighter), and the lower VOC DRE restriction is indicated for flows with heavier hydrocarbons. SPMT contends that, as the flows to the West Cold Flare and East Cold Flare contain butane, pentane, and other hydrocarbons with more than three carbons, a VOC DRE restriction of 98% applies to these cold flares. SPMT also contends that, since "[t]he flows to the [proposed] Project Phoenix Cold Flare will always contain trace amounts of hydrocarbons with three carbons or more," a VOC DRE restriction of 98% applies to this cold flare as well.

- Two entries from the Bay Area Air Quality Management District BACT Guidance database propose the use of fuel gas recovery, where available. SPMT contends that a fuel gas recovery system for the West Cold Flare and East Cold Flare is infeasible because the operational and maintenance flows to those flares are not continuous. And while the flows to the Project Phoenix Cold Flare are proposed to be continuous, SPMT contends that the facility does not have the available capacity in combustion equipment to combust all of the fuel gas that would be generated by a fuel gas recovery system.

- SPMT has proposed that compliance with the design and operating requirements of 40 CFR § 60.18 (including maximum exit velocity, visible emissions, and a minimum net heating value for gas streams combusted in flares), as previously established by DEP as LAER for the West Warm Flare under Plan Approval No. 23-0119H, likewise constitutes LAER for the cold flares. SPMT has stated that the West Cold Flare and East Cold Flare already meet these design and operating requirements, and that the proposed Project Phoenix Cold Flare will also meet these requirements.

As part of its review of LAER requirements for flares, DEP has corresponded with Ms. Anne Inman, P.E., Air Permits Division, TCEQ, regarding the LAER requirements for flares established by TCEQ. Ms. Inman has indicated that, besides the entries presented by SPMT, TCEQ has permitted additional facilities with flares subject to a VOC DRE restriction of 99%. In addition, Ms. Inman indicated that, generally, TCEQ considers a VOC DRE of 99% to constitute LAER for flares processing flows where the portion of VOCs containing more than three carbon atoms is less than or equal to 1%. Specifically, Ms. Inman has conveyed that, for a flare processing the materials that the Project Phoenix Cold Flare is proposed to process (i.e., methane/natural gas, ethane, propane, and fuel gas), TCEQ would consider compliance with the design and operating requirements of 40 CFR § 60.18 (including maximum exit velocity, visible emissions, and a minimum net heating value for gas streams combusted in flares) sufficient to demonstrate compliance with a VOC DRE restriction of 99% (regardless of vendor guarantee). DEP likewise considers compliance with these requirements to constitute LAER.

Nonetheless, DEP has analyzed the flows to each of the cold flares of the single aggregated project, and has calculated the total percentages of hydrocarbons and VOCs containing more than three carbon atoms for each cold flare tip (see *Attachment #7*). Based on these flows, DEP has established the following VOC DRE restrictions for each of the cold flares:

- West Cold Flare: 99.0% whenever flows are being sent to the LP cold flare tip only, otherwise 98.0%.[33]

[33] Plan Approval Nos. 23-0119 and 23-0119D (and subsequently, TVOP No. 23-00119) did/do not include any VOC DRE restrictions for the West Cold Flare and East Cold Flare. Accordingly, DEP has added the VOC DRE restrictions for the West Cold Flare and East Cold Flare to Plan Approval No. 23-0119E (revised) (i.e., Condition # 001, Section D (under Source IDs C01–C02), respectively).

- East Cold Flare: 98.0%.[33]

- Project Phoenix Cold Flare: 99.0%. While the total percentage of VOCs containing more than three carbon atoms for the HP cold flare tip is calculated as slightly greater than 1%, the calculation is based on a conservative isobutane content for the propane proposed to be used in the refrigeration system and also assumes no concurrent flows to the LP cold flare tip. Therefore, DEP considers a VOC DRE restriction of 99.0% to be appropriate.

4. Internal floating roof storage tanks: DEP performed a search of EPA's RBLC for VOC LAER precedents for internal floating roof storage tanks, which revealed two entries, RBLC IDs TX-0825 and TX-0835, that indicated primary and secondary seals for the internal floating roof. More specifically, RBLC ID TX-0835 indicated a mechanical shoe (primary) seal and a rim-mounted secondary seal for the internal floating roof. RBLC ID TX-0835 also indicated welded decks and a vapor pressure restriction of less than 11.0 *psia* for the materials stored in the tank. RBLC ID TX-0825 indicated white paint for the tank shell. DEP considers these features to constitute LAER.

   The methanol-rich wastewater tank has all of these features; therefore, it meets LAER. Tank 609 has all of these features except for a rim-mounted secondary seal; therefore, it does not meet LAER. Accordingly, Plan Approval No. 23-0119E (revised) includes a requirement (i.e., Condition # 002, Section D (under Source ID 190)) for SPMT to install a rim-mounted secondary seal for the internal floating roof within 18 months after the date of issuance. [Note: This requirement would not preclude incorporation of Plan Approval No. 23-0119E (revised) into TVOP No. 23-00119.]

5. Cooling towers: As previously indicated in the applications for Plan Approval Nos. 23-0119C and 23-0119D, SPMT has proposed the use of a heat exchanger LDAR program to monitor the water circulating through the 'new' cooling towers for the presence of hydrocarbons/VOCs. DEP concurs with SPMT's LAER proposal for the 'new' cooling towers and has extended this program, as well as a PM emission concentration restriction and associated monitoring, recordkeeping, and reporting requirements, to the 15-2B cooling tower. SPMT has indicated that the 15-2B cooling tower currently does not comply with the PM emission concentration restriction and that, to do so, SPMT will need to install new drift eliminator controls on the cooling tower. Accordingly, Plan Approval No. 23-0119E (revised) includes a requirement (i.e., Condition # 016, Section D (under Source ID 139)) for SPMT to install the new drift eliminator controls within 18 months after the date of issuance.

6. Meter provers: SPMT has proposed the use of best management practices for the meter provers to minimize VOC blowdowns. DEP concurs with SPMT's LAER proposal for the meter provers.

B. 25 Pa. Code § 127.205(2)

To SPMT's knowledge, all existing sources located within the Commonwealth that are owned, operated, or controlled by SPMT are in compliance with applicable local, state, and federal regulations and consent decree requirements, or are on a compliance schedule.

C. 25 Pa. Code § 127.205(3)–(4)

Pursuant to 25 Pa. Code § 127.201(f), the facility is subject to the requirements applicable to a major facility located in a severe nonattainment area for ozone. Therefore, as indicated in 25 Pa. Code § 127.210(a), SPMT is required to offset the aggregated emissions increases of NO_x and VOCs at the ratio of 1.3:1. Based on the significant aggregated emissions increases of NO_x and VOCs indicated in Table 3, above, and the required offset ratio, SPMT is required to obtain and surrender 79.15 tons of NO_x Emission Reduction Credits (ERCs) and 243.72 tons of VOC ERCs.[34] SPMT has previously surrendered, and DEP has previously retired,

[34] As a result of the changes discussed in Footnote 31, above, the amount of NO_x ERCs required to be surrendered by SPMT differs from the values indicated in the previous draft of this technical review memo, dated February 28, 2020, and the *Pa. Bulletin* notice published on February 29, 2020, for Plan Approval No. 23-0119E (revised), by –9.12 *tons/yr* and

32.80 tons of NO_x ERCs and 134.72 tons of VOC ERCs[35] under previously-issued Plan Approvals for certain sources and equipment of the single aggregated project. Therefore, to fully offset the aggregated emissions increases of NO_x and VOCs, SPMT is required to obtain and surrender an additional 46.35 tons of NO_x ERCs and 109.00 tons of VOC ERCs for the single aggregated project (see *Attachment #6*). Of these ERC amounts, SPMT shall obtain and surrender 46.35 tons of NO_x ERCs and 59.07 tons of VOC ERCs under Plan Approval No. 23-0119E (revised), and 49.93 tons of VOC ERCs under Plan Approval No. 23-0119J (pending). SPMT currently (i.e., as of the date of this technical review memo) holds sufficient NO_x ERCs and VOC ERCs to satisfy the amounts it is required to surrender under Plan Approval No. 23-0119E (revised), as follows:

- NO_x ERCs: On June 9, 2020, DEP approved the transfer of 64.00 tons of NO_x ERCs from Exelon Generation Company, LLC (Exelon) to SPMT. The NO_x ERCs were generated on February 17, 2011, by the shutdown of Boiler #1 at Exelon's Eddystone Generation Station facility, located in Eddystone Borough, Delaware County; certified on March 19, 2013; and expire on February 17, 2021. The current balance of the NO_x ERCs remains 64.00 tons.

- VOC ERCs: On February 23, 2017, DEP approved the transfer of 147.93 tons of VOC ERCs from Sunoco, Inc. (as successor to Sun Company, Inc.) to SPMT. The VOC ERCs were generated on September 30, 1994, by the over-control of emissions at the former Marcus Hook Refinery, Marcus Hook Borough, Delaware County; certified on April 19, 2002; and do not expire. The current balance of the VOC ERCs is 89.62 tons.

D. 25 Pa. Code § 127.205(5)

SPMT has conducted an analysis of alternative sites, sizes, production processes, and environmental control techniques to demonstrate that the benefits of the facility significantly outweigh the environmental and social costs imposed on the Commonwealth as a result of its location, construction, or modification. Except for the sources and equipment proposed under Plan Approval No. 23-0119J, as well as one of the depropanizers (Source ID 090) permitted under the original Plan Approval No. 23-0119E, the sources and equipment of the single aggregated project have already commenced operation and rely upon existing equipment and utilities at the facility, including marine vessel loading docks and pipeline infrastructure that terminates at the facility. Furthermore, SPMT has stated that "equipment sizing and production processes were determined in order to meet technical requirements and business demands of the MHIC," and contends that relocating, replacing, or rerouting the pipeline infrastructure outside of existing right-of-ways would create an unnecessary net environmental and community disturbance. Lastly, SPMT contends that, because of the facility's location in an area subject to the requirements applicable to a severe nonattainment area for ozone, the sources and equipment of the single aggregated project have been/will be designed to minimize overall emissions and meet associated NSR, LAER, and ERC requirements, which may not be the same for a suitable alternate industrial location. Based on the above, DEP concurs that the benefits of the facility significantly outweigh the environmental and social costs imposed on the Commonwealth as a result of its location, construction, or modification.

VI. Regulatory Analysis

Plan Approval No. 23-0119E (revised) incorporates all terms and conditions indicated in the previously-issued Plan Approvals, which, except as specified in the *NSR Analysis* section, above, have not been modified. As the associated applicable federal regulations and requirements have already been detailed in DEP's corresponding technical review memos, they are not discussed further here.

–8.79 *tons/yr*, respectively. Based on this and a recalculation the emissions increases of VOCs associated with certain sources, the amount of VOC ERCs required to be surrendered by SPMT differs by +4.69 *tons/yr* and +13.81 *tons/yr*, respectively.

[35] The amount of VOC ERCs previously surrendered/retired includes 19.02 tons under Plan Approval No. 23-0119H for flows to the West Warm Flare that are attributable to various sources and equipment of the single aggregated project.

To the extent not already discussed in the *NSR Requirements* section, above, the applicable federal regulations and requirements for the sources and equipment proposed under Plan Approval No. 23-0119J (pending) are discussed in the *Emissions/Regulatory Analysis* and *Additional Regulatory Analysis* sections of DEP's corresponding technical review memo, dated February 5, 2021 (pages 5–8 and 9, respectively).

VII. Additional Information for the Auxiliary Boilers

Each of the three auxiliary boilers at the facility is capable of producing steam at a rate of 267,000 *lbs/hr*. Therefore, the total rated steam production for all three auxiliary boilers is 801,000 *lbs/hr*. SPMT has provided an updated source-by-source breakdown of the actual MHIC operational steam demand (see *Attachment #8*). In DEP's determination of the incremental emissions increases for the auxiliary boilers in the previous draft of this technical review memo, dated February 28, 2020, DEP considered the entire base MHIC steam demand to be unrelated to the sources and equipment of the single aggregated project. However, based on the source-by-source breakdown, DEP considers the steam demand for additional (highlighted) supporting sources and equipment at the MHIC, listed under the "general use/facility baseload" grouping, to be related to the sources and equipment of the single aggregated project. The total annualized operational steam demand for the sources and equipment of or related to the single aggregated project, including the projected operational steam demand for the sources and equipment proposed under Plan Approval No. 23-0119J (pending), is listed in Table 4, below, and is less than the total rated steam production for the auxiliary boilers:

Table 4
Total Annualized Operational Steam Demand for the Single Aggregated Project (*lbs/hr*)

Plan Approval Nos. 23-0119A, 23-0119B, 23-0119D, 23-0119E, and 23-0119H	157,535
General Use at MHIC	12,950
Estimated Auxiliary Boiler Losses	26,750
Plan Approval No. 23-0119J (Project Phoenix; Pending)	36,300
Total	**233,535**

In addition, SPMT has provided updated CO, CO_2e, H_2SO_4, NO_2/NO_x, Pb, $PM/PM_{10}/PM_{2.5}$, SO_2, and VOC emission factors for the auxiliary boilers based on 2018–2019 performance. Based on the total annualized MHIC operational steam demand of 379,000 *lbs/hr*, the projected operational steam demand for the sources and equipment proposed under Plan Approval No. 23-0119J (pending), and the updated emission factors for the auxiliary boilers, the PTEs do not exceed any of the emission restrictions indicated in TVOP No. 23-00119. The CO, CO_2e, H_2SO_4, NO_2/NO_x, Pb, $PM/PM_{10}/PM_{2.5}$, SO_2, and VOC emission factors, PTEs, and emission rate restrictions for the auxiliary boilers are listed in Table 5, below:

Table 5
CO, CO_2e, H_2SO_4, NO_2/NO_x, Pb, $PM/PM_{10}/PM_{2.5}$, SO_2, and VOC Emission Factors, PTEs, & Emission Rate Restrictions for the Auxiliary Boilers

Pollutant	Emission Factors (*lbs/lb steam*)	PTEs (*tons/yr*)	Emission Rate Restrictions (*tons/yr*)
CO	7.55×10^{-6}	13.73	27.23
CO_2e	1.89×10^{-1}	343,794	———
H_2SO_4	5.61×10^{-8}	0.102	3.15
NO_2/NO_x	3.74×10^{-5}	68.03	92.71 (NO_x)
Pb	6.69×10^{-9}	0.0122	———
$PM/PM_{10}/PM_{2.5}$	1.37×10^{-6}	2.49	21.94 (PM)
SO_2	4.15×10^{-6}	7.55	41.10
VOCs	2.73×10^{-6}	4.97	5.49

VIII. Changes to Conditions in Draft Plan Approval No. 23-0119E (Revised)

DEP has removed the following two conditions that appeared in draft Plan Approval No. 23-0119E (revised):

- Condition # 002, Section D (under Source IDs 188 and 192), of draft Plan Approval No. 23-0119E read as follows: "The emission limit on internal floating roof storage tanks 23, 607, and 611 (Source ID 221 in Title V Operating Permit No. 23-00119, and Source IDs 188 and 192 in this plan approval, respectively) does not provide any relief from obtaining a plan approval for any future physical change or change in the method of operation of any of these three tanks. Future applicability determinations must consider the baseline actual emissions of the emissions unit(s) and not the compliance cap. The latter is true even if the company does not request a change in the compliance cap. Furthermore, by accepting this compliance cap and agreeing to consider these three tanks as one emissions unit for NSR/PSD purposes (to avoid NSR/PSD), any future applicability determinations must involve all three tanks (i.e., should major NSR/PSD be triggered for any one tank, LAER/BACT is required for all three tanks)." DEP inadvertently included this condition from an earlier version of TVOP No. 23-00119 (i.e., the significant modification issued on December 19, 2016). This condition no longer applies, as Tank 23 has since been removed from the facility and the current version of TVOP No. 23-00119 (i.e., the minor modification issued on August 25, 2020) includes separate VOC emission rate restrictions for Tanks 607 and 611.

- Condition # 023, Section E (under the Auxiliary Boilers source group), of draft Plan Approval No. 23-0119E read as follows: "The throughput limit on boilers 1, 3, and 4 does not provide any relief from obtaining a plan approval for any future physical change or change in the method of operation of any of the boilers, or the addition or modification of any steam-consuming process(es) at the facility. Future applicability determinations must consider the baseline actual emissions of the emissions unit(s) and not the cap. The latter is true even if the permittee does not request a change in the compliance cap. Furthermore, by accepting this cap and agreeing to consider the three boilers as one emissions unit for NSR/PSD purposes (to avoid NSR/PSD), any future applicability determinations must involve all three boilers, e.g. should major NSR/PSD be triggered for any one boiler or process change, BACT/LAER is required for all three boilers." While this condition is included in the current version of TVOP No. 23-00119, there has not been a throughput restriction for the auxiliary boilers since DEP incorporated the requirements of Plan Approval No. 23-0119B into TVOP No. 23-00119 (i.e., the significant modification issued on December 19, 2016). SPMT operates and maintains a continuous monitoring system to monitor CO, NO_x, and oxygen (O_2) from the auxiliary boilers, and performs periodic stack testing to demonstrate compliance with other pollutant emission restrictions indicated for the auxiliary boilers. Therefore, this condition is not necessary.

IX. Recommendation

Based on a review of the previously-issued Plan Approvals and associated applications, the previously-approved RFDs and associated applications, and the previously-approved de minimis emissions increases and associated letters for the facility; TVOPs No. 23-00001 and 23-00119; the applications for Plan Approval Nos. 23-0119E (revised) and 23-0119J (pending); and EPA's RBLC, I recommend that DEP issue the Plan Approval No. 23-0119E (revised) for SPMT for the facility.

Table D-7: New Fugitive Equipment Component Counts (total for each)

Component Category	Component	Component Counts (Units/Streams in VOC service and in LDAR Program)	
		Propane Refrigeration System	Amine Treatment System
Valves	Valves	1787	1323
	Pump Seal Valves	29	26
	Compressor Seal Valves	254	0
	Sample Station Valves	0	48
	Analyzer Valves	0	0
Reliefs	Pressure Relief Valves	77	30
Connectors	Connectors	5,996	3416
	Analyzer Connectors	0	0
	Pump Seal Connectors	86	204
	Compressor Seal Connectors	662	0
	Sampling Connections	0	2
	Sample Station Connectors	0	240
---	Compressor Seals	12	0
---	Pump Seals	2	6

Table D-8: LDAR Screening Values

	Default 0	0-500	500-1000	1,001-10,000	>10000
Assumed Leak Concentration		18	751	1393	61483
Assumed Leak Rate - Valves	0.02%	97.40%	0.79%	1.58%	0.21%
Assumed Leak Rate - Pump Seals	0.44%	94.36%	0.77%	3.76%	0.66%
Assumed Leak Rate - Connectors	0.01%	98.95%	0.24%	0.67%	0.12%
Assumed Leak Rate - Others	0.06%	98.51%	0.46%	0.97%	0.00%

Table D-9: Screening Value Emission Factors

	Leak Rate (kg/hr)				
Component Type					
Valves	7.80E-06	2.000E-05	3.201E-04	5.074E-04	6.400E-02
Pump Seals	2.40E-05	2.959E-04	2.857E-03	4.164E-03	7.400E-02
Connectors	7.50E-06	1.294E-05	1.988E-04	3.130E-04	2.800E-02
Others	4.00E-06	7.527E-05	6.721E-04	9.670E-04	7.300E-02
	Table 2-12	Table 2-10	Table 2-10	Table 2-10	Table 2-14

(Source: "Protocol for Equipment Leak Emission Estimates", EPA-453/R-95-017)

Attachment #3

Sunoco Partners Marketing & Terminals L.P.
Project Phoenix
July 2019
Fugitive Component Emissions, Screening Methodology

Table D-10: Total Material Emissions Due to Fugitive Equipment (lbs)

Component	Leak Rate (lb/yr)					Total (lbs/day)	Total (lbs/year)	Total (tons/year)
	Default 0	0-500	500-1000	1,001-10,000	>10000			
Valves	0	1304	169	535	9098	30.43	11106.87	5.55
Pump Seals	0	45	4	25	80	0.42	153.98	0.08
Connectors	0	2623	99	432	6955	27.70	10109.35	5.05
Others	0	171	7	22	0	0.55	199.83	0.10
Total (all components)	0	4143.86	278.08	1014.36	16133.35	59.10	21570.02	10.79

Table D-11 Percent (%) of Total Components per Unit

	Propane Refrigeration System	Amine Treatment System
Valves	59.7%	40.3%
Pump Seals	28.6%	71.4%
Connectors	63.6%	36.4%
July 2019	74.9%	25.1%
Total (all components)	62.7%	37.3%

Table D-12: Gas Speciation for New Fugitive Equipment

Speciation	Propane Refrigeration System - Weight %	Amine Treatment System - Weight %
Methane		
Ethane	2%	
Propane	97%	
i-Butane	1%	
Diethanolamine (DEA)		10%
Water		90%
CO2		
Total VOC	98%	10%
Total GHG	0%	0%

Table D-13: Emissions Summary by Component Type

Components	Total (tons/year)	Propane Refrigeration System (TPY)	Amine Treatment System (TPY)
Valves	5.55	3.32	2.24
Pump Seals	0.08	0.02	0.05
Connectors	5.05	3.21	1.84
Others	0.10	0.07	0.03
Total (all components)	10.79	6.63	4.16

Total VOC Percentage By Unit Stream (%)	98%	10%
Total VOC Emissions By Unit Stream (TPY)	6.49	0.42

Total CO_2e Percentage By Unit Stream (%)	0%	0%
Total CO_2e Emissions By Unit Stream (TPY)	0.00	0.00

Total VOC Emissions (TPY)	6.91
Total CO_2e Emissions (TPY)	0.00

Sunoco Partners Marketing & Terminals L.P.
Project Phoenix
July 2019
Fugitive Component Emissions

Table D-5: Detailed Fugitive Component Emissions

Area	Equipment Type	Service	Emission Factor (kg/hr/source)[a]	Component Counts	Control Efficiency for LDAR Monitored Components	Total VOC (weight %)	Total GHG (weight %)	VOC Emissions (tons/year)	CO_2e Emissions (tons/year)[g]
Natural Gas System	Valves	Gas[b]	0.00597	445	0%	0%	90%	0.00	577.46
	Pressure Relief Valves	Gas	0.104	10	0%	0%	90%	0.00	216.92
	Connectors	All	0.00183	1,134	0%	0%	90%	0.00	450.87
Ethane System	Valves	Gas[b]	0.00597	1,748	0%	4%	1%	3.63	12.60
		Light Liquid[c]	0.00403	2,623	0%	4%	1%	3.67	12.76
	Pump Seal Valves	Light Liquid[c]	0.00403	108	0%	4%	1%	0.15	0.53
	Pump Seal Connectors	All	0.00183	343	0%	4%	1%	0.22	0.76
	Analyzer Valves	Gas[b]	0.00597	540	0%	4%	1%	1.12	3.89
	Analyzer Connectors	All	0.00183	1,140	0%	4%	1%	0.73	2.52
	Sample Station Valves	Light Liquid[c]	0.00403	24	0%	4%	1%	0.03	0.12
	Sample Station Connectors	All	0.00183	120	0%	4%	1%	0.08	0.27
	Compressor Seal Valves	Gas	0.00597	331	0%	4%	1%	0.69	2.39
		Light Liquid[c]	0.00403	0	0%	4%	1%	0.00	0.00
		Heavy Liquid[d]	0.00023	0	0%	4%	1%	0.00	0.00
	Compressor Seal Connectors	All	0.00183	840	0%	4%	1%	0.53	1.86
	Pump Seals	Light Liquid[c]	0.0199	10	0%	4%	1%	0.07	0.23
		Heavy Liquid[d]	0.00862	0	0%	4%	1%	0.00	0.00
	Compressor Seals	Gas	0.228	14	0%	4%	1%	1.14	3.96
	Pressure Relief Valves	Gas	0.104	212	0%	4%	1%	7.68	26.66
	Connectors	All	0.00183	14,965	0%	4%	1%	9.52	33.06
	Sampling Connections	All	0.015	1	0%	4%	1%	0.01	0.02
Methane / Ethane System	Valves	Gas[b]	0.00597	602	0%	0%	50%	0.00	434.09
	Analyzer Valves	Gas[b]	0.00597	720	0%	0%	50%	0.00	518.83
	Analyzer Connectors	All	0.00183	1,440	0%	0%	50%	0.00	318.08
	Pressure Relief Valves	Gas	0.104	38	0%	0%	50%	0.00	482.04
	Connectors	All	0.00183	1,758	0%	0%	50%	0.00	388.32
Flare System	Valves	Gas[b]	0.00597	685	0%	0%	90%	0.00	888.76
	Pump Seal Valves	Heavy Liquid[d]	0.00023	10	0%	0%	90%	0.00	0.48
	Pump Seal Connectors	All	0.00183	65	0%	0%	90%	0.00	25.76
	Analyzer Valves	Gas[b]	0.00597	120	0%	0%	90%	0.00	155.65
	Analyzer Connectors	All	0.00183	300	0%	0%	90%	0.00	119.28
	Connectors	All	0.00183	2,119	0%	0%	90%	0.00	842.59
Acid Gas System	Valves	Gas[b]	0.00597	40	0%	0%	24%	0.00	0.55
	Connectors	All	0.00183	48	0%	0%	24%	0.00	0.20
							TOTALS	29.26	5,521.48

Attachment #4

MHIC Natural Gas Composition - 2019 Daily Avgs

Data courtesy of Williams Pipeline Co.

Attachment #5

Meter ID	Chrmtg	Beg Date Time	G A Eff Date	Spec Grav	Heat Fctr	Nitrogen	Carbon Dic	Methane	Ethane	Propane	I-Butane	N-Butane	I-Pentane	N-Pentane	Hexane	Hydrogen S	Smpl Dev	Smpl Type
6133	GQC06041	1/1/2019 9:00	1/1/2019	0.567	1.0288	0.244	0.04	97.535	2.112	0.065	0.001	0.003	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/2/2019 9:00	1/2/2019	0.568	1.0304	0.245	0.051	97.311	2.308	0.078	0.002	0.005	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/3/2019 9:00	1/3/2019	0.569	1.0309	0.246	0.056	97.237	2.370	0.083	0.002	0.005	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/4/2019 9:00	1/4/2019	0.569	1.0315	0.248	0.064	97.149	2.444	0.087	0.003	0.006	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/5/2019 9:00	1/5/2019	0.570	1.0328	0.251	0.074	96.969	2.593	0.1	0.004	0.008	0.001	0.001	0.001	0	Chromatog	Accumulated
6133	GQC06041	1/6/2019 9:00	1/6/2019	0.568	1.0292	0.251	0.045	97.459	2.171	0.069	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/7/2019 9:00	1/7/2019	0.567	1.029	0.246	0.043	97.496	2.141	0.068	0.001	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/8/2019 9:00	1/8/2019	0.568	1.0304	0.246	0.057	97.299	2.309	0.08	0.002	0.005	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/9/2019 9:00	1/9/2019	0.568	1.0297	0.248	0.051	97.393	2.226	0.075	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/10/2019 9:00	1/10/2019	0.567	1.0283	0.252	0.038	97.582	2.062	0.062	0.001	0.003	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/11/2019 9:00	1/11/2019	0.567	1.0284	0.253	0.039	97.558	2.082	0.063	0.001	0.003	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/12/2019 9:00	1/12/2019	0.567	1.0286	0.253	0.039	97.532	2.106	0.064	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/13/2019 9:00	1/13/2019	0.567	1.0289	0.253	0.041	97.502	2.132	0.067	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/14/2019 9:00	1/14/2019	0.568	1.0292	0.249	0.045	97.468	2.162	0.07	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/15/2019 9:00	1/15/2019	0.567	1.0291	0.248	0.045	97.477	2.155	0.07	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/16/2019 9:00	1/16/2019	0.568	1.0297	0.248	0.048	97.401	2.219	0.076	0.002	0.005	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/17/2019 9:00	1/17/2019	0.568	1.0297	0.249	0.047	97.405	2.216	0.075	0.002	0.005	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/18/2019 9:00	1/18/2019	0.568	1.0293	0.251	0.045	97.446	2.179	0.072	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/19/2019 9:00	1/19/2019	0.568	1.0293	0.25	0.045	97.446	2.178	0.072	0.002	0.004	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/20/2019 9:00	1/20/2019	0.567	1.0276	0.252	0.033	97.667	1.989	0.056	0.001	0.003	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/21/2019 9:00	1/21/2019	0.568	1.0293	0.251	0.048	97.444	2.177	0.072	0.002	0.004	0.001	0	0.001	0	Chromatog	Accumulated
6133	GQC06041	1/22/2019 9:00	1/22/2019	0.568	1.029	0.249	0.046	97.49	2.140	0.069	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/23/2019 9:00	1/23/2019	0.567	1.028	0.25	0.036	97.618	2.033	0.059	0.001	0.003	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/24/2019 9:00	1/24/2019	0.567	1.0289	0.248	0.043	97.502	2.133	0.068	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/25/2019 9:00	1/25/2019	0.568	1.0299	0.247	0.045	97.386	2.235	0.079	0.003	0.005	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/26/2019 9:00	1/26/2019	0.568	1.0293	0.248	0.043	97.457	2.174	0.071	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/27/2019 9:00	1/27/2019	0.568	1.0299	0.25	0.049	97.368	2.250	0.075	0.002	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6133	GQC06041	1/28/2019 9:00	1/28/2019	0.567	1.0287	0.253	0.042	97.513	2.121	0.066	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/29/2019 9:00	1/29/2019	0.567	1.0291	0.255	0.043	97.465	2.163	0.068	0.002	0.004	0	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/30/2019 9:00	1/30/2019	0.568	1.0296	0.255	0.048	97.407	2.205	0.076	0.003	0.005	0.001	0	0	0	Chromatog	Accumulated
6133	GQC06041	1/31/2019 9:00	1/31/2019	0.571	1.0338	0.255	0.085	96.868	2.633	0.131	0.008	0.013	0.002	0.002	0.002	0	Chromatog	Accumulated
6075	GQC06041	2/1/2019 9:00	2/1/2019	0.571	1.0334	0.255	0.079	96.917	2.602	0.123	0.007	0.011	0.002	0.001	0.002	0	Chromatog	Accumulated
6075	GQC06041	2/2/2019 9:00	2/2/2019	0.568	1.0302	0.253	0.051	97.325	2.283	0.078	0.003	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/3/2019 9:00	2/3/2019	0.569	1.0308	0.252	0.053	97.252	2.349	0.083	0.003	0.006	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/4/2019 9:00	2/4/2019	0.57	1.0335	0.246	0.065	96.925	2.638	0.108	0.005	0.009	0.002	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/5/2019 9:00	2/5/2019	0.569	1.032	0.242	0.057	97.131	2.462	0.095	0.004	0.007	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/6/2019 9:00	2/6/2019	0.569	1.0313	0.241	0.052	97.227	2.374	0.093	0.004	0.007	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/7/2019 9:00	2/7/2019	0.569	1.0309	0.239	0.052	97.274	2.336	0.088	0.003	0.006	0.001	0	0	0	Chromatog	Accumulated
6075	GQC06041	2/8/2019 9:00	2/8/2019	0.568	1.0302	0.248	0.052	97.335	2.277	0.079	0.003	0.005	0.001	0	0	0	Chromatog	Accumulated
6075	GQC06041	2/9/2019 9:00	2/9/2019	0.568	1.0295	0.25	0.049	97.414	2.212	0.069	0.002	0.004	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/10/2019 9:00	2/10/2019	0.569	1.0311	0.25	0.061	97.202	2.39	0.084	0.003	0.006	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/11/2019 9:00	2/11/2019	0.568	1.0296	0.25	0.049	97.411	2.21	0.073	0.002	0.004	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/12/2019 9:00	2/12/2019	0.568	1.0296	0.249	0.048	97.407	2.211	0.075	0.003	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/13/2019 9:00	2/13/2019	0.568	1.0295	0.248	0.05	97.421	2.197	0.075	0.003	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/14/2019 9:00	2/14/2019	0.568	1.0294	0.249	0.047	97.433	2.19	0.073	0.002	0.005	0	0	0	0	Chromatog	Accumulated
6075	GQC06041	2/15/2019 9:00	2/15/2019	0.569	1.0315	0.249	0.067	97.156	2.418	0.095	0.005	0.008	0.001	0.001	0.002	0	Chromatog	Accumulated
6075	GQC06041	2/16/2019 9:00	2/16/2019	0.568	1.0297	0.247	0.05	97.396	2.222	0.076	0.003	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/17/2019 9:00	2/17/2019	0.568	1.0295	0.248	0.045	97.433	2.192	0.075	0.003	0.005	0.001	0	0	0	Chromatog	Accumulated
6075	GQC06041	2/18/2019 9:00	2/18/2019	0.568	1.0299	0.245	0.051	97.378	2.239	0.078	0.003	0.005	0.001	0	0	0	Chromatog	Accumulated
6075	GQC06041	2/19/2019 9:00	2/19/2019	0.569	1.0303	0.248	0.057	97.319	2.282	0.082	0.003	0.006	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/20/2019 9:00	2/20/2019	0.569	1.0303	0.247	0.063	97.306	2.288	0.083	0.004	0.006	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/21/2019 9:00	2/21/2019	0.569	1.0308	0.247	0.066	97.247	2.336	0.089	0.004	0.007	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/22/2019 9:00	2/22/2019	0.569	1.0305	0.248	0.062	97.291	2.296	0.089	0.004	0.007	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/23/2019 9:00	2/23/2019	0.568	1.03	0.242	0.051	97.382	2.235	0.08	0.003	0.005	0.001	0	0	0	Chromatog	Accumulated
6075	GQC06041	2/24/2019 9:00	2/24/2019	0.569	1.0314	0.246	0.067	97.187	2.384	0.098	0.005	0.008	0.002	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/25/2019 9:00	2/25/2019	0.569	1.0305	0.249	0.054	97.296	2.305	0.084	0.004	0.006	0.001	0.001	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/26/2019 9:00	2/26/2019	0.568	1.0294	0.251	0.055	97.425	2.187	0.073	0.003	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/27/2019 9:00	2/27/2019	0.568	1.0288	0.252	0.055	97.487	2.126	0.071	0.003	0.005	0.001	0	0.001	0	Chromatog	Accumulated
6075	GQC06041	2/28/2019 9:00	2/28/2019	0.567	1.0279	0.248	0.041	97.625	2.02	0.061	0.001	0.003	0	0	0	0	Chromatog	Accumulated

6075	GQC06041	3/1/2019 9:00	3/1/2019	0.567	1.0283	0.248	0.045	97.577	2.06	0.064	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/2/2019 9:00	3/2/2019	0.568	1.0291	0.249	0.052	97.472	2.145	0.073	0.003	0.005	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/3/2019 9:00	3/3/2019	0.567	1.0284	0.247	0.043	97.564	2.075	0.065	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/4/2019 9:00	3/4/2019	0.567	1.0287	0.245	0.046	97.533	2.104	0.067	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/5/2019 9:00	3/5/2019	0.567	1.0286	0.252	0.051	97.522	2.099	0.068	0.002	0.004	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/6/2019 9:00	3/6/2019	0.567	1.0285	0.249	0.053	97.535	2.085	0.069	0.002	0.005	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/7/2019 9:00	3/7/2019	0.567	1.0285	0.25	0.056	97.528	2.089	0.069	0.002	0.004	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/8/2019 9:00	3/8/2019	0.567	1.0284	0.249	0.054	97.548	2.073	0.068	0.002	0.004	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/9/2019 9:00	3/9/2019	0.567	1.0284	0.249	0.052	97.555	2.069	0.067	0.002	0.004	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/10/2019 9:00	3/10/2019	0.568	1.0293	0.245	0.055	97.442	2.173	0.075	0.003	0.005	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/11/2019 9:00	3/11/2019	0.567	1.0287	0.248	0.045	97.53	2.105	0.067	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/12/2019 9:00	3/12/2019	0.568	1.0294	0.248	0.049	97.441	2.181	0.074	0.002	0.005	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/13/2019 9:00	3/13/2019	0.567	1.0289	0.245	0.045	97.513	2.123	0.069	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/14/2019 9:00	3/14/2019	0.568	1.0305	0.241	0.057	97.311	2.295	0.085	0.003	0.006	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/15/2019 9:00	3/15/2019	0.567	1.0289	0.248	0.045	97.502	2.127	0.07	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/16/2019 9:00	3/16/2019	0.568	1.0302	0.246	0.055	97.339	2.266	0.083	0.003	0.006	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/17/2019 9:00	3/17/2019	0.567	1.0283	0.246	0.037	97.596	2.054	0.063	0.001	0.003	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/18/2019 9:00	3/18/2019	0.567	1.0293	0.245	0.042	97.468	2.168	0.071	0.002	0.004	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/19/2019 9:00	3/19/2019	0.569	1.0312	0.243	0.059	97.208	2.393	0.086	0.003	0.006	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/20/2019 9:00	3/20/2019	0.569	1.031	0.242	0.062	97.23	2.369	0.086	0.003	0.006	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/21/2019 9:00	3/21/2019	0.569	1.0306	0.241	0.066	97.267	2.332	0.084	0.003	0.006	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/22/2019 9:00	3/22/2019	0.568	1.0296	0.246	0.052	97.404	2.214	0.075	0.002	0.005	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/23/2019 9:00	3/23/2019	0.568	1.0296	0.245	0.05	97.419	2.205	0.073	0.002	0.005	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/24/2019 9:00	3/24/2019	0.569	1.0312	0.241	0.066	97.202	2.389	0.09	0.003	0.007	0.001	0.001	0.001	0 Chromatog Accumulated
6075	GQC06041	3/25/2019 9:00	3/25/2019	0.569	1.0312	0.245	0.065	97.201	2.39	0.087	0.003	0.006	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/26/2019 9:00	3/26/2019	0.568	1.0298	0.241	0.049	97.402	2.226	0.075	0.002	0.005	0	0	0	0 Chromatog Accumulated
6075	GQC06041	3/27/2019 9:00	3/27/2019	0.569	1.0306	0.245	0.056	97.282	2.323	0.084	0.003	0.006	0.001	0	0.001	0 Chromatog Accumulated
6075	GQC06041	3/28/2019 9:00	3/28/2019	0.569	1.0306	0.246	0.059	97.274	2.326	0.085	0.003	0.006	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/29/2019 9:00	3/29/2019	0.569	1.0315	0.245	0.065	97.164	2.423	0.091	0.003	0.007	0.001	0.001	0.001	0 Chromatog Accumulated
6075	GQC06041	3/30/2019 9:00	3/30/2019	0.569	1.0309	0.24	0.059	97.246	2.361	0.086	0.003	0.006	0.001	0	0	0 Chromatog Accumulated
6075	GQC06041	3/31/2019 9:00	3/31/2019	0.567	1.0285	0.251	0.041	97.544	2.094	0.065	0.001	0.003	0	0	0	0 Chromatog Accumulated
6075	GQC06041	4/1/2019 9:00	4/1/2019	0.567	1.0288	0.245	0.042	97.523	2.117	0.067	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/2/2019 9:00	4/2/2019	0.568	1.0297	0.242	0.049	97.41	2.217	0.076	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	4/3/2019 9:00	4/3/2019	0.569	1.0309	0.246	0.06	97.241	2.350	0.09	0.003	0.007	0.001	0.001	0.001	0 Chromatograph
6075	GQC06041	4/4/2019 9:00	4/4/2019	0.568	1.03	0.248	0.056	97.348	2.258	0.081	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	4/5/2019 9:00	4/5/2019	0.567	1.0286	0.25	0.04	97.546	2.094	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/6/2019 9:00	4/6/2019	0.568	1.0297	0.245	0.045	97.407	2.223	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/7/2019 9:00	4/7/2019	0.569	1.0308	0.24	0.053	97.269	2.348	0.083	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	4/8/2019 9:00	4/8/2019	0.568	1.0296	0.244	0.048	97.414	2.214	0.075	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/9/2019 9:00	4/9/2019	0.568	1.0296	0.243	0.047	97.418	2.212	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/10/2019 9:00	4/10/2019	0.568	1.0291	0.246	0.042	97.485	2.152	0.07	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/11/2019 9:00	4/11/2019	0.568	1.0293	0.247	0.044	97.453	2.178	0.072	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/12/2019 9:00	4/12/2019	0.568	1.0293	0.246	0.045	97.449	2.182	0.073	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/13/2019 9:00	4/13/2019	0.567	1.029	0.244	0.042	97.504	2.135	0.069	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/14/2019 9:00	4/14/2019	0.567	1.0283	0.249	0.038	97.581	2.064	0.063	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/15/2019 9:00	4/15/2019	0.567	1.0284	0.255	0.039	97.558	2.08	0.065	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/16/2019 9:00	4/16/2019	0.567	1.0279	0.251	0.036	97.636	2.016	0.059	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/17/2019 9:00	4/17/2019	0.566	1.0276	0.251	0.032	97.671	1.987	0.056	0	0.002	0	0	0	0 Chromatograph
6075	GQC06041	4/18/2019 9:00	4/18/2019	0.566	1.0275	0.252	0.032	97.685	1.973	0.055	0	0.002	0	0	0	0 Chromatograph
6075	GQC06041	4/19/2019 9:00	4/19/2019	0.566	1.0279	0.251	0.034	97.631	2.022	0.058	0	0.002	0	0	0	0 Chromatograph
6075	GQC06041	4/20/2019 9:00	4/20/2019	0.568	1.0297	0.249	0.047	97.398	2.228	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/21/2019 9:00	4/21/2019	0.568	1.0293	0.252	0.046	97.433	2.193	0.071	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/22/2019 9:00	4/22/2019	0.568	1.0292	0.254	0.044	97.453	2.174	0.07	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/23/2019 9:00	4/23/2019	0.568	1.0298	0.253	0.042	97.381	2.247	0.072	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/24/2019 9:00	4/24/2019	0.568	1.0295	0.246	0.043	97.435	2.2	0.07	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/25/2019 9:00	4/25/2019	0.568	1.0296	0.251	0.05	97.391	2.229	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/26/2019 9:00	4/26/2019	0.568	1.0295	0.25	0.047	97.415	2.208	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/27/2019 9:00	4/27/2019	0.568	1.0296	0.25	0.047	97.409	2.214	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/28/2019 9:00	4/28/2019	0.568	1.0292	0.252	0.043	97.462	2.167	0.07	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	4/29/2019 9:00	4/29/2019	0.567	1.0287	0.252	0.04	97.523	2.115	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	4/30/2019 9:00	4/30/2019	0.567	1.0285	0.247	0.038	97.563	2.085	0.064	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/1/2019 9:00	5/1/2019	0.566	1.0276	0.249	0.033	97.678	1.982	0.056	0	0.002	0	0	0	0 Chromatograph
6075	GQC06041	5/2/2019 9:00	5/2/2019	0.567	1.0282	0.253	0.038	97.583	2.06	0.062	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/3/2019 9:00	5/3/2019	0.567	1.0281	0.252	0.038	97.604	2.042	0.061	0.001	0.003	0	0	0	0 Chromatograph

6075	GQC06041	5/4/2019 9:00	5/4/2019	0.568	1.0294	0.248	0.046	97.436	2.192	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/5/2019 9:00	5/5/2019	0.568	1.0294	0.254	0.045	97.426	2.196	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/6/2019 9:00	5/6/2019	0.568	1.0295	0.257	0.045	97.412	2.208	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/7/2019 9:00	5/7/2019	0.568	1.0298	0.25	0.048	97.377	2.243	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/8/2019 9:00	5/8/2019	0.568	1.0291	0.257	0.044	97.454	2.167	0.072	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/9/2019 9:00	5/9/2019	0.568	1.0292	0.254	0.044	97.455	2.169	0.071	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/10/2019 9:00	5/10/2019	0.567	1.0289	0.253	0.04	97.494	2.14	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/11/2019 9:00	5/11/2019	0.567	1.0287	0.253	0.041	97.52	2.115	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/12/2019 9:00	5/12/2019	0.567	1.0289	0.253	0.041	97.493	2.141	0.067	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/13/2019 9:00	5/13/2019	0.567	1.0291	0.253	0.041	97.47	2.162	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/14/2019 9:00	5/14/2019	0.568	1.0298	0.242	0.047	97.406	2.224	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/15/2019 9:00	5/15/2019	0.568	1.0298	0.244	0.046	97.392	2.236	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/16/2019 9:00	5/16/2019	0.568	1.0294	0.246	0.043	97.449	2.186	0.072	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/17/2019 9:00	5/17/2019	0.568	1.0292	0.249	0.041	97.467	2.166	0.071	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/18/2019 9:00	5/18/2019	0.567	1.029	0.251	0.041	97.488	2.146	0.069	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/19/2019 9:00	5/19/2019	0.567	1.0286	0.257	0.039	97.529	2.105	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/20/2019 9:00	5/20/2019	0.567	1.0287	0.26	0.038	97.515	2.117	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/21/2019 9:00	5/21/2019	0.567	1.0291	0.258	0.039	97.467	2.164	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/22/2019 9:00	5/22/2019	0.568	1.0294	0.256	0.04	97.426	2.202	0.071	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	5/23/2019 9:00	5/23/2019	0.567	1.0284	0.256	0.037	97.556	2.083	0.064	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/24/2019 9:00	5/24/2019	0.567	1.0285	0.257	0.038	97.54	2.098	0.064	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/25/2019 9:00	5/25/2019	0.567	1.0283	0.257	0.038	97.558	2.08	0.063	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/26/2019 9:00	5/26/2019	0.567	1.0284	0.255	0.038	97.554	2.086	0.064	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/27/2019 9:00	5/27/2019	0.567	1.0281	0.253	0.036	97.593	2.052	0.062	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/28/2019 9:00	5/28/2019	0.567	1.0287	0.255	0.038	97.52	2.119	0.065	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/29/2019 9:00	5/29/2019	0.567	1.0287	0.255	0.037	97.525	2.115	0.065	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/30/2019 9:00	5/30/2019	0.567	1.0288	0.253	0.04	97.511	2.126	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	5/31/2019 9:00	5/31/2019	0.567	1.0287	0.248	0.04	97.53	2.113	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/1/2019 9:00	6/1/2019	0.567	1.0288	0.248	0.04	97.525	2.117	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/2/2019 9:00	6/2/2019	0.567	1.0288	0.249	0.04	97.518	2.122	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/3/2019 9:00	6/3/2019	0.567	1.0285	0.251	0.039	97.548	2.094	0.064	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/4/2019 9:00	6/4/2019	0.567	1.0286	0.25	0.039	97.535	2.106	0.065	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/5/2019 9:00	6/5/2019	0.568	1.0294	0.244	0.041	97.45	2.189	0.071	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/6/2019 9:00	6/6/2019	0.568	1.0303	0.24	0.045	97.343	2.285	0.079	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	6/7/2019 9:00	6/7/2019	0.568	1.0298	0.244	0.046	97.394	2.234	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/8/2019 9:00	6/8/2019	0.568	1.0302	0.241	0.048	97.352	2.276	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/9/2019 9:00	6/9/2019	0.568	1.0293	0.251	0.045	97.442	2.188	0.069	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/10/2019 9:00	6/10/2019	0.567	1.029	0.254	0.042	97.472	2.159	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/11/2019 9:00	6/11/2019	0.568	1.0294	0.254	0.043	97.423	2.204	0.07	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/12/2019 9:00	6/12/2019	0.568	1.0299	0.254	0.045	97.364	2.259	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/13/2019 9:00	6/13/2019	0.568	1.0297	0.252	0.043	97.394	2.234	0.072	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/14/2019 9:00	6/14/2019	0.568	1.0295	0.253	0.042	97.42	2.209	0.07	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/15/2019 9:00	6/15/2019	0.567	1.028	0.256	0.036	97.607	2.037	0.06	0.001	0.002	0	0	0	0 Chromatograph
6075	GQC06041	6/16/2019 9:00	6/16/2019	0.567	1.0289	0.26	0.04	97.474	2.153	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/17/2019 9:00	6/17/2019	0.568	1.0293	0.257	0.042	97.429	2.198	0.07	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	6/18/2019 9:00	6/18/2019	0.569	1.0314	0.246	0.048	97.181	2.437	0.082	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	6/19/2019 9:00	6/19/2019	0.568	1.0304	0.249	0.049	97.304	2.314	0.078	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/20/2019 9:00	6/20/2019	0.568	1.0303	0.249	0.047	97.321	2.299	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/21/2019 9:00	6/21/2019	0.568	1.0304	0.249	0.046	97.305	2.317	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/22/2019 9:00	6/22/2019	0.568	1.0296	0.253	0.046	97.394	2.229	0.072	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/23/2019 9:00	6/23/2019	0.568	1.0293	0.253	0.044	97.441	2.188	0.07	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/24/2019 9:00	6/24/2019	0.568	1.0293	0.25	0.045	97.447	2.181	0.071	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/25/2019 9:00	6/25/2019	0.569	1.0312	0.248	0.045	97.209	2.411	0.08	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/26/2019 9:00	6/26/2019	0.569	1.0307	0.246	0.049	97.267	2.352	0.079	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/27/2019 9:00	6/27/2019	0.568	1.0304	0.244	0.052	97.314	2.306	0.078	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	6/28/2019 9:00	6/28/2019	0.568	1.0303	0.246	0.051	97.314	2.303	0.079	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	6/29/2019 9:00	6/29/2019	0.569	1.0313	0.237	0.052	97.223	2.394	0.086	0.003	0.005	0	0	0	0 Chromatograph
6075	GQC06041	6/30/2019 9:00	6/30/2019	0.569	1.0304	0.251	0.049	97.303	2.311	0.079	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/1/2019 9:00	7/1/2019	0.568	1.0302	0.249	0.046	97.339	2.283	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/2/2019 9:00	7/2/2019	0.568	1.0301	0.243	0.047	97.363	2.265	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/3/2019 9:00	7/3/2019	0.568	1.0304	0.239	0.049	97.326	2.299	0.08	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/4/2019 9:00	7/4/2019	0.568	1.0301	0.241	0.047	97.369	2.259	0.078	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/5/2019 9:00	7/5/2019	0.567	1.0288	0.251	0.04	97.509	2.128	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	7/6/2019 9:00	7/6/2019	0.567	1.0291	0.246	0.041	97.484	2.154	0.069	0.001	0.003	0	0	0	0 Chromatograph

6075	GQC06041	7/7/2019 9:00	7/7/2019	0.568	1.0294	0.242	0.044	97.455	2.182	0.071	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/8/2019 9:00	7/8/2019	0.567	1.0287	0.25	0.041	97.522	2.116	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	7/9/2019 9:00	7/9/2019	0.568	1.0297	0.247	0.044	97.403	2.227	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/10/2019 9:00	7/10/2019	0.568	1.0304	0.242	0.048	97.321	2.306	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/11/2019 9:00	7/11/2019	0.568	1.0305	0.236	0.052	97.315	2.311	0.079	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/12/2019 9:00	7/12/2019	0.568	1.0302	0.246	0.051	97.335	2.284	0.077	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/13/2019 9:00	7/13/2019	0.568	1.0303	0.244	0.049	97.327	2.292	0.082	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/14/2019 9:00	7/14/2019	0.568	1.0295	0.246	0.045	97.435	2.192	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/15/2019 9:00	7/15/2019	0.568	1.03	0.248	0.045	97.372	2.249	0.079	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/16/2019 9:00	7/16/2019	0.568	1.0303	0.237	0.048	97.356	2.271	0.082	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/17/2019 9:00	7/16/2019	0.568	1.0303	0.237	0.048	97.346	2.28	0.082	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/18/2019 9:00	7/18/2019	0.569	1.0307	0.238	0.052	97.302	2.312	0.088	0.003	0.005	0.001	0	0	0 Chromatograph
6075	GQC06041	7/19/2019 9:00	7/19/2019	0.568	1.0301	0.248	0.049	97.359	2.25	0.085	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	7/20/2019 9:00	7/19/2019	0.568	1.0301	0.248	0.049	97.359	2.25	0.085	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	7/21/2019 9:00	7/19/2019	0.568	1.0301	0.248	0.049	97.359	2.25	0.085	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	7/22/2019 9:00	7/19/2019	0.568	1.0301	0.248	0.049	97.358	2.252	0.085	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	7/23/2019 9:00	7/23/2019	0.568	1.03	0.244	0.049	97.369	2.251	0.08	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/24/2019 9:00	7/24/2019	0.568	1.029	0.243	0.039	97.508	2.136	0.069	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/25/2019 9:00	7/25/2019	0.568	1.03	0.246	0.043	97.373	2.255	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/26/2019 9:00	7/26/2019	0.568	1.0304	0.241	0.048	97.329	2.295	0.08	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/27/2019 9:00	7/27/2019	0.568	1.0299	0.247	0.047	97.384	2.239	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/28/2019 9:00	7/28/2019	0.568	1.0298	0.248	0.045	97.386	2.238	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/29/2019 9:00	7/29/2019	0.568	1.0301	0.242	0.046	97.359	2.271	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	7/30/2019 9:00	7/30/2019	0.569	1.0306	0.239	0.051	97.297	2.322	0.083	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	7/31/2019 9:00	7/31/2019	0.568	1.0303	0.241	0.049	97.336	2.29	0.078	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	8/1/2019 9:00	8/1/2019	0.568	1.0304	0.246	0.049	97.306	2.314	0.079	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	8/2/2019 9:00	8/2/2019	0.569	1.0307	0.244	0.049	97.276	2.344	0.081	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/3/2019 9:00	8/3/2019	0.569	1.0308	0.248	0.046	97.276	2.327	0.091	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/4/2019 9:00	8/4/2019	0.569	1.0315	0.245	0.049	97.198	2.399	0.096	0.004	0.007	0.001	0	0	0 Chromatograph
6075	GQC06041	8/5/2019 9:00	8/5/2019	0.569	1.0309	0.245	0.049	97.264	2.344	0.089	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/6/2019 9:00	8/6/2019	0.569	1.0313	0.243	0.049	97.221	2.384	0.092	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/7/2019 9:00	8/7/2019	0.569	1.031	0.245	0.049	97.259	2.349	0.089	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/8/2019 9:00	8/8/2019	0.568	1.0309	0.243	0.049	97.272	2.339	0.088	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/9/2019 9:00	8/9/2019	0.569	1.0313	0.247	0.05	97.211	2.388	0.093	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/10/2019 9:00	8/10/2019	0.568	1.0308	0.245	0.047	97.284	2.33	0.086	0.003	0.005	0.001	0	0	0 Chromatograph
6075	GQC06041	8/11/2019 9:00	8/11/2019	0.568	1.0294	0.248	0.041	97.45	2.181	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	8/12/2019 9:00	8/12/2019	0.568	1.0302	0.25	0.042	97.343	2.277	0.08	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/13/2019 9:00	8/13/2019	0.569	1.031	0.243	0.048	97.261	2.353	0.086	0.003	0.005	0.001	0	0	0 Chromatograph
6075	GQC06041	8/14/2019 9:00	8/14/2019	0.568	1.0304	0.245	0.047	97.319	2.299	0.083	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/15/2019 9:00	8/15/2019	0.568	1.0305	0.249	0.047	97.293	2.323	0.081	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/16/2019 9:00	8/16/2019	0.569	1.0309	0.248	0.049	97.252	2.354	0.087	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/17/2019 9:00	8/17/2019	0.569	1.0308	0.25	0.047	97.268	2.336	0.089	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/18/2019 9:00	8/18/2019	0.569	1.0309	0.251	0.047	97.26	2.345	0.087	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/19/2019 9:00	8/19/2019	0.568	1.0306	0.247	0.047	97.294	2.318	0.085	0.003	0.005	0.001	0	0	0 Chromatograph
6075	GQC06041	8/20/2019 9:00	8/20/2019	0.569	1.0308	0.241	0.05	97.281	2.329	0.089	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	8/21/2019 9:00	8/21/2019	0.569	1.031	0.232	0.05	97.286	2.33	0.092	0.004	0.007	0.001	0	0	0 Chromatograph
6075	GQC06041	8/22/2019 9:00	8/22/2019	0.568	1.0301	0.244	0.046	97.376	2.243	0.083	0.003	0.006	0	0	0	0 Chromatograph
6075	GQC06041	8/23/2019 9:00	8/23/2019	0.568	1.0303	0.24	0.047	97.348	2.274	0.083	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/24/2019 9:00	8/24/2019	0.568	1.0298	0.242	0.045	97.403	2.223	0.078	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/25/2019 9:00	8/25/2019	0.568	1.0296	0.242	0.043	97.433	2.197	0.077	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/26/2019 9:00	8/26/2019	0.568	1.0296	0.248	0.042	97.432	2.193	0.078	0.002	0.005	0.001	0	0	0 Chromatograph
6075	GQC06041	8/27/2019 9:00	8/27/2019	0.568	1.0298	0.248	0.04	97.402	2.225	0.078	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	8/28/2019 9:00	8/28/2019	0.568	1.0294	0.244	0.041	97.461	2.176	0.072	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	8/29/2019 9:00	8/29/2019	0.568	1.0297	0.243	0.042	97.42	2.216	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	8/30/2019 9:00	8/30/2019	0.567	1.0285	0.245	0.037	97.566	2.084	0.064	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	8/31/2019 9:00	8/31/2019	0.567	1.0289	0.244	0.039	97.519	2.126	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	9/1/2019 9:00	9/1/2019	0.568	1.0293	0.242	0.041	97.469	2.17	0.072	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/2/2019 9:00	9/2/2019	0.568	1.0296	0.245	0.042	97.432	2.2	0.075	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/3/2019 9:00	9/3/2019	0.568	1.0296	0.239	0.042	97.451	2.189	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/4/2019 9:00	9/4/2019	0.568	1.0299	0.24	0.043	97.402	2.234	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/5/2019 9:00	9/5/2019	0.568	1.03	0.235	0.046	97.389	2.247	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/6/2019 9:00	9/6/2019	0.568	1.0295	0.238	0.044	97.449	2.191	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/7/2019 9:00	9/7/2019	0.567	1.0289	0.241	0.039	97.529	2.119	0.067	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	9/8/2019 9:00	9/8/2019	0.567	1.0287	0.243	0.038	97.544	2.104	0.066	0.001	0.003	0	0	0	0 Chromatograph

6075	GQC06041	9/9/2019 9:00	9/9/2019	0.567	1.0286	0.245	0.037	97.554	2.096	0.065	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	9/10/2019 9:00	9/10/2019	0.567	1.0288	0.244	0.037	97.528	2.121	0.066	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	9/11/2019 9:00	9/11/2019	0.568	1.0304	0.236	0.044	97.34	2.295	0.078	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	9/12/2019 9:00	9/12/2019	0.568	1.0302	0.24	0.046	97.358	2.27	0.079	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	9/13/2019 9:00	9/13/2019	0.568	1.0298	0.243	0.043	97.408	2.225	0.075	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/14/2019 9:00	9/14/2019	0.567	1.0291	0.24	0.041	97.506	2.139	0.069	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/15/2019 9:00	9/15/2019	0.568	1.0294	0.242	0.042	97.458	2.177	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/16/2019 9:00	9/16/2019	0.568	1.0298	0.245	0.041	97.405	2.228	0.075	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/17/2019 9:00	9/17/2019	0.568	1.0304	0.239	0.043	97.342	2.292	0.078	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/18/2019 9:00	9/18/2019	0.568	1.0302	0.238	0.044	97.366	2.269	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/19/2019 9:00	9/19/2019	0.568	1.0295	0.239	0.041	97.458	2.185	0.071	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/20/2019 9:00	9/20/2019	0.567	1.0291	0.244	0.039	97.492	2.151	0.069	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/21/2019 9:00	9/21/2019	0.568	1.0294	0.243	0.038	97.468	2.174	0.071	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/22/2019 9:00	9/22/2019	0.568	1.0295	0.243	0.039	97.445	2.194	0.073	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/23/2019 9:00	9/23/2019	0.568	1.0302	0.235	0.042	97.382	2.259	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/24/2019 9:00	9/24/2019	0.569	1.0314	0.234	0.047	97.22	2.406	0.086	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	9/25/2019 9:00	9/25/2019	0.567	1.029	0.24	0.038	97.514	2.136	0.068	0.001	0.003	0	0	0	0 Chromatograph
6075	GQC06041	9/26/2019 9:00	9/26/2019	0.569	1.0306	0.242	0.045	97.298	2.331	0.078	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	9/27/2019 9:00	9/27/2019	0.569	1.0308	0.243	0.045	97.276	2.348	0.081	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	9/28/2019 9:00	9/28/2019	0.568	1.0295	0.241	0.04	97.458	2.184	0.072	0.001	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/29/2019 9:00	9/29/2019	0.568	1.0298	0.24	0.041	97.411	2.228	0.075	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	9/30/2019 9:00	9/30/2019	0.568	1.0298	0.242	0.04	97.414	2.225	0.073	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/1/2019 9:00	10/1/2019	0.567	1.0293	0.242	0.039	97.477	2.167	0.071	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/2/2019 9:00	10/2/2019	0.568	1.0298	0.231	0.042	97.431	2.217	0.073	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/3/2019 9:00	10/3/2019	0.567	1.0293	0.233	0.041	97.493	2.158	0.071	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/4/2019 9:00	10/4/2019	0.568	1.0293	0.239	0.043	97.47	2.171	0.072	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/5/2019 9:00	10/5/2019	0.567	1.0291	0.247	0.042	97.489	2.148	0.069	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/6/2019 9:00	10/6/2019	0.567	1.0288	0.246	0.039	97.52	2.124	0.066	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/7/2019 9:00	10/7/2019	0.567	1.0282	0.246	0.035	97.609	2.046	0.061	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/8/2019 9:00	10/8/2019	0.567	1.0293	0.247	0.042	97.458	2.18	0.069	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/9/2019 9:00	10/9/2019	0.568	1.0299	0.248	0.046	97.369	2.256	0.074	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/10/2019 9:00	10/10/2019	0.568	1.0295	0.249	0.045	97.424	2.205	0.072	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/11/2019 9:00	10/11/2019	0.568	1.0292	0.243	0.048	97.472	2.161	0.071	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/12/2019 9:00	10/12/2019	0.567	1.0291	0.245	0.046	97.486	2.147	0.071	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/13/2019 9:00	10/13/2019	0.568	1.0293	0.245	0.046	97.453	2.177	0.073	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/14/2019 9:00	10/14/2019	0.568	1.0295	0.244	0.044	97.433	2.200	0.074	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/15/2019 9:00	10/15/2019	0.568	1.0296	0.244	0.044	97.428	2.204	0.074	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/16/2019 9:00	10/16/2019	0.567	1.0293	0.24	0.044	97.469	2.171	0.071	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/17/2019 9:00	10/17/2019	0.567	1.0292	0.236	0.042	97.493	2.155	0.069	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/18/2019 9:00	10/18/2019	0.567	1.0289	0.239	0.04	97.527	2.124	0.067	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/19/2019 9:00	10/19/2019	0.567	1.029	0.24	0.041	97.51	2.136	0.069	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/20/2019 9:00	10/20/2019	0.567	1.029	0.24	0.041	97.509	2.137	0.069	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/21/2019 9:00	10/21/2019	0.567	1.0292	0.238	0.042	97.495	2.151	0.07	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/22/2019 9:00	10/22/2019	0.567	1.0291	0.242	0.042	97.489	2.152	0.07	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/23/2019 9:00	10/23/2019	0.568	1.0292	0.245	0.042	97.479	2.157	0.071	0.002	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/24/2019 9:00	10/24/2019	0.567	1.0291	0.244	0.042	97.491	2.149	0.07	0.001	0.004	0	0	0	0 Chromatograph
6133	GQC06041	10/25/2019 9:00	10/25/2019	0.567	1.029	0.244	0.041	97.503	2.138	0.069	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/26/2019 9:00	10/26/2019	0.567	1.0287	0.245	0.04	97.543	2.102	0.066	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/27/2019 9:00	10/27/2019	0.567	1.0285	0.247	0.037	97.56	2.087	0.065	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/28/2019 9:00	10/28/2019	0.567	1.0286	0.245	0.037	97.555	2.093	0.065	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/29/2019 9:00	10/29/2019	0.567	1.0287	0.244	0.039	97.537	2.108	0.067	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/30/2019 9:00	10/30/2019	0.567	1.029	0.244	0.041	97.498	2.142	0.07	0.001	0.003	0	0	0	0 Chromatograph
6133	GQC06041	10/31/2019 9:00	10/31/2019	0.568	1.0295	0.243	0.044	97.433	2.200	0.074	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	11/1/2019 9:00	11/1/2019	0.568	1.0298	0.243	0.044	97.403	2.228	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	11/2/2019 9:00	11/2/2019	0.568	1.0298	0.237	0.045	97.412	2.223	0.076	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	11/3/2019 9:00	11/3/2019	0.568	1.0303	0.237	0.047	97.351	2.282	0.077	0.002	0.004	0	0	0	0 Chromatograph
6075	GQC06041	11/4/2019 9:00	11/4/2019	0.568	1.0302	0.237	0.047	97.365	2.265	0.079	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	11/5/2019 9:00	11/5/2019	0.568	1.0306	0.231	0.049	97.317	2.316	0.08	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	11/6/2019 9:00	11/6/2019	0.568	1.0306	0.236	0.049	97.315	2.315	0.079	0.002	0.005	0	0	0	0 Chromatograph
6075	GQC06041	11/7/2019 9:00	11/7/2019	0.568	1.0303	0.236	0.047	97.371	2.247	0.087	0.004	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	11/8/2019 9:00	11/8/2019	0.568	1.03	0.251	0.044	97.377	2.229	0.087	0.003	0.007	0.001	0.001	0.001	0 Chromatograph
6075	GQC06041	11/9/2019 9:00	11/9/2019	0.566	1.028	0.236	0.035	97.654	2.013	0.058	0.001	0.002	0	0	0	0 Chromatograph
6075	GQC06041	11/10/2019 9:00	11/10/2019	0.568	1.0306	0.234	0.047	97.33	2.296	0.084	0.003	0.006	0.001	0	0	0 Chromatograph
6075	GQC06041	11/11/2019 9:00	11/11/2019	0.568	1.0304	0.238	0.046	97.345	2.275	0.085	0.003	0.006	0.001	0	0	0 Chromatograph

6075	GQC06041	11/12/2019 9:00	11/12/2019	0.567	1.029	0.239	0.039	97.531	2.115	0.07	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/13/2019 9:00	11/13/2019	0.567	1.029	0.235	0.041	97.525	2.124	0.07	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/14/2019 9:00	11/14/2019	0.568	1.0291	0.238	0.041	97.505	2.141	0.069	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/15/2019 9:00	11/15/2019	0.567	1.0285	0.237	0.037	97.586	2.071	0.064	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	11/16/2019 9:00	11/16/2019	0.566	1.0281	0.238	0.035	97.642	2.023	0.059	0.001	0.002	0	0	0	0	Chromatograph
6075	GQC06041	11/17/2019 9:00	11/17/2019	0.567	1.028	0.236	0.036	97.647	2.02	0.058	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	11/18/2019 9:00	11/18/2019	0.567	1.0281	0.236	0.035	97.641	2.025	0.059	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	11/19/2019 9:00	11/19/2019	0.567	1.0285	0.236	0.038	97.586	2.073	0.063	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	11/20/2019 9:00	11/20/2019	0.566	1.028	0.24	0.035	97.642	2.021	0.059	0.001	0.002	0	0	0	0	Chromatograph
6075	GQC06041	11/21/2019 9:00	11/21/2019	0.568	1.0297	0.234	0.044	97.434	2.206	0.075	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/22/2019 9:00	11/22/2019	0.568	1.0302	0.233	0.046	97.375	2.259	0.08	0.002	0.005	0	0	0	0	Chromatograph
6075	GQC06041	11/23/2019 9:00	11/23/2019	0.567	1.029	0.235	0.04	97.526	2.125	0.069	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/24/2019 9:00	11/24/2019	0.567	1.0283	0.234	0.036	97.621	2.045	0.061	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	11/25/2019 9:00	11/25/2019	0.568	1.0299	0.236	0.044	97.411	2.227	0.075	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/26/2019 9:00	11/26/2019	0.568	1.0301	0.236	0.046	97.377	2.258	0.077	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	11/27/2019 9:00	11/27/2019	0.568	1.0301	0.237	0.047	97.373	2.259	0.078	0.002	0.005	0	0	0	0	Chromatograph
6075	GQC06041	11/28/2019 9:00	11/28/2019	0.568	1.0301	0.237	0.047	97.382	2.25	0.078	0.002	0.005	0	0	0	0	Chromatograph
6075	GQC06041	11/29/2019 9:00	11/29/2019	0.567	1.029	0.234	0.04	97.532	2.122	0.068	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	11/30/2019 9:00	11/30/2019	0.568	1.0296	0.23	0.043	97.462	2.188	0.072	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/1/2019 9:00	12/1/2019	0.567	1.0282	0.233	0.036	97.639	2.031	0.059	0	0.002	0	0	0	0	Chromatograph
6075	GQC06041	12/2/2019 9:00	12/2/2019	0.566	1.028	0.235	0.034	97.656	2.014	0.057	0.001	0.002	0	0	0	0	Chromatograph
6075	GQC06041	12/3/2019 9:00	12/3/2019	0.566	1.0281	0.234	0.035	97.639	2.029	0.059	0.001	0.002	0	0	0	0	Chromatograph
6075	GQC06041	12/4/2019 9:00	12/4/2019	0.567	1.0287	0.233	0.038	97.57	2.09	0.064	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/5/2019 9:00	12/5/2019	0.566	1.0282	0.233	0.036	97.635	2.034	0.059	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/6/2019 9:00	12/6/2019	0.567	1.0284	0.233	0.038	97.601	2.062	0.062	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/7/2019 9:00	12/7/2019	0.567	1.0281	0.234	0.036	97.637	2.029	0.059	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/8/2019 9:00	12/8/2019	0.566	1.028	0.231	0.035	97.662	2.011	0.057	0.001	0.002	0	0	0	0	Chromatograph
6075	GQC06041	12/9/2019 9:00	12/9/2019	0.567	1.0286	0.233	0.038	97.586	2.076	0.063	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/10/2019 9:00	12/10/2019	0.568	1.03	0.235	0.047	97.397	2.239	0.076	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/11/2019 9:00	12/11/2019	0.567	1.0285	0.236	0.038	97.584	2.076	0.063	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/12/2019 9:00	12/12/2019	0.567	1.0286	0.234	0.04	97.569	2.089	0.064	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/13/2019 9:00	12/13/2019	0.568	1.0294	0.236	0.043	97.468	2.176	0.07	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/14/2019 9:00	12/14/2019	0.569	1.0314	0.237	0.055	97.212	2.397	0.089	0.003	0.006	0.001	0	0	0	Chromatograph
6075	GQC06041	12/15/2019 9:00	12/15/2019	0.567	1.0286	0.235	0.039	97.575	2.084	0.063	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/16/2019 9:00	12/16/2019	0.567	1.0284	0.232	0.038	97.607	2.058	0.061	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/17/2019 9:00	12/17/2019	0.568	1.0293	0.24	0.046	97.468	2.169	0.071	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/18/2019 9:00	12/18/2019	0.567	1.0279	0.237	0.036	97.665	2.002	0.056	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/19/2019 9:00	12/19/2019	0.568	1.0293	0.237	0.051	97.469	2.163	0.073	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/20/2019 9:00	12/20/2019	0.568	1.0298	0.237	0.049	97.42	2.21	0.076	0.003	0.005	0.001	0	0	0	Chromatograph
6075	GQC06041	12/21/2019 9:00	12/21/2019	0.567	1.0283	0.235	0.04	97.616	2.043	0.061	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/22/2019 9:00	12/22/2019	0.567	1.0288	0.235	0.041	97.547	2.105	0.066	0.001	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/23/2019 9:00	12/23/2019	0.567	1.029	0.236	0.042	97.521	2.127	0.068	0.002	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/24/2019 9:00	12/24/2019	0.567	1.0283	0.235	0.037	97.616	2.047	0.06	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/25/2019 9:00	12/25/2019	0.567	1.0282	0.234	0.037	97.624	2.041	0.06	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/26/2019 9:00	12/26/2019	0.566	1.028	0.234	0.036	97.659	2.011	0.058	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/27/2019 9:00	12/27/2019	0.567	1.0292	0.229	0.043	97.509	2.145	0.069	0.001	0.004	0	0	0	0	Chromatograph
6075	GQC06041	12/28/2019 9:00	12/28/2019	0.567	1.0289	0.233	0.041	97.542	2.113	0.066	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/29/2019 9:00	12/29/2019	0.567	1.0284	0.233	0.038	97.612	2.053	0.061	0.001	0.003	0	0	0	0	Chromatograph
6075	GQC06041	12/30/2019 9:00	12/30/2019	0.566	1.028	0.233	0.036	97.663	2.009	0.057	0	0.002	0	0	0	0	Chromatograph
6075	GQC06041	12/31/2019 9:00	12/31/2019	0.567	1.028	0.234	0.036	97.651	2.019	0.058	0.001	0.003	0	0	0	0	Chromatograph

Calculating Realistic PM_{10} Emissions from Cooling Towers

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ABSTRACT

Particulate matter less than 10 micrometers in diameter (PM_{10}) emissions from wet cooling towers may be calculated using the methodology presented in EPA's AP-42[1] , which assumes that all total dissolved solids (TDS) emitted in "drift" particles (liquid water entrained in the air stream and carried out of the tower through the induced draft fan stack.) are PM_{10}. However, for wet cooling towers with medium to high TDS levels, this method is overly conservative, and predicts significantly higher PM_{10} emissions than would actually occur, even for towers equipped with very high efficiency drift eliminators (e.g., 0.0006% drift rate). Such over-prediction may result in unrealistically high PM_{10} modeled concentrations and/or the need to purchase expensive Emission Reduction Credits (ERCs) in PM_{10} non-attainment areas. Since these towers have fairly low emission points (10 to 15 m above ground), over-predicting PM_{10} emission rates can easily result in exceeding federal Prevention of Significant Deterioration (PSD) significance levels at a project's fenceline. This paper presents a method for computing realistic PM_{10} emissions from cooling towers with medium to high TDS levels.

INTRODUCTION

Cooling towers are heat exchangers that are used to dissipate large heat loads to the atmosphere. Wet, or evaporative, cooling towers rely on the latent heat of water evaporation to exchange heat between the process and the air passing through the cooling tower. The cooling water may be an integral part of the process or may provide cooling via heat exchangers, for example, steam condensers. Wet cooling towers provide direct contact between the cooling water and air passing through the tower, and as part of normal operation, a very small amount of the circulating water may be entrained in the air stream and be carried out of the tower as "drift" droplets. Because the drift droplets contain the same chemical impurities as the water circulating through the tower, the particulate matter constituent of the drift droplets may be classified as an emission. The magnitude of the drift loss is influenced by the number and size of droplets produced within the tower, which are determined by the tower fill design, tower design, the air and water patterns, and design of the drift eliminators.

AP-42 METHOD OF CALCULATING DRIFT PARTICULATE

EPA's AP-42[1] provides available particulate emission factors for wet cooling towers, however, these values only have an emission factor rating of "E" (the lowest level of confidence acceptable). They are also rather high, compared to typical present-day manufacturers' guaranteed drift rates, which are on the order of 0.0006%. (Drift emissions are typically

expressed as a percentage of the cooling tower water circulation rate). AP-42 states that "a *conservatively high* PM_{10} emission factor can be obtained by (a) multiplying the total liquid drift factor by the TDS fraction in the circulating water, and (b) assuming that once the water evaporates, all remaining solid particles are within the PM_{10} range." (Italics per EPA).

If TDS data for the cooling tower are not available, a source-specific TDS content can be estimated by obtaining the TDS for the make-up water and multiplying it by the cooling tower cycles of concentration. [The cycles of concentration is the ratio of a measured parameter for the cooling tower water (such as conductivity, calcium, chlorides, or phosphate) to that parameter for the make-up water.]

Using AP-42 guidance, the total particulate emissions (PM) (after the pure water has evaporated) can be expressed as:

$$PM = \text{Water Circulation Rate} \times \text{Drift Rate} \times TDS \qquad [1]$$

For example, for a typical power plant wet cooling tower with a water circulation rate of 146,000 gallons per minute (gpm), drift rate of 0.0006%, and TDS of 7,700 parts per million by weight (ppmw):

$$PM = 146{,}000 \text{ gpm} \times 8.34 \text{ lb water/gal} \times 0.0006/100 \times 7{,}700 \text{ lb solids}/10^6 \text{ lb water} \times 60 \text{ min/hr} = \underline{3.38 \text{ lb/hr}}$$

On an annual basis, this is equivalent to almost 15 tons per year (tpy). Even for a state-of-the-art drift eliminator system, this is not a small number, especially if assumed to all be equal to PM_{10}, a regulated criteria pollutant. However, as the following analysis demonstrates, only a very small fraction is actually PM_{10}.

COMPUTING THE PM_{10} FRACTION

Based on a representative drift droplet size distribution and TDS in the water, the amount of solid mass in each drop size can be calculated. That is, for a given initial droplet size, assuming that the mass of dissolved solids condenses to a spherical particle after all the water evaporates, and assuming the density of the TDS is equivalent to a representative salt (e.g., sodium chloride), the diameter of the final solid particle can be calculated. Thus, using the drift droplet size distribution, the percentage of drift mass containing particles small enough to produce PM_{10} can be calculated. This method is conservative as the final particle is assumed to be perfectly spherical; hence as small a particle as can exist.

The droplet size distribution of the drift emitted from the tower is critical to performing the analysis. Brentwood Industries, a drift eliminator manufacturer, was contacted and agreed to provide drift eliminator test data from a test conducted by Environmental Systems Corporation (ESC) at the Electric Power Research Institute (EPRI) test facility in Houston, Texas in 1988 (Aull[2], 1999). The data consist of water droplet size distributions for a drift eliminator that achieved a tested drift rate of 0.0003 percent. As we are using a 0.0006 percent drift rate, it is reasonable to expect that the 0.0003 percent drift rate would produce smaller droplets, therefore,

this size distribution data can be assumed to be conservative for predicting the fraction of PM_{10} in the total cooling tower PM emissions.

In calculating PM_{10} emissions the following assumptions were made:

- Each water droplet was assumed to evaporate shortly after being emitted into ambient air, into a single, solid, spherical particle.
- Drift water droplets have a density (ρ_w) of water; $1.0\ g/cm^3$ or $1.0 * 10^{-6}\ \mu g/\mu m^3$.
- The solid particles were assumed to have the same density (ρ_{TDS}) as sodium chloride, (i.e., 2.2 g/cm^3).

Using the formula for the volume of a sphere, $V = 4\pi r^3/3$, and the density of pure water, $\rho_w = 1.0\ g/cm^3$, the following equations can be used to derive the solid particulate diameter, D_p, as a function of the TDS, the density of the solids, and the initial drift droplet diameter, D_d :

Volume of drift droplet = $(4/3)\pi(D_d/2)^3$ [2]

Mass of solids in drift droplet = (TDS)(ρ_w)(Volume of drift droplet) [3]

substituting,

Mass of solids in drift = (TDS)(ρ_w) $(4/3)\pi(D_d/2)^3$ [4]

Assuming the solids remain and coalesce after the water evaporates, the mass of solids can also be expressed as:

Mass of solids = (ρ_{TDS}) (solid particle volume) = (ρ_{TDS})$(4/3)\pi(D_p/2)^3$ [5]

Equations [4] and [5] are equivalent:

$(\rho_{TDS})(4/3)\pi(D_p/2)^3 = (TDS)(\rho_w)(4/3)\pi(D_d/2)^3$ [6]

Solving for D_p:

$D_p = D_d\ [(TDS)(\rho_w/\rho_{TDS})]^{1/3}$ [7]

Where,

TDS is in units of ppmw
D_p = diameter of solid particle, micrometers (μm)
D_d = diameter of drift droplet, μm

Using formulas [2] – [7] and the particle size distribution test data, Table 1 can be constructed for drift from a wet cooling tower having the same characteristics as our example; 7,700 ppmw TDS and a 0.0006% drift rate. The first and last columns of this table are the particle size distribution derived from test results provided by Brentwood Industries. Using straight-line interpolation for a solid particle size 10 μm in diameter, we conclude that approximately 14.9 percent of the mass emissions are equal to or smaller than PM_{10}. The balance of the solid

particulate are particulate greater than 10 μm. Hence, PM_{10} emissions from this tower would be equal to PM emissions x 0.149, or 3.38 lb/hr x 0.149 = 0.50 lb/hr. The process is repeated in Table 2, with all parameters equal except that the TDS is 11,000 ppmw. The result is that approximately 5.11 percent are smaller at 11,000 ppm. Thus, while total PM emissions are larger by virtue of a higher TDS, overall PM_{10} emissions are actually lower, because more of the solid particles are larger than 10 μm.

Table 1. Resultant Solid Particulate Size Distribution (TDS = 7700 ppmw)

EPRI Droplet Diameter (μm)	Droplet Volume (μm^3) [2][1]	Droplet Mass (μg) [3]	Particle Mass (Solids) (μg) [4]	Solid Particle Volume (μm^3)	Solid Particle Diameter (μm) [7]	EPRI % Mass Smaller
10	524	5.24E-04	4.03E-06	1.83	1.518	0.000
20	4189	4.19E-03	3.23E-05	14.66	3.037	0.196
30	14137	1.41E-02	1.09E-04	49.48	4.555	0.226
40	33510	3.35E-02	2.58E-04	117.29	6.073	0.514
50	65450	6.54E-02	5.04E-04	229.07	7.591	1.816
60	113097	1.13E-01	8.71E-04	395.84	9.110	5.702
70	179594	1.80E-01	1.38E-03	628.58	10.628	21.348
90	381704	3.82E-01	2.94E-03	1335.96	13.665	49.812
110	696910	6.97E-01	5.37E-03	2439.18	16.701	70.509
130	1150347	1.15E+00	8.86E-03	4026.21	19.738	82.023
150	1767146	1.77E+00	1.36E-02	6185.01	22.774	88.012
180	3053628	3.05E+00	2.35E-02	10687.70	27.329	91.032
210	4849048	4.85E+00	3.73E-02	16971.67	31.884	92.468
240	7238229	7.24E+00	5.57E-02	25333.80	36.439	94.091
270	10305995	1.03E+01	7.94E-02	36070.98	40.994	94.689
300	14137167	1.41E+01	1.09E-01	49480.08	45.549	96.288
350	22449298	2.24E+01	1.73E-01	78572.54	53.140	97.011
400	33510322	3.35E+01	2.58E-01	117286.13	60.732	98.340
450	47712938	4.77E+01	3.67E-01	166995.28	68.323	99.071
500	65449847	6.54E+01	5.04E-01	229074.46	75.915	99.071
600	113097336	1.13E+02	8.71E-01	395840.67	91.098	100.000

[1] Bracketed numbers refer to equation number in text.

The percentage of PM_{10}/PM was calculated for cooling tower TDS values from 1000 to 12000 ppmw and the results are plotted in Figure 1. Using these data, Figure 2 presents predicted PM_{10} emission rates for the 146,000 gpm example tower. As shown in this figure, the PM emission rate increases in a straight line as TDS increases, however, the PM_{10} emission rate increases to a maximum at around a TDS of 4000 ppmw, and then begins to decline. The reason is that at higher TDS, the drift droplets contain more solids and therefore, upon evaporation, result in larger solid particles for any given initial droplet size.

CONCLUSION

The emission factors and methodology given in EPA's AP-42[1] Chapter 13.4 *Wet Cooling Towers*, do not account for the droplet size distribution of the drift exiting the tower. This is a critical factor, as more than 85% of the mass of particulate in the drift from most cooling towers will result in solid particles larger than PM_{10} once the water has evaporated. Particles larger than PM_{10} are no longer a regulated air pollutant, because their impact on human health has been shown to be insignificant. Using reasonable, conservative assumptions and a realistic drift

droplet size distribution, a method is now available for calculating realistic PM_{10} emission rates from wet mechanical draft cooling towers equipped with modern, high-efficiency drift eliminators and operating at medium to high levels of TDS in the circulating water.

Table 2. Resultant Solid Particulate Size Distribution (TDS = 11000 ppmw)

EPRI Droplet Diameter (μm)	Droplet Volume (μm^3) [2][1]	Droplet Mass (μg) [3]	Particle Mass (Solids) (μg) [4]	Solid Particle Volume (μm^3)	Solid Particle Diameter (μm) [7]	EPRI % Mass Smaller
10	524	5.24E-04	5.76E-06	2.62	1.710	0.000
20	4189	4.19E-03	4.61E-05	20.94	3.420	0.196
30	14137	1.41E-02	1.56E-04	70.69	5.130	0.226
40	33510	3.35E-02	3.69E-04	167.55	6.840	0.514
50	65450	6.54E-02	7.20E-04	327.25	8.550	1.816
60	113097	1.13E-01	1.24E-03	565.49	10.260	5.702
70	179594	1.80E-01	1.98E-03	897.97	11.970	21.348
90	381704	3.82E-01	4.20E-03	1908.52	15.390	49.812
110	696910	6.97E-01	7.67E-03	3484.55	18.810	70.509
130	1150347	1.15E+00	1.27E-02	5751.73	22.230	82.023
150	1767146	1.77E+00	1.94E-02	8835.73	25.650	88.012
180	3053628	3.05E+00	3.36E-02	15268.14	30.780	91.032
210	4849048	4.85E+00	5.33E-02	24245.24	35.909	92.468
240	7238229	7.24E+00	7.96E-02	36191.15	41.039	94.091
270	10305995	1.03E+01	1.13E-01	51529.97	46.169	94.689
300	14137167	1.41E+01	1.56E-01	70685.83	51.299	96.288
350	22449298	2.24E+01	2.47E-01	112246.49	59.849	97.011
400	33510322	3.35E+01	3.69E-01	167551.61	68.399	98.340
450	47712938	4.77E+01	5.25E-01	238564.69	76.949	99.071
500	65449847	6.54E+01	7.20E-01	327249.23	85.499	99.071
600	113097336	1.13E+02	1.24E+00	565486.68	102.599	100.000

Figure 1: Percentage of Drift PM that Evaporates to PM10

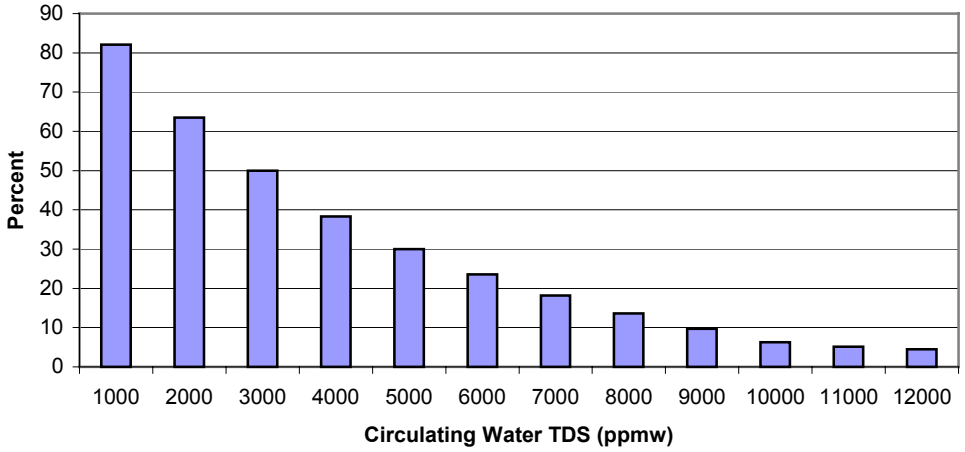
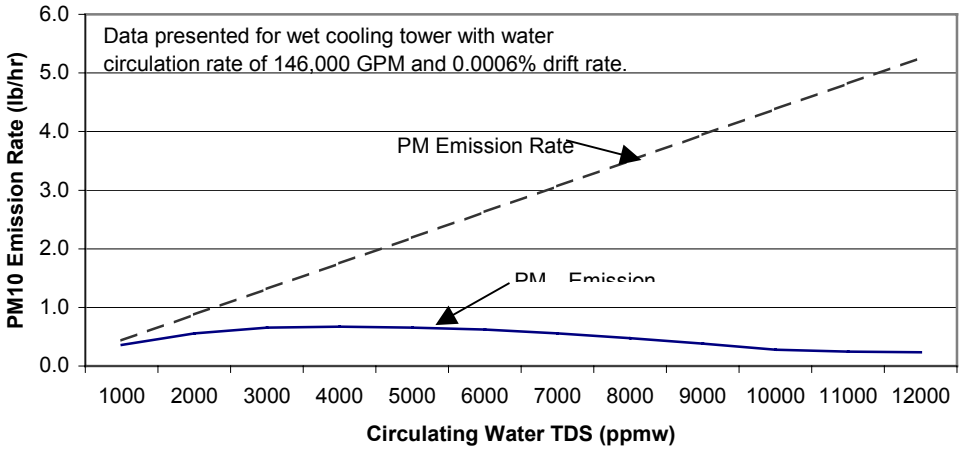


Figure 2: PM_{10} Emission Rate vs. TDS



REFERENCES

1. EPA, 1995. Compilation of Air pollutant Emission Factors, AP-42 Fifth edition, Volume I: *Stationary Point and Area Sources*, Chapter 13.4 Wet Cooling Towers, http://www.epa.gov/ttn/chief/ap42/, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, January.

2. Aull, 1999. Memorandum from R. Aull, Brentwood Industries to J. Reisman, Greystone, December 7, 1999.

KEY WORDS

Drift
Drift eliminators
Cooling tower
PM_{10} emissions
TDS