RTI INTERNATIONAL | Memorandum

Date: August 19, 2016

Subject: Section 112(d)(6) Technology Review for the NESHAP for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills
EPA Contract No. EP-D-11-084; Work Assignment No. 4-05

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I. Introduction

Section 112(f)(2) of the Clean Air Act (CAA) directs the U.S. Environmental Protection Agency (EPA) to conduct risk assessments on each source category subject to maximum achievable control technology (MACT) standards and determine if additional standards are needed to reduce residual risks from the remaining hazardous air pollutant (HAP) emissions from the category. Section 112(d)(6) of the CAA requires the EPA to review and revise the MACT standards, as necessary, taking into account developments in practices, processes, and control technologies. The section 112(f)(2) residual risk review and section 112(d)(6) technology review are to be done 8 years after promulgation. The national emissions standards for hazardous air pollutants (NESHAP) for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills, (40 CFR part 63, subpart MM) originally promulgated on January 12, 2001 is due for residual risk and technology review (RTR) under CAA sections 112(f)(2) and 112(d)(6).

The purpose of this memorandum is to present the results of the technology review of the current subpart MM emission standards for chemical recovery combustion sources in the pulp and paper production source category. Section II of this memorandum provides background information on the requirements of CAA section 112(d)(6); chemical recovery combustion sources in the pulp and paper production source category; and the requirements of the subpart MM NESHAP. Section III discusses the review of information on developments in practices, processes, and control technologies that have occurred since promulgation of the subpart MM emission standards. Section IV presents references.

II. Background

A. Requirements of Section 112(d)(6) of the CAA

Section 112 of the CAA requires the EPA to establish technology-based standards for sources of HAP. These technology-based standards are often referred to as MACT standards. Section 112 also contains provisions requiring the EPA to revisit previously promulgated emission standards. Specifically, paragraph 112(d)(6) section states:

> *(6) REVIEW AND REVISION. – The Administrator shall review, and revise as necessary (taking into account developments in practices, processes, and control technologies), emission standards promulgated under this section no less often than every 8 years.*

For the purpose of this technology review, a "development" was considered to be any of the following that was not considered during the development of the promulgated subpart MM standards that could result in significant additional emissions reductions of the regulated HAP:

- Add-on control technology or other equipment not previously identified
- Improvements in add-on control technology or other equipment
- Work practices or operational procedures that were not previously identified
- Process change or pollution prevention alternative that could be broadly applied to further reduce HAP emissions
- Improvements in work practices, operational procedures, process changes or pollution prevention alternatives

B. Description of Source Category

The pulp and paper production source category includes any facility engaged in the production of pulp and/or paper. There are four pulping processes currently being employed in the United States that use some form of chemical pulping--kraft, soda, sulfite, and semichemical. These four processes are discussed in the paragraphs below, based on information from the EPA document, *Pulp and Paper Combustion Sources National Emission Standards for Hazardous Air Pollutants (NESHAP): A Plain English Description*. (EPA 2001)

1. Kraft and Soda Processes

The kraft process is the dominant pulping process in the United States, accounting for approximately 85 percent of all domestic pulp production. In this process, wood chips are cooked (digested) at an elevated temperature and pressure in white liquor, which is a water solution of sodium sulfide (Na_2S) and sodium hydroxide (NaOH). The white liquor chemically dissolves lignin from the wood. The remaining cellulose (pulp) is filtered from the spent cooking liquor and washed with water. Usually, the pulp then proceeds through various intermittent stages of washing and possibly bleaching, after which it is pressed and dried into the finished product (*e.g.*, paper, paperboard). The soda pulping process is similar to the kraft process, except that soda pulping is a nonsulfur process that does not use Na_2S.

The balance of the kraft pulping process is designed to recover the cooking chemicals and heat. Spent cooking liquor and the pulp wash water are combined to form a weak black liquor which is concentrated in a multiple-effect evaporator (MEE) system to about 55 percent solids. The strong black liquor from the evaporators is then further concentrated to about 65 percent solids in a concentrator (non-direct contact evaporator [NDCE]) or a direct-contact evaporator (DCE). If the black liquor is further concentrated in a DCE, the liquor is first oxidized in a black liquor oxidation (BLO) system to convert the sulfide to thiosulfate, which produces a more stable liquor that results in less odor when processed. The strong black liquor is then fired in a recovery furnace. Combustion of the organics dissolved in the black liquor provides heat for generating process steam and converts sodium sulfate (Na_2SO_4) to Na_2S. To make up for chemicals lost in the operating cycle, salt cake (Na_2SO_4) may be added to the concentrated black liquor before it is sprayed into the furnace. A diagram of the kraft chemical recovery area (with DCE) is presented in Figure 1.

Inorganic chemicals present in the black liquor collect as a molten smelt at the bottom of the furnace. The smelt, consisting of sodium carbonate (Na_2CO_3) and Na_2S, is dissolved in water in a smelt dissolving tank (SDT) to form green liquor, which is transferred to a causticizing tank, where lime (CaO) is added to convert the Na_2CO_3 to NaOH. Formation of the NaOH completes the regeneration of white liquor, which is returned to the digester system. A calcium carbonate ($CaCO_3$) mud, referred to as “lime mud,” precipitates from the causticizing tank and is calcined in a lime kiln to regenerate the lime.

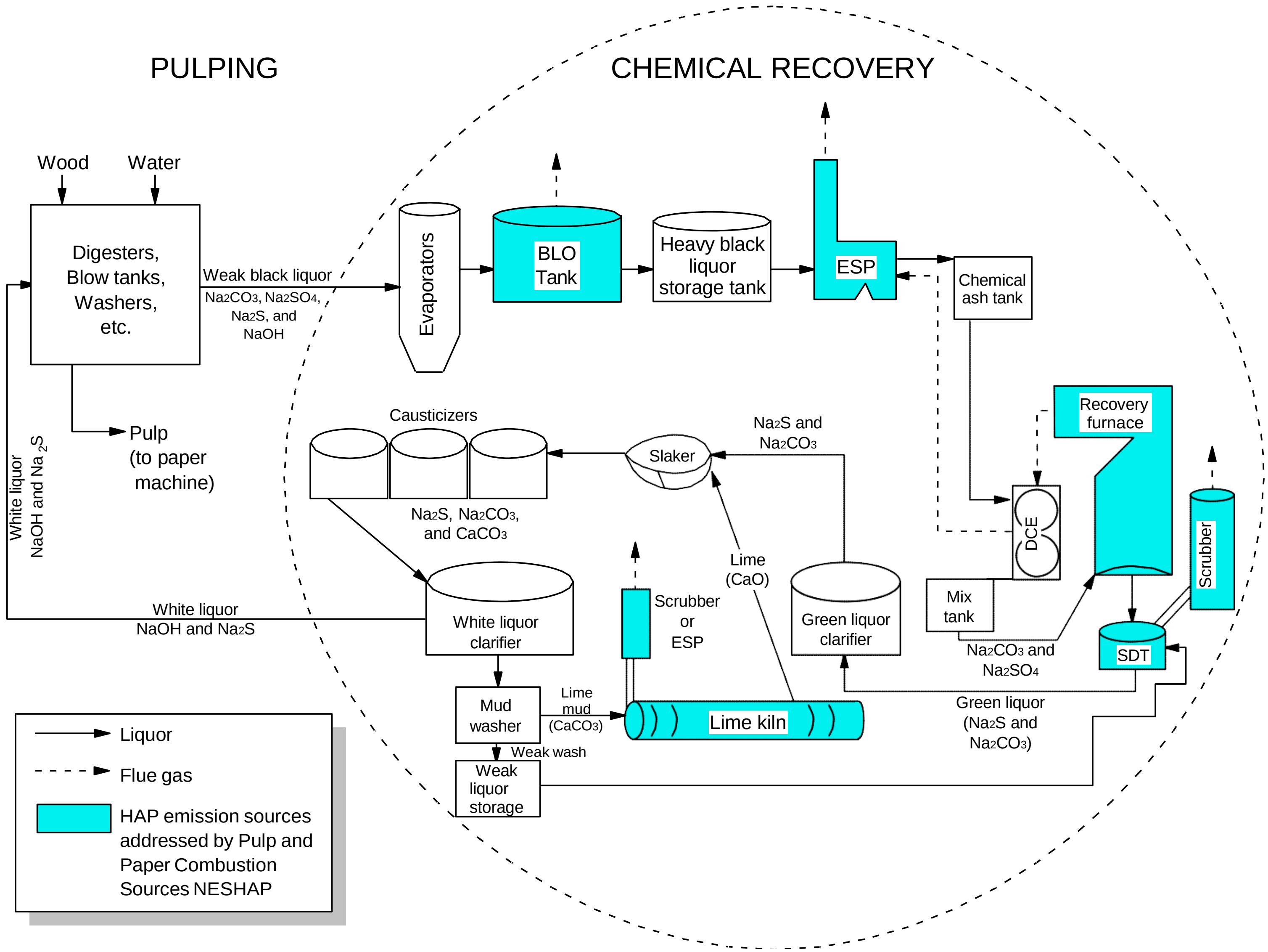


Figure 1. Chemical Recovery Area (with DCE Recovery Furnace) for the Kraft Pulping Process.

2. Sulfite Process

In the sulfite process, an acid cooking liquor is used to cook the wood chips, and the cooking liquor is prepared by absorbing cooled sulfur dioxide (SO_2) gas in water containing one of four chemical bases--ammonia (NH_3), magnesium, (Mg), sodium (Na), or calcium (Ca). The currently operating sulfite mills that are subject to subpart to subpart MM use either NH_3 or Mg as the chemical base. There are no Na-based sulfite mills currently operating, and Ca-based sulfite mills do not use chemical recovery combustion equipment. Therefore, only the NH_3- and Mg-based sulfite processes are discussed in this memorandum.

The function of the chemical recovery process at sulfite pulp mills is to recover chemicals from spent sulfite cooking liquor (also called red liquor). Spent liquor is fired in a recovery furnace. Combustion of the spent liquor produces heat for steam generation and also combustion gases that contain recoverable SO_2 and (for the Mg-based process) magnesium oxide (MgO) particulate.

In the NH_3-based process, the NH_3 base is consumed during combustion, forming nitrogen and water. A small amount of ash is produced and periodically removed from the furnace bottom. Sulfur dioxide is recovered from cooled flue gas in an absorption tower/scrubbing system by reaction with fresh aqueous NH_3 to form an ammonium bisulfite (NH_4HSO_3) solution. The NH_4HSO_3 solution is fortified with makeup SO_2 from a sulfur burner and used as cooking liquor in a digester. A diagram of the chemical recovery area for the NH_3-based sulfite pulping process is presented in Figure 2.

In the Mg-based process, the major portion of the MgO is recovered from the exhaust gases of the combustion unit as a fine white powder using multiple cyclones. The MgO is then slaked with water to form magnesium hydroxide ($Mg(OH)_2$), which is used as circulating liquid in a series of absorption towers and/or venturi scrubbers designed to recover SO_2 from the recovery furnace exhaust gases. Prior to passing through the absorption towers/venturi scrubbers, exit gases from the MgO particulate matter (PM) removal equipment enter a cooling tower. Cooling the gases increases SO_2 absorption. In the absorption towers/venturi scrubbers, SO_2 is recovered by reaction with $Mg(OH)_2$ to form a magnesium bisulfite solution. The magnesium bisulfite solution is then routed to a fortification tower where it is fortified with makeup SO_2 from a sulfur burner and subsequently used as cooking liquor in a digester. The fortification tower and sulfur burner area of the mill are typically referred to as the “acid plant.” However, the term acid plant is used loosely, and the acid plant may be defined to include the SO_2 absorption towers/venturi scrubbers. A diagram of the chemical recovery area for the Mg-based sulfite pulping process is presented in Figure 3.

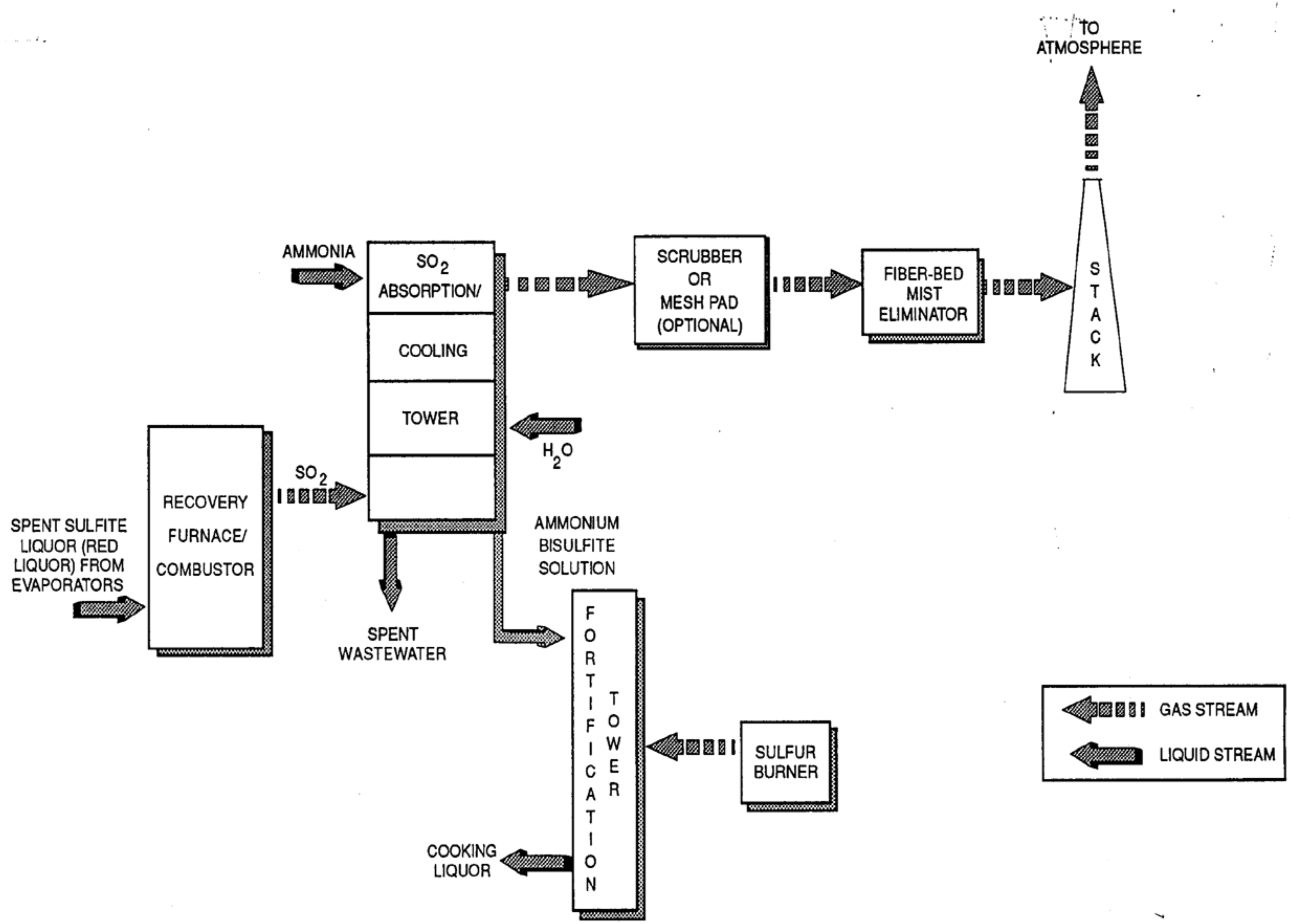


Figure 2. Chemical Recovery Area for the NH_3-Based Sulfite Pulping Process.

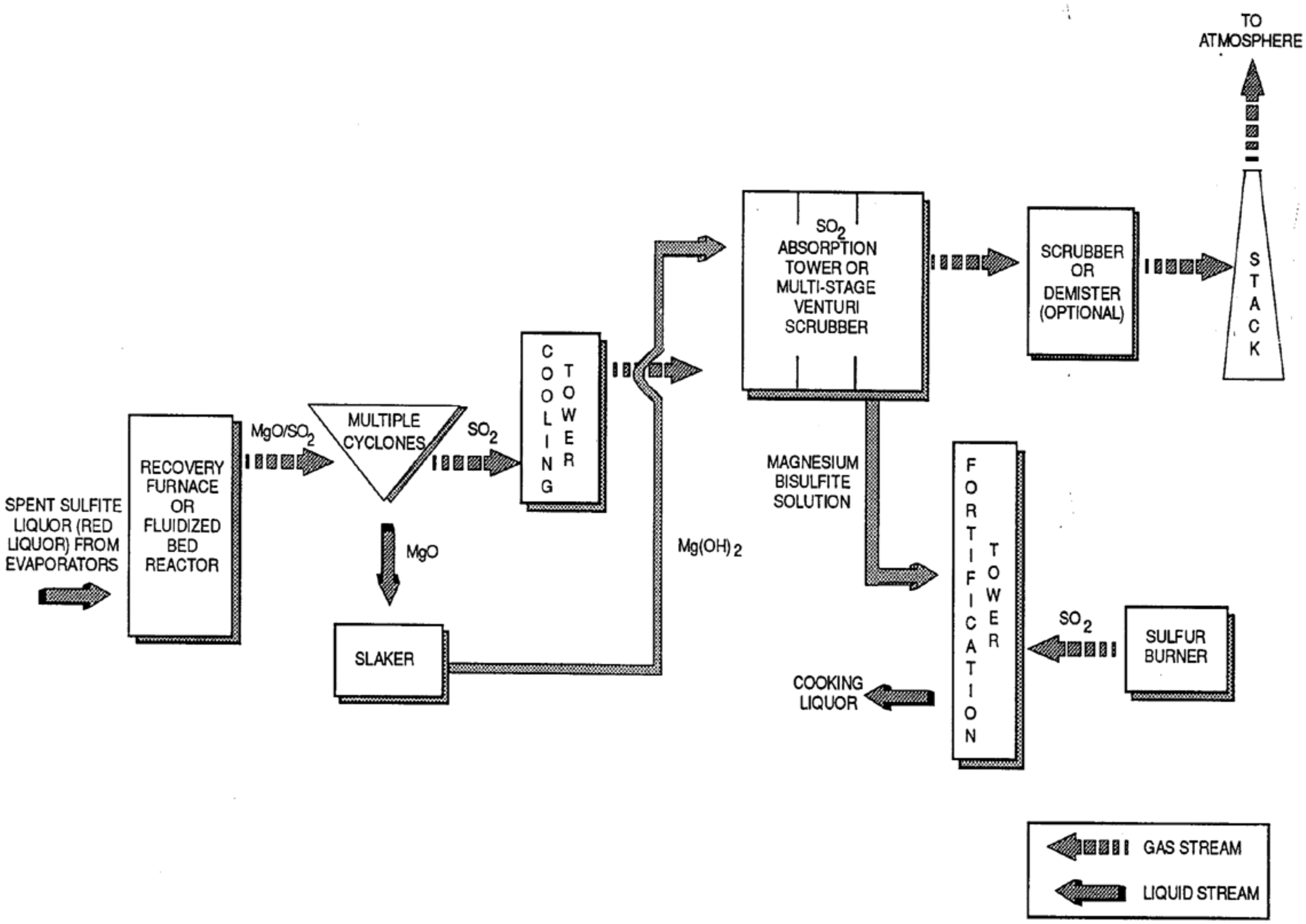


Figure 3. Chemical Recovery Area for the Mg-Based Sulfite Pulping Process.

3. Semichemical Process

Stand-alone semichemical pulp mills (*i.e.*, mills that use only the semichemical pulping process and are not co-located with another chemical pulping process such as kraft) use a combination of chemical and mechanical methods to pulp wood. Wood chips first are partially softened in a digester with chemicals, steam, and heat. At currently operating mills, the chemical portion of the semichemical pulping process primarily uses a nonsulfur process, which uses either Na_2CO_3 only or mixtures of Na_2CO_3 and NaOH for cooking the wood chips. One mill uses the neutral sulfite semichemical (NSSC) process, which uses a Na-based sulfite cooking liquor. Once chips are softened, mechanical methods complete the pulping process. The pulp is washed after digestion to remove cooking liquor chemicals and organic compounds dissolved from the wood chips. This virgin pulp is then mixed with 20 to 35 percent recovered fiber (*e.g.*, double-lined kraft clippings) or repulped secondary fiber (*e.g.*, old corrugated containers) to enhance machinability. Washer filtrate, called "black liquor," is routed to a chemical recovery process to reclaim the remaining cooking chemicals for reuse in the digester.

The black liquor is concentrated in a MEE system, then in a DCE and/or NDCE, to between 39 and 60 percent solids. Semichemical black liquor containing greater than 60 percent solids is too viscous to be pumped. At most mills, black liquor solids have a solids content of 50 percent or less. The black liquor is then fired in a chemical recovery combustion unit.

Cooking liquor chemicals from the chemical recovery combustion units are recovered as either smelt or ash. The recovered smelt or ash is mixed with water in a dissolving tank. The recovered chemicals are combined with makeup chemicals to form fresh cooking liquor, which is routed to the digester. A diagram of the chemical recovery area for the semichemical pulping process is presented in Figure 4.

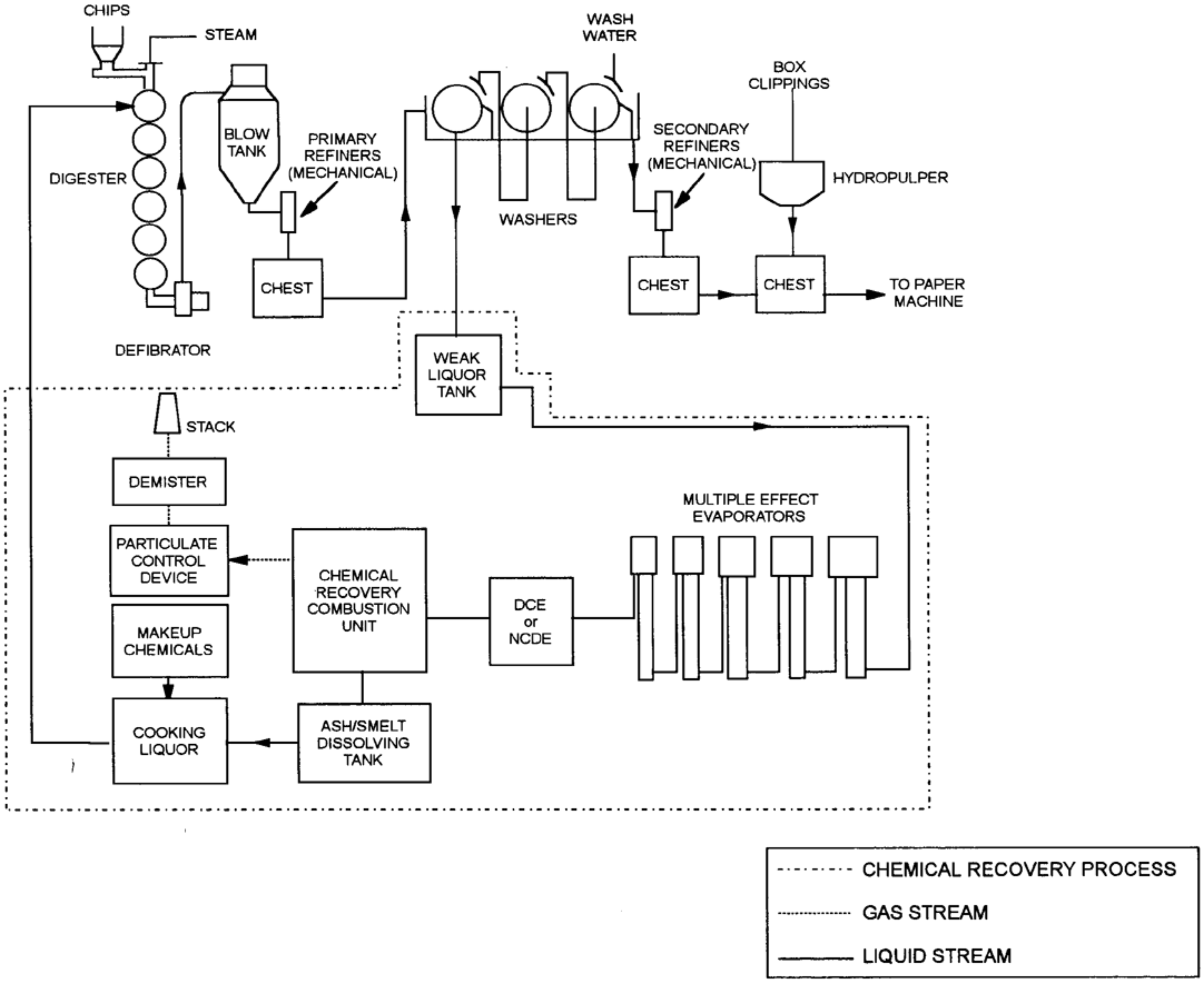


Figure 4. Chemical Recovery Area for the Semichemical Pulping Process.

C. Promulgated NESHAP Requirements

The MACT standards for the pulp and paper production source category were developed in three parts:

- *MACT I.* Regulates HAP emissions from the pulp production areas and bleaching operations at chemical pulp mills (kraft, soda, sulfite, and semichemical pulping processes) and the bleaching operations at pulp mills using mechanical, secondary fiber, and non-wood pulping
- *MACT II.* Regulates HAP emissions from the chemical recovery combustion areas of chemical pulp mills (kraft, soda, sulfite, and semichemical pulping processes)
- *MACT III.* Regulates HAP emissions from pulp and paper production areas of pulp mills using mechanical, secondary fiber, and non-wood pulping, and papermaking systems at all mills

The MACT I and MACT III standards are contained in 40 CFR part 63, subpart S (NESHAP for the Pulp and Paper Industry), which was promulgated on April 15, 1998 and amended on September 11, 2012 based on the results of an RTR. The MACT II standards are contained in 40 CFR part 63, subpart MM (NESHAP for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills), which were promulgated on January 12, 2001. As noted previously, the purpose of this memorandum is to present the results of a technology review for the sources with emission standards promulgated under the subpart MM NESHAP. A complete list of the relevant Federal Register (FR) actions associated with the subpart MM NESHAP is provided in Table 1.

Table 1. List of Federal Register Actions Associated with the Subpart MM NESHAP

FR notice	FR citation	Nature of FR notice
April 15, 1998	63 FR 18754	Original proposal of chemical recovery combustion sources NESHAP
January 12, 2001	66 FR 3180	Original promulgation of chemical recovery combustion sources NESHAP
March 26, 2001	66 FR 16400	Direct final rule with compliance date extension and site-specific recordkeeping and reporting requirements for Georgia-Pacific's Big Island, Virginia facility
March 26, 2001	66 FR 16434	Parallel proposal with compliance date extension and site-specific recordkeeping and reporting requirements for Georgia-Pacific's Big Island, Virginia facility
July 19, 2001	66 FR 37593	Technical corrections to the January 12, 2001 final rule
August 6, 2001	66 FR 41086	Correction to July 19, 2001 technical corrections
February 18, 2003	68 FR 7706	Direct final rule with amendments to the January 12, 2001 final rule and site-specific alternative standard for Weyerhaeuser Paper Company's Cosmopolis, Washington facility

FR notice	FR citation	Nature of FR notice
February 18, 2003	68 FR 7735	Parallel proposal with amendments to the January 12, 2001 final rule and site-specific alternative standard for Weyerhaeuser Paper Company's Cosmopolis, Washington facility
May 8, 2003	68 FR 24653	Technical corrections to the February 18, 2003 direct final rule
July 18, 2003	68 FR 42603	Amendments to the February 18, 2003 direct final rule withdrawing provisions receiving adverse comment and making technical corrections
May 6, 2004	69 FR 25321	Additional technical corrections to the February 18, 2003 direct final rule
April 20, 2006	71 FR 20458	Amendments to SSM requirements for all NESHAP
June 23, 2010	75 FR 35791	Notice requesting public comment on an ICR to assist EPA in re-evaluating emission standards for the pulp and paper source category
December 7, 2010	75 FR 76005	Notice that the ICR has been forwarded to OMB for review and approval and requesting additional public comment

Subpart MM regulates the following sources at kraft, soda, sulfite, and stand-alone semichemical pulp mills:

- Kraft and soda NDCE recovery furnaces
- Kraft and soda DCE recovery furnace systems (including associated BLO units)
- Kraft and soda lime kilns
- Kraft and soda SDTs
- Sulfite combustion units
- Semichemical combustion units

The kraft sources regulated under the subpart MM NESHAP are also covered under the new source performance standards (NSPS) for kraft pulp mills (40 CFR part 60, subparts BB and BBa). The NSPS are required under CAA section 111 to reflect "the degree of emission limitation achievable through the application of the best system of emission reduction [BSER] which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated." Table 2 summarizes the current subpart MM standards. Table 3 summarizes the emissions control techniques associated with the current subpart MM standards.

Subpart MM requires opacity monitoring for recovery furnaces and lime kilns with electrostatic precipitators (ESPs). For existing kraft or soda recovery furnaces or lime kilns, monitoring exceedances occur when there are ten consecutive 6-minute average opacity values exceed 20 percent, and violations occur when opacity is greater than 35 percent for 6 percent of operating time within a quarter. For new kraft or soda recovery furnaces or lime kilns, a violation occurs if opacity is greater than 20 percent for 6 percent of operating time within a quarter. Control device operating parameters are also monitored to demonstrate ongoing compliance for subpart MM emission units. Separate memoranda discuss opacity monitoring under subpart MM and review of the monitoring requirements to address periods of startup and shutdown. (EPA 2016a, RTI 2016a)

Table 2. Summary of Subpart MM Standards Promulgated in 2001

Affected sources	MACT standards	
	PM (surrogate for HAP metals)	**Gaseous organic HAP**
EXISTING SOURCES		
Kraft and soda combustion sources	Comply with the following individual PM emission limits in subpart MM for recovery furnaces, lime kilns, and SDTs:	NA
Recovery furnace	0.044 gr/dscf @ 8% O_2	
Lime kiln	0.064 gr/dscf @ 10% O_2	
SDT	0.20 lb/ton BLS	
	OR	
Chemical recovery system that operates ≥6,300 hr/yr [1]	PM bubble compliance alternative: Comply with mill-specific PM limits (lb/ton BLS) for recovery furnaces, lime kilns, and SDTs, whose sum is equivalent to the sum of the individual PM emission limits in subpart MM listed above	
Sulfite combustion units	0.040 gr/dscf @ 8% O_2	NA
Semichemical combustion units	NA	2.97 lb/ton BLS, as measured by THC (as carbon) **OR** Reduce outlet gaseous organic HAP emissions by 90%
NEW SOURCES		
Kraft and soda NDCE recovery furnace/DCE recovery furnace system [2]	0.015 gr/dscf @ 8% O_2	0.025 lb/ton BLS, as measured by methanol
Kraft and soda lime kiln	0.010 gr/dscf @ 10% O_2	NA
Kraft and soda SDT	0.12 lb/ton BLS	NA
Sulfite combustion units	0.020 gr/dscf @ 8% O_2	NA
Semichemical combustion units	NA	2.97 lb/ton BLS, as measured by THC (as carbon) **OR** Reduce outlet gaseous organic HAP emissions by 90%

gr/dscf = grains per dry standard cubic foot, O_2 = oxygen, lb/ton BLS = pounds per ton of black liquor solids, THC = total hydrocarbons

1. Kraft and soda chemical recovery system includes all existing recovery furnaces, lime kilns, and SDTs at the mill.

2. Kraft and soda DCE recovery furnace system includes all new or reconstructed DCE recovery furnaces and associated BLO units at the mill.

Table 3. Control Techniques Associated with the Promulgated Subpart MM Standards

Affected sources	Control techniques	
	PM (surrogate for HAP metals)	**Gaseous organic HAP**
EXISTING SOURCES		
Kraft/soda recovery furnaces	Recovery furnace ESP	None
Kraft/soda lime kiln	ESP	None
Kraft/soda SDT	Wet scrubber	None
Sulfite combustion units	Fiber bed demister	None
Semichemical combustion units	None	WESP/RTO
NEW SOURCES		
Kraft and soda recovery furnace	High-efficiency recovery furnace ESP	NDCE furnace design with dry bottom ESP and dry PM return
Kraft and soda lime kiln	High-efficiency ESP	None
Kraft and soda SDT	High efficiency wet scrubber	None
Sulfite combustion units	Fiber bed demister/wet scrubber	None
Semichemical combustion units	None	WESP/RTO

WESP = wet electrostatic precipitator, RTO – regenerative thermal oxidizer

As discussed in further in section III.A below, black liquor gasification (BLG) systems were considered to be a promising chemical recovery system technology change and emission reduction measure at the time when subpart MM was promulgated.

D. Emissions and Profile of the Source Category

In 2011, the EPA conducted an information collection request (ICR) to gather information on the pulp and paper mills and emission units operating in the U.S. Part III of the ICR focused on chemical recovery combustion sources, and Part II requested updated emissions inventories from major source pulp and paper production facilities. Additional emissions inventory updates have been received from pulp and paper production facilities since the 2011 ICR to provide data for residual risk modeling for subparts S and MM conducted under CAA section 112(f)(2).

The number of U.S. mills has declined since 2001 when subpart MM was promulgated. Table 4 compares the number of mills operating in 2001 and 2016. A total of 28 pulp mills have ceased operation since 2001.

Table 4. Comparison of the Current Number of Pulp Mills to the Number of Mills at the Time of Subpart MM Promulgation

Pulp process	No. of mills in 2001	No. of mills in 2016
Kraft*	114	97
Soda	2	1
Semichemical	12	7
Sulfite	8	3
Total	**136**	**108**

*Includes mills with other processes co-located at kraft mills (*e.g.*, kraft with co-located semichemical pulp production).

Nationwide baseline HAP emissions for the subpart MM source category, including gaseous organic HAP and HAP metals, were estimated at 22,500 tons per year (tpy) prior to implementation of subpart MM. (66 FR 3188) In addition, emissions of hydrogen chloride (HCl) from recovery furnaces were estimated to be 10,950 tpy prior to promulgation of subpart MM (EPA 1996), for a total of 33,450 tpy. No emission limit was established for recovery furnace HCl based on a risk assessment performed according to CAA section 112(d)(4) at the time when subpart MM was promulgated.

Post-MACT nationwide HAP emissions estimates for subpart MM sources are estimated to be 11,600 tpy, substantially lower than the 33,450 tpy of total HAP emissions at promulgation. Methanol and HCl account for 52 and 28 percent of the remaining total HAP emissions, respectively, while other HAP account for 20 percent. Table 5 presents a list of the pollutants and their reported emissions for subpart MM sources. The pollutants in Table 5 are broken out according to the types of HAP that are typically of interest for residual risk rulemaking. Methanol accounts for 73 percent of the gaseous organic HAP emissions, while HCl accounts for nearly 100 percent of the acid gas HAP emissions.

Figure 5 depicts the magnitude of subpart MM HAP emissions by source using the current inventory. Sources with the most emissions following MACT implementation are NDCE recovery furnaces, DCE recovery furnace systems (which include BLO units), and SDTs. Nationwide emissions from chemical recovery combustion sources at sulfite and semichemical mills are very low relative to kraft and soda mill sources, in part because there are fewer of these sources nationwide. Also, the average subpart MM source total HAP emissions per mill are lower for sulfite mills (20 tpy average per mill) and stand-alone semichemical mills (6 tpy average per mill) than for kraft/soda mills (117 tpy average per mill). Chemical recovery combustion sources at the one remaining soda mill are grouped with kraft sources because of similarities in the types of equipment used (recovery furnace, SDT, and lime kiln). However, it is noted that the soda mill subpart MM HAP emissions (8 tpy) are lower than most kraft mills. Figures 6A and 6B provide a more-detailed break out of the emissions for each source at kraft and soda mills by HAP type. As shown in Figures 6A and 6B, recovery furnace systems account for the majority (75 percent) of the remaining HAP emissions from kraft/soda mills. SDTs account for 22 percent, and lime kilns account for only 3 percent of the remaining HAP emissions.

Section III below provides additional details on the current universe of subpart MM process units, their emissions, and emission control measures. Section III identifies control options for consideration under the 2016 RTR. A separate memorandum discusses costs and environmental impacts of the control options. (RTI 2016b)

Table 5. Nationwide HAP Emissions from Subpart MM Sources Reported in Part II of the 2011 ICR

HAP category name	Nationwide HAP emissions, tpy
Gaseous Organic HAP	
Methanol	6,056
Acetaldehyde	470
Formaldehyde	332
Phenol	327
Methyl Chloride (Chloromethane)	255
Propionaldehyde	135
Cresol/Cresylic Acid (Mixed Isomers)	119
Acetophenone	71
Naphthalene	60
Benzene (Including Benzene From Gasoline)	51
Xylenes (Mixed Isomers)	48
Cumene	39
Carbon Disulfide	36
Hexane	35
Methylene Chloride (Dichloromethane)	31
Polycyclic Organic Matter	30
Methyl Isobutyl Ketone (Hexone)	24
Hexachloroethane	23
Toluene	20
Carbonyl Sulfide	19
Ethylbenzene	16
1,2,4-Trichlorobenzene	16
Acrolein	14
Styrene	12
Other	40
Total Gaseous Organic HAP	**8,280**
Acid Gases	
Hydrochloric Acid (Hydrogen Chloride [Gas Only])	3,304
Hydrogen Fluoride (Hydrofluoric Acid)	7.8
Chlorine	2.2
Total Acid Gases	**3,314**
Non-Mercury HAP Metals	
Manganese Compounds	6.0
Lead Compounds	4.4
Nickel Compounds	2.9
Chromium Compounds	1.6
Selenium Compounds	0.60
Cadmium Compounds	0.36
Arsenic Compounds	0.18
Cobalt Compounds	0.17
Antimony Compounds	0.16
Beryllium Compounds	0.038
Total Non-Mercury HAP Metals	**16.4**

HAP category name	Nationwide HAP emissions, tpy
Mercury	
Mercury Compounds	0.15
Polychlorinated CDD/CDF	
Dioxins/Furans as 2,3,7,8-TCDD TEQs	0.0000013
Total subpart MM source HAP	**11,611**

Figure 5. Nationwide HAP Emissions by Subpart MM Process (11,611 tpy total)

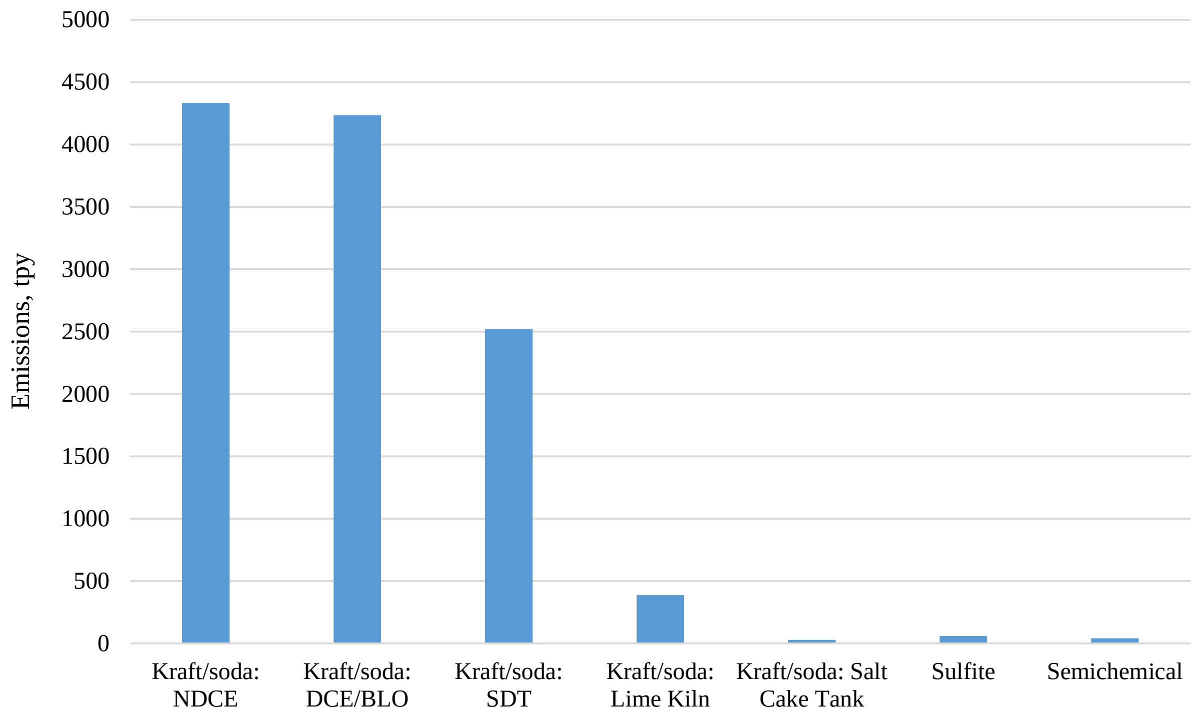


Figure 6A. Nationwide Kraft/Soda HAP Emissions by Key HAP-Emitting Process (11,508 tpy total)

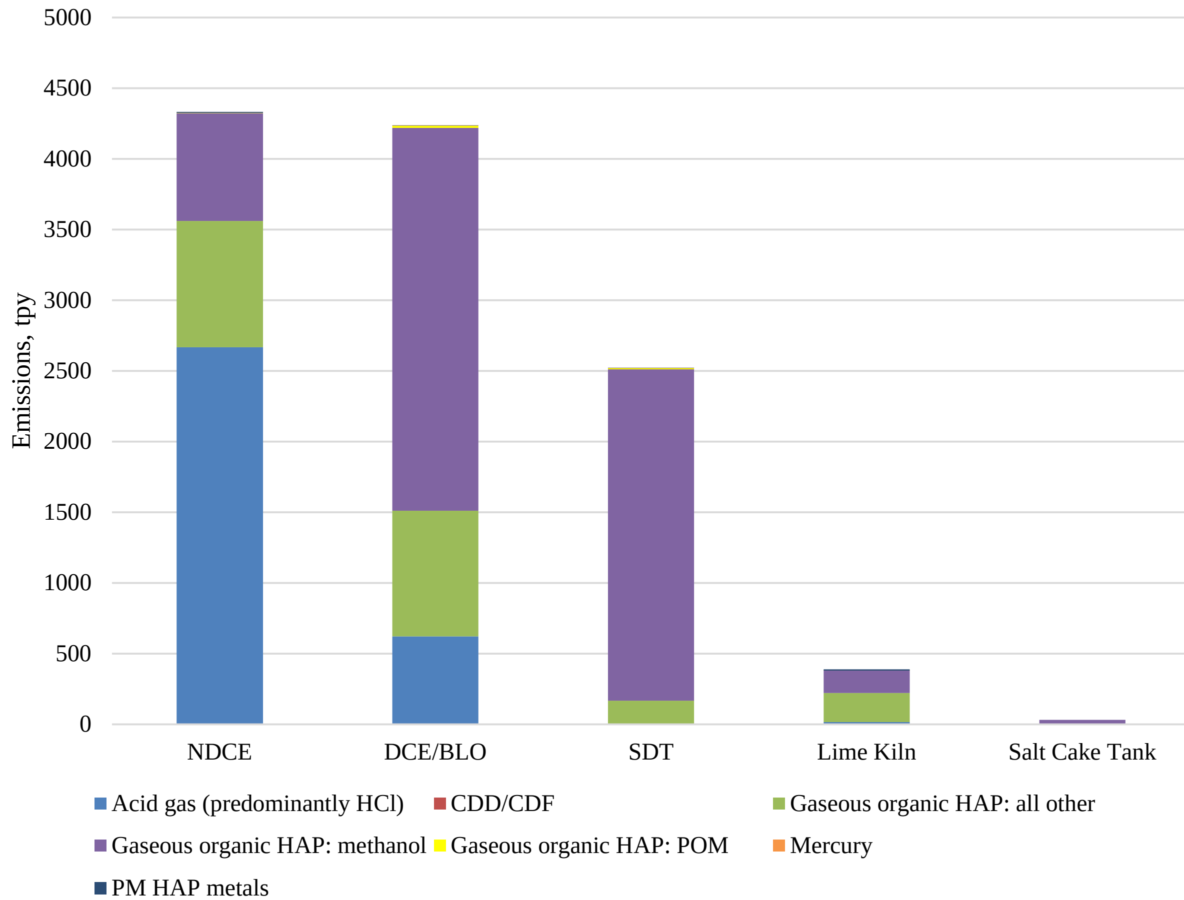
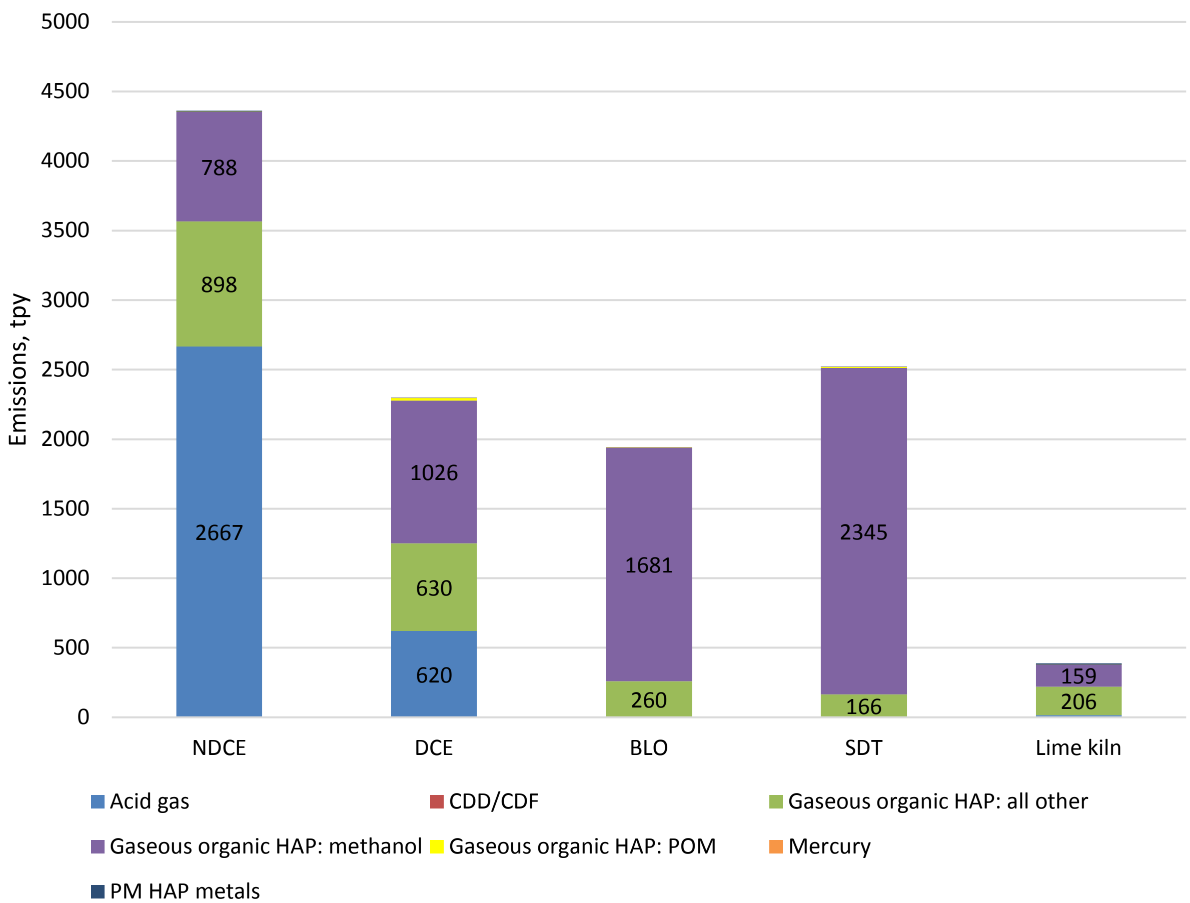


Figure 6B. Nationwide Kraft/Soda HAP Emissions by Key HAP-Emitting Process (11,508 tpy total)



III. Developments in Practices, Processes, and Control Technologies

The following information sources were reviewed to determine if there have been developments in practices, processes, or control technologies relative to the promulgated subpart MM emissions standards for chemical recovery combustion sources:

- Process, equipment, and control device details from industry responses to Part III of EPA's 2011 Pulp and Paper Sector ICR, which requested information on subpart MM processes (EPA 2011a, 2011b)
- Permit limits from permits submitted with the ICR (EPA 2011a, 2011b) and collected from state agencies (EPA 2016b)
- Information sources compiled by state/local, national, and international agencies (RTI 2016c), including:
  - EPA's RACT/BACT/LAER Clearinghouse (RBLC) (EPA 2016c)
  - A document from the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials

    - (STAPPA/ALAPCO) titled *Controlling Fine Particulate Matter Under the Clean Air Act: A Menu of Options* (STAPPA 2006)
    - A 2015 European Commission (EC) document entitled *Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and Board* (EC 2015)
- Stack test data collected in the 2011 ICR for PM tabulated for the recent kraft pulp mill NSPS review (RTI 2013)
- Stack test data collected in the 2011 ICR for soda recovery furnaces, lime kilns, and SDTs (EPA 2011a, 2011b)
- Stack test data collected in the 2011 ICR for sulfite and semichemical combustion units (EPA 2011a, 2011b)
- Technical bulletins prepared by the National Council for Air and Stream Improvement, Inc. (NCASI), a major source of environmental data from the pulp and paper industry (NCASI 2002, 2005, 2010)

The conclusions from our review of the above information are consolidated in the following sections.

A. <u>Kraft and Soda Recovery Furnaces</u>

The purpose of the kraft recovery furnace is to: (1) recover inorganic pulping chemicals (*e.g.*, Na_2S, NaOH); and (2) produce steam. Inputs to the furnace include concentrated black liquor, combustion air, and auxiliary fuel. Auxiliary fuel is typically only used during startup or shutdown. Outputs from the recovery furnaces include molten smelt (primarily Na_2S and Na_2CO_3), flue gases, and steam. The smelt exits from the bottom of the furnace into an SDT, where the recovery of kraft pulping chemicals continues. Particulate matter (primarily Na_2SO_4 [salt cake] and Na_2CO_3) entrained in the flue gases is also recovered using an ESP, collected in a chemical ash tank or salt cake mix tank, and subsequently added to the concentrated black liquor. Steam produced by the recovery furnace is used in other processes around the mill or for electricity generation. (EPA 2001)

As noted previously, prior to being fired in the recovery furnace, the black liquor is concentrated using an NDCE or DCE. The NDCE is an indirect, steam-heated black liquor concentrator. The DCE uses the hot combustion gases exiting the furnace to increase the solids content of the black liquor. A BLO system precedes the DCE to reduce malodorous total reduced sulfur (TRS) emissions (primarily hydrogen sulfide [H_2S]) that can be stripped in the DCE when hot flue gases from the recovery furnace come in contact with the black liquor. The BLO system uses molecular oxygen (O_2) or air to oxidize Na_2S to nonvolatile sodium thiosulfate ($Na_2S_2O_3$) to reduce the potential for stripping. Either weak or strong black liquor may be oxidized in the BLO, and some BLO systems are comprised of multiple oxidation stages. (EPA 2001)

Because soda pulping is a nonsulfur process, the soda recovery furnace is designed to recover NaOH. The molten smelt from the soda recovery furnace and the PM entrained in the flue gases are primarily composed of Na_2CO_3.

Based on data from EPA's 2011 ICR, and updated with more recent information from the industry, Table 6 presents a breakout of the types of recovery furnaces (DCE, NDCE) and subpart MM standards (existing, new) to which they are subject, as well as the types of control systems they use. Electrostatic precipitators designed to capture recovery furnace PM for reuse are the most commonly used to control emissions. However, a few mills use wet scrubbers. The updated ICR data indicate that 142 recovery furnaces (96 percent) have ESPs, 2 recovery furnaces have wet scrubbers, and 4 recovery furnaces have ESP-scrubber combinations.

Table 6. Breakout of Kraft and Soda Recovery Furnace Types and Existing/New Sources

Control device type	DCE	NDCE	Total
ESP	33 existing	105 existing 4 new*	142
SCBR	0	2 existing	2
ESP/SCBR	3 existing	1 existing	4
Total	**36 existing**	**108 existing 4 new***	**148**

Sources: RTI 2016d, RTI 2016e. ESP = electrostatic precipitator, SCBR = scrubber
* Includes one new soda recovery furnace, the only remaining soda recovery furnace in the U.S.

Electrostatic precipitators used to control PM emissions from kraft recovery furnaces typically have two parallel chambers (*i.e.*, flue gas passages) with three or four electrostatic fields per chamber. (EPA 2001) Recovery furnace ESPs can be further characterized as wet- or dry-bottom ESPs having either a wet or dry PM return system. Either oxidized or unoxidized black liquor is used in a wet-bottom ESP to collect the PM and carry it to the salt cake mix tank via a wet PM return system. In a dry-bottom ESP, the captured PM is routed to the mix tank via a screw conveyor or drag chain without the use of liquid, typically with a dry PM return system. However, there are some dry-bottom ESPs with a wet PM return system in which black liquor or other process water is used to transport the dry collected PM to the mix tank. Table 7 presents a breakout of the different types of control systems used on DCE and NDCE recovery furnaces.

Table 7. Breakout of Recovery Furnace Control Systems

	No. of recovery furnaces		
Recovery furnace control device type	**DCE**	**NDCE**	**Total**
DBESP	8	80	88
DBESP/SCBR	1	1	2
DBESP-WPR	3	13	16
DBESP-WPR/DBESP/DBESP	NA	1	1
DB-WBESP [2-sided dry and wet]	NA	1	1
SCBR	NA	2	2
WBESP	22	14*	36
WBESP/SCBR	2	NA	2
Total	**36**	**112***	**148**

DBESP = dry-bottom ESP, WBESP = wet-bottom ESP, SCBR = scrubber, and WPR = wet PM return. If "WPR" is not specified for DBESP, then the ESP has a dry PM return system. WBESPs use wet PM return systems.
* Includes one new soda recovery furnace installed in 2002.

1. Recovery Furnace Particulate Matter

Filterable PM is used as a surrogate for particulate metal HAPs in the subpart MM NESHAP. The NESHAP subpart MM PM limit for existing recovery furnaces is 0.044 grain per dry standard cubic foot (gr/dscf) at 8 percent O_2. The NESHAP subpart MM limit for new and reconstructed recovery furnaces is 0.015 gr/dscf at 8 percent O_2. Filterable PM standards were not developed for kraft BLO systems or kraft and soda salt cake mix tanks under the original subpart MM NESHAP. BLO systems do not generate PM. Salt cake mix tanks are not a significant source of PM, and have no associated HAP metals data. For the technology review, recovery furnace NESHAP PM limits were evaluated based on the ICR data base, permit limits, information from the RBLC data base and EC and STAPPA/ALAPCO guidance documents, and stack test data. The results of these reviews are summarized in the paragraphs below.

PM permit limits.[1] Based on information provided in a separate memorandum (EPA 2016b), and recent information from the industry (RTI 2016d), permit limits for 148 recovery furnaces were reviewed. Many of the units (59) are permitted to meet the existing source NESHAP limit of 0.044 gr/dscf. Four units (three kraft and one soda) are permitted to meet the new source NESHAP limit of 0.015 gr/dscf. Three units are permitted higher than the existing source NESHAP limit because they are debit sources in the PM bubble compliance alternative. The remaining 82 units are permitted between 0.02 and 0.044 gr/dscf, with 47 of these units being located at facilities that utilize the PM bubble compliance alternative.

RBLC and other information sources (RTI 2016c). While our search of the RBLC data base identified some recovery furnaces with PM limits below the existing source NESHAP limit of 0.044 gr/dscf at 8 percent O_2, no new control measures for recovery furnaces were revealed. All of the recovery furnaces control PM emissions using an ESP.

No new controls were discussed in the 2015 EC BAT document, *Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and Board* (EC 2015). Recovery furnace ESP and ESP-scrubber combinations (for PM and SO_2 control) were discussed. Similarly, the 2006 STAPPA/ALAPCO document, *Controlling Fine Particulate Matter Under the Clean Air Act: A Menu of Options* (STAPPA 2006), noted that recovery furnaces currently rely on an ESP or ESP-scrubber combination to control PM emissions and that opportunities may exist to reduce current PM emissions levels by upgrading or replacing older ESPs or wet scrubbers.

PM stack test data for kraft recovery furnaces.[2] Stack test data were extracted from test reports received with the 2011 ICR responses and compiled for analysis under the 2014 promulgated NSPS review. (RTI 2013) The data and graphs assembled for the NSPS review were used to review the limits for new sources but are relevant for the subpart MM technology review and are discussed in this section in the context of both new and existing sources under subpart MM.

[1] All of the recovery furnace PM concentrations in this section are filterable PM concentrations corrected to 8 percent O_2.
[2] *Ibid*.

Data from 211 filterable PM stack tests, including some repeat tests, on 133 recovery furnaces in the U.S. were compiled and analyzed.[3] Most of the test data were obtained using EPA Method 5. Oregon Department of Environmental Quality Method 5 (ORDEQ5) was used for a few of the tests. Test dates ranged from 2001 to 2011. Test data were reviewed for DCE and NDCE recovery furnaces using a variety of PM emission controls (ESP, ESP and wet scrubber combinations, and wet scrubbers). Table 8 presents a breakout of the number of PM tests analyzed by recovery furnace type and control system. Multiple tests of the same recovery furnace were included in the test data sets analyzed: (1) if the recovery furnace had multiple stacks (each with its own PM concentration test result), (2) if multiple tests were conducted at different conditions, or (3) if multiple tests were conducted at different times. Additional data from one NDCE with a dry-bottom ESP and scrubber combination were also considered.

Table 8. Number of Recovery Furnace PM Emissions Tests Included in Analysis
(Includes multiple tests of the same recovery furnace)

	No. of recovery furnaces		
Recovery furnace control device type	**DCE**	**NDCE**	**Total**
DBESP	18	95	**113**
DBESP/SCBR	1	7	**8**
DBESP-WPR	4	18	**22**
DBESP-WPR/DBESP/DBESP	NA	1	**1**
DB-WBESP [2-sided dry and wet]	NA	1	**1**
SCBR	NA	1	**1**
WBESP	36	22	**58**
WBESP/SCBR	7	NA	**7**
Total	**66**	**145**	**211**

DBESP = dry-bottom ESP, WBESP = wet-bottom ESP, SCBR = scrubber, and
WPR = wet PM return. If “WPR” is not specified, then the ESP has a dry PM return system.

Appendix A presents graphs of the recovery furnace test data, and Appendix D contains data tables associated with the graphs. All 211 of the recovery furnace tests are shown in Figure A-1 grouped by DCE or NDCE systems. As shown in Figure A-1, the PM stack test data revealed little or no distinction between DCE and NDCE recovery furnaces for PM emissions. Nearly all of the recovery furnaces tested met the existing source NESHAP (subpart MM) limit (0.044 gr/dscf), and several met the subpart MM new source limit of 0.015 gr/dscf.

In Figures A-2 through A-7, PM emissions data are shown for individual recovery furnaces on each vertical line. If multiple tests were available and tabulated for a recovery furnace, then multiple points (one for each 3-run test average) are shown on the vertical line. Appendix D contains data tables corresponding to each graph, where the graph sort order can be used to identify each specific mill and recovery furnace tested.

Figures A-2 and A-3 depict PM emissions from DCE recovery furnaces by control type. Figure A-2 shows that all DCE recovery furnaces with wet-bottom ESP (WBESP) control met

[3] It is noted that additional PM stack test data were received with the 2011 ICR. Generally, the most recent data for each recovery furnace were compiled in order to ensure coverage of the population of recovery furnaces. Additional data were compiled for recovery furnaces with controls of interest (*e.g.*, ESP-scrubber combinations) in order to understand emissions variability and determine the performance of these systems.

the MACT existing limit of 0.044 gr/dscf, and several met the MACT new limit of 0.015 gr/dscf. Recovery furnace PM emission extended up to 0.033 gr/dscf. Direct contact evaporator recovery furnaces with controls other than WBESPs are shown in Figure A-3. All of the DCE furnace control systems met the MACT existing limit, and several DCE furnaces with dry-bottom ESP (DBESP) or DBESP-scrubber control met the MACT new limit. However, the furnaces with DBESPs and a wet PM return (DBESP-WPR) did not meet the MACT new limit, nor did the WBESP-scrubber combination controls. The DBESP-WPR and WBESP-scrubber systems are not subject to the lower limit of 0.015 gr/dscf, but demonstrated compliance with the 0.044 gr/dscf limit. After initially finding that the WBESP-scrubber systems were performing above the MACT new limit, additional data for the WBESP-scrubber controlled furnaces were reviewed and added to the graph, revealing that one of these systems consistently performs between 0.015 and 0.044 gr/dscf, while the other system exhibited variability above and below 0.015 gr/dscf. Emissions extended up to 0.0373 gr/dscf for WBESP-scrubber controls. No additional PM data were available for the DBESP-scrubber controlled DCE furnace.

Figures A-4 and A-5 show PM emissions from NDCE recovery furnaces with DBESP control. Figure A-4 shows all 95 of the tabulated emissions tests for 63 NDCE furnaces with a DBESP, and Figure A-5 shows only the furnaces for which multiple PM test results were tabulated. All of the tests shown in Figure A-4 met the MACT existing limit of 0.044 gr/dscf, but only some met the MACT new limit of 0.015 gr/dscf. Figure A-5 shows the variability in performance for 23 of the NDCE recovery furnaces equipped with a DBESP. Twelve of the DBESP-controlled NDCE furnaces were below 0.015 gr/dscf in all tests, seven were at or above 0.015 gr/dscf, and four had tests both above and below 0.015 gr/dscf. Emissions extended up to 0.033 and 0.0373 gr/dscf for NDCEs with DBESP controls. Overall, the test results for the existing recovery furnaces shown in Figures A-4 and A-5 are indicative of the variability in performance experienced by existing NDCE recovery furnaces with DBESPs.

Figure A-6 presents PM data for 14 NDCE recovery furnaces with WBESP control. Six of the furnaces had all test results below 0.015 gr/dscf, six had all test results above 0.015 gr/dscf, and two furnaces had test results both above and below 0.015 gr/dscf. None of the NDCE recovery furnaces with WBESPs are currently subject to the lower limit of 0.015 gr/dscf. Emissions extended up to 0.0294 and 0.038 gr/dscf[4] for NDCE furnaces with a WBESP. The data in Figure A-6 are indicative of the variability in performance experienced by existing NDCE recovery furnaces with WBESPs.

Sixteen NDCE recovery furnaces with various control systems are shown in Figure A-7. While all of the DBESP-WPR tests included test results below 0.015 gr/dscf, one of these systems had repeated results between 0.015 and 0.044 gr/dscf. The two-sided dry-bottom and wet-bottom ESP (DB-WBESP) achieved 0.021 gr/dscf. The scrubber-controlled NDCE furnace achieved 0.032 gr/dscf. Finally, an NDCE furnace with three parallel ESPs (a DBESP-WPR and two DBESPs) achieved 0.015 gr/dscf in a retest following a test result of 0.076 gr/dscf.

The NDCE furnace with a DBESP-scrubber combination shown in Figure A-7 had multiple test results above 0.015 gr/dscf extending up to 0.0305 gr/dscf. Data for this furnace

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[4] It is noted that the recovery furnace exhibiting emissions of 0.038 gr/dscf also had emissions of 0.048 gr/dscf in a separate stack during the same test. This facility is now closed.

were studied because it was expected that this combined ESP and scrubber system would exhibit improved performance over ESP systems alone. Monthly PM test data are available for this particular recovery furnace and are shown in Figure A-8. This NDCE furnace is an existing source subject to a permit limit of 0.033 gr/dscf. From 2001 to 2009, monthly test results varied from below 0.015 gr/dscf up to the furnace's 0.033 gr/dscf permit limit. The scrubber on this NDCE furnace was installed in 1984 and may be approaching the end of its useful life. The DBESP was upgraded in 1998, which may explain why PM test results shown in Figure A-8 were generally lower (often achieving 0.015 gr/dscf) through about 2006. The recovery furnace depicted in Figure A-8 was one of the units used in determining the performance of DBESP-scrubber systems during subpart MM development, but was not the single best-performing "MACT new" unit.

The graphs of PM data in Appendix A indicate that DCE and NDCE recovery furnaces have achieved the subpart MM existing source limit of 0.044 gr/dscf. Some recovery furnaces have also achieved 0.015 gr/dscf, the new source limit under subpart MM. Some recovery furnaces equipped with a wet scrubber alone or with a wet scrubber in combination with an ESP exhibited PM emissions above 0.015 gr/dscf (but below the 0.044 gr/dscf limit). This suggests that wet scrubbing of recovery furnace exhaust gases (either alone or in conjunction with an ESP) does not necessarily improve filterable PM removal. The wet scrubbers installed following recovery furnace ESPs are typically designed for SO_2 removal rather than for removal of PM. Overall, the graphs of recovery furnace PM data exhibit considerable variability in emissions, with data scatter approaching the existing source limit of 0.044 gr/dscf regardless of the type of recovery furnace or control system used.

<u>PM stack test data for the soda recovery furnace</u>. The one remaining soda recovery furnace is a new unit subject to a PM limit of 0.015 gr/dscf at 8 percent O_2. Two emissions tests are available for this unit. In 2004, recovery furnace and SDT emissions were combined and vented through the recovery furnace ESP during the emissions test, and the system achieved PM emissions of 0.0034 gr/dscf at 8 percent O_2. The soda recovery furnace was retested in 2008, when the SDT emissions were no longer combined with the recovery furnace emissions and achieved PM emissions of 0.012 gr/dscf at 8 percent O_2.

<u>Regulatory options for recovery furnace PM</u>.[5] Review of ICR data, permit limits, the RBLC, and other information reflected predominant use of ESP control systems and a few ESP-scrubber control combinations for recovery furnaces. The information reviewed did not reveal use of any new practices, processes, or control systems for PM reduction other than those considered in the prior NESHAP rulemaking. Emissions test data were reviewed to determine if the performance of ESP and ESP-scrubber control systems has evolved since promulgation of the 2001 NESHAP (subpart MM) to justify a lower PM limit. The stack test data showed little distinction in recovery furnace design (DCE vs. NDCE) and control system relative to the current NESHAP PM limit of 0.044 gr/dscf for existing sources. There was considerable scatter in test results between 0.015 and 0.044 gr/dscf including variability in test results for the same unit tested multiple times. Based on a review of permits, four new recovery furnaces are required to meet a limit of 0.015 gr/dscf to date, and no limits lower than 0.015 gr/dscf were revealed.

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[5] All of the recovery furnace PM concentrations in this section are filterable PM concentrations corrected to 8 percent O_2.

Forty percent of recovery furnaces are permitted at the subpart MM existing source limit of 0.044 gr/dscf, and two percent are permitted above the limit (debit sources under the PM bubble compliance alternative). Over than half of the furnaces permitted below 0.044 gr/dscf are credit sources under the PM bubble compliance alternative. No new technologies or regulatory options for incremental improvements to the subpart MM PM emission limits for recovery furnaces were identified. Regulatory options for more stringent opacity monitoring requirements to better ensure continuous compliance with the recovery furnace PM limit are presented in a separate memorandum. (EPA 2016a) These opacity options were analyzed for their potential to further reduce PM emissions.

2. Recovery Furnace Gaseous Organic HAP

Subpart MM contains a limit of 0.025 pound per ton of black liquor solids (lb/ton BLS) (measured as methanol) for new recovery furnaces. There is no gaseous organic HAP limit for existing recovery furnaces. Gaseous organic HAP emissions are reduced through use of lower-emitting technologies, including:

- Use of an NDCE furnace instead of a DCE furnace system, thereby eliminating the BLO,
- BLO vent incineration control,
- Use of a dry-bottom ESP instead of a wet-bottom ESP, and
- Use of a dry PM return system instead of sluicing PM caught by the ESP with contaminated process water or black liquor.

Replacement of a DCE recovery furnace system with a new NDCE recovery furnace, or conversion of an existing DCE to an NDCE design (referred to as a “low-odor conversion”), along with removal of the associated BLO system provides the greatest reduction in gaseous organic HAP emissions. Conversion of existing ESPs to a dry-bottom ESP system with a dry PM return also reduces gaseous organic HAP emissions.

Recovery furnace conversions. The number of DCE recovery furnaces has decreased since the promulgation of subpart MM. When subpart MM was proposed in 1998, there were 211 kraft and soda recovery furnaces in the U.S., 83 of which were DCE furnaces, and 128 were NDCE furnaces. (63 FR 18768, 18770, and 18779, April 15, 1998.) At the time of subpart MM promulgation, there were 78 DCE and 119 NDCE recovery furnaces at kraft and soda mills. As shown in Table 6 above, there are currently 36 DCE and 112 NDCE recovery furnaces. Thus, the fraction of the recovery furnace population that is DCE design has been reduced from 39 percent to 24 percent of all U.S. recovery furnace systems.

Of the 112 kraft/soda NDCE furnaces, according to the 2011 ICR data, 85 were originally installed as NDCE furnaces. For 7 NDCE recovery furnaces, it was not specified whether the furnace was converted from a DCE to NDCE design, so these were assumed to have been installed originally as NDCE furnaces, for a total of 92 recovery furnaces installed as NDCE systems. The capacity for these 92 units ranges from 0.1 to 6.9 million (MM) lb BLS/day (3.4 average).

The ICR results indicated that 20 recovery furnaces were converted from DCE to NDCE technology. The years of service of furnaces converted from DCE to NDCE design ranged from

7 to 52 years (average of 25 years) from the installation year to conversion year. Capacity of the converted furnaces ranged from 0.44 to 4.32 MMlb BLS/day (2.5 average). Table 9 outlines the number and average capacity of recovery furnaces installed by decade, according to the ICR results.

Table 9. Number and Average Capacity of NDCE and DCE Recovery Furnaces Installed by Decade at U.S. Mills in Operation as of the 2011 ICR

Decade	NDCEs	DCE to NDCE conversions	DCEs
	(Average MMlb BLS/day)		
1950s	1* (0.75)		6 (1.0)
1960s	4* (2.1)		19 (2.5)
1970s	33 (3.0)	1 (2.5)	10 (2.5)
1980s	27 (3.8)	6 (2.6)	1 (1.5)
1990s	22 (3.5)	7 (2.4)	
2000s	5 (4.3)	2 (3.4)	
2010s		4 (2.1)	
TOTAL	**92**	**20**	**36**

*Although not labeled as a converted NDCE in the ICR responses, it is likely that these units were originally installed as a DCE furnace and converted to an NDCE.

Several DCE furnaces have been rebuilt or upgraded, with the most recent upgrades occurring in 2001 and 2007. However, most of the DCE furnace rebuilds and upgrades occurred in the 1980s and 90s. Capacity of the remaining DCEs (excluding two units not operated in the ICR base year) ranged from 0.567 to 5.2 MMlb BLS/day (2.2 average).

BLO units. Black liquor oxidation units are used to stabilize sulfur compounds in black liquor to minimize stripping of odorous TRS emissions when hot flue gases contact the black liquor in the DCE. Black liquor that is concentrated in an NDCE does not come into direct contact with hot flue gases and does not require oxidation. Thus, there is no BLO unit for NDCE recovery furnaces, and NDCE systems are often referred to as “low-odor” recovery furnaces.

Black liquor oxidation systems use either air or molecular O_2 to oxidize the black liquor. Air-sparging BLO systems may have one or more oxidation tanks which are vented to the atmosphere, or in some cases to incineration-based air emissions control (*e.g.*, through the mill’s high-volume, low-concentration [HVLC] system or to a regenerative thermal oxidizer [RTO]). Molecular O_2 systems may not have a vent because all of the added gas is consumed in the oxidation reaction. (EPA 1996) Because organic compounds not released from the black liquor during the molecular O_2 oxidation process could be subsequently stripped, in theory, from the oxidized black liquor when the black liquor enters the DCE, molecular O_2 BLO systems are not viewed as a control option for DCE recovery furnace systems. (63 FR 18770, April 15, 1998)

Based on responses to the 2011 ICR, there remain 25 BLO systems serving 36 DCEs in the U.S. Some BLO systems supply oxidized black liquor to multiple DCE furnaces. The BLO systems have from one to three stages and process from 66 to 4,644 gallons per minute (gpm) of liquor ranging from 26 to 66 percent solids (0.75 to 6.7 MM lb BLS/day). Of the 25 remaining

BLO systems, three operate with some form of incineration control. The majority of BLO units (21) are air-sparging units, while three units use molecular O_2, and one unit uses a combination of air and O_2.

Recovery furnace ESPs. As noted above, the presence of black liquor or process water contaminated with pollutants in the bottom of a wet ESP or in the PM return system can lead to gaseous organic HAP emissions. Use of dry-bottom ESPs with dry PM return eliminates the source of HAP emissions. As shown in Table 7, of the 148 recovery furnaces in the U.S., 58 (40 percent) involve use of liquids in the ESP, including:

- 17 dry-bottom ESPs with wet PM return (including 1 hybrid system)
- 39 wet-bottom ESPs (including 2 with WBESP/SCBRs and 1 hybrid system), and
- 2 wet scrubber-only control

The remaining 90 recovery furnaces (60 percent) have either a dry-bottom ESP or dry-bottom ESP combined with scrubber control. Of the currently operating NDCE recovery furnaces (112 units), over 70 percent have dry-bottom ESP systems, as compared to an estimated 5 percent of NDCE furnaces having dry-bottom systems at the time when subpart MM was proposed.[6] Conversions of wet- to dry ESP systems were noted in the ICR results for eight NDCE furnaces, with ESP conversion dates ranging from 1984 to 2004.

According to the ICR results, NDCE furnaces reporting wet-bottom ESP (WBESP) systems use the following types of liquid in the ESP:

- Black liquor (6 units)
- Surface water (1 unit)
- Weak wash from mill water (1 unit)
- Weak liquor/water – black liquor in return system (1 unit)
- Water in ESP and – fresh "salt" water in return system (1 unit)
- Water – black liquor in return system (2 units)
- Unspecified liquid in the WBESP – water in wet return system (2 units)

The majority of the NDCE furnaces with dry bottom ESPs having wet PM return systems (DBESP-WPR, DBESP-WPR/DBESP/DBESP) use black liquor in the PM return system. The NDCE with a 2-sided dry and wet ESP uses black liquor in the ESP and return system. The DCE furnaces reporting WBESP systems, or DBESP-WPR use oxidized black liquor in the ESP bottom according to the ICR.

Salt cake mix tanks. As shown in Figure 5, salt cake mix tanks are negligible HAP emission sources in the chemical recovery system. However, it is noted that a few salt cake mix tanks in the industry vent to incineration-based control. Methanol is the primary HAP that can be emitted.

Gaseous organic HAP permit limits. Permit limits for gaseous organic HAP from recovery furnaces were reviewed from 2011 ICR responses (EPA 2011a, EPA 2011b) and state

[6] Additional dry-bottom ESP systems were identified during the public comment period following proposal of subpart MM, raising the percentage of NDCE furnaces with dry ESPs to about 10 percent.

agency websites (EPA 2016b), based on the latest inventory information (RTI 2016d). Four new recovery furnaces are permitted to meet the new source NESHAP limit of 0.025 lb/ton BLS (as methanol). Seven existing recovery furnaces are permitted to meet a variety of state permit limits, expressed in units of pounds per hour (lb/hr). Using available information on BLS process rate for these furnaces, these permit limits were converted to units of lb/ton BLS, to facilitate a comparison with the NESHAP limit. All but one of these furnaces are permitted at a higher limit than the new source NESHAP; one furnace is permitted at a lower limit of 0.007 lb/ton BLS, when converted from the published permit limit of 0.87 lb/hr.

RBLC and other information sources (RTI 2016c). Except for formaldehyde, no RBLC data were found for gaseous organic HAP for kraft recovery furnaces. Control measures for TRS, H_2S, or volatile organic compounds (VOC) in the RBLC results were evaluated because gaseous organic HAP are often expected to be reduced by the same control measures that reduce these pollutants. Installation of or conversion to an NDCE recovery furnace was noted as an effective means of reducing gaseous organic HAP emissions because two sources of gaseous organic HAP emissions are eliminated (the DCE and BLO units).

The 2015 EC BAT for control of VOC suggested that maintaining low recovery furnace CO levels (35-69 parts per million [ppm] at 8 percent O_2) could ensure low emissions of VOC and polycyclic aromatic hydrocarbons (PAH), which are a component of gaseous organic HAP.

Gaseous organic HAP emissions data. Gaseous organic HAP data were summarized in section 3.2 of EPA 1996. Limited additional recovery furnace methanol data were received with the 2011 ICR, including data for only two BLO systems, one operating DCE recovery furnace (with two stacks), one shutdown DCE recovery furnace, and eight NDCE recovery furnaces. (It should be noted that recovery furnaces are not required under subpart MM to conduct methanol testing.) Older (1990s) emissions data are also available for methanol and other gaseous organic HAPs, but given the age of the data, many of these test results may no longer be representative of current mill operation (*e.g.*, units shut down, DCE furnaces converted). Emission factors for methanol and other gaseous organic HAPs are also available in NCASI Technical Bulletin 973 for BLO systems, DCE recovery furnaces, and NDCE recovery furnaces (NCASI 2010), but unit-specific emissions data are not publicly available for these sources.

The data in EPA 1996 indicate that elimination of black liquor from NDCE recovery furnace ESPs (through wet-to-dry ESP conversions) can lead to a:

- 90 percent reduction in emissions of methanol and total gaseous organic HAP, and
- 55 percent reduction in TRS emissions.

BLO vent incineration was assumed to reduce gaseous organic HAP emissions from the BLO by 98 percent in EPA 1996.

Emission factors more recent than those compared in EPA 1996 were used to estimate the potential gaseous organic HAP reduction that could be associated with furnace conversions. Comparison of the emission factors for DCE and NDCE recovery furnaces in NCASI Technical Bulletin 973 (NCASI 2010) suggests that the following percent reductions may be associated with conversion or replacement of DCE recovery furnaces with NDCE technology:

- 84 percent reduction in emissions of methanol--the predominant gaseous organic HAP emitted from recovery furnaces and surrogate pollutant for the new source limit;
- 58 percent reduction in emissions of total gaseous organic HAP, with the total including those pollutants that account for 99 percent of recovery furnace gaseous organic HAP in the HAP emissions inventory used for residual risk modeling; and
- 73 percent reduction in emissions of TRS (as sulfur).

Regulatory options for recovery furnaces gaseous organic HAP. The regulatory option that would have the greatest effect on reducing gaseous organic HAP emissions from recovery furnace systems would involve replacement or conversion of the remaining DCE furnaces to adopt NDCE technology with a dry-bottom ESP and dry PM return system. This option would eliminate the BLO and DCE units responsible for emissions eluding from black liquor associated with bubbling air or O_2 (in the BLO) or from the direct contact of hot flue gases with the incoming black liquor (in the DCE). Elimination of the BLO achieves greater emission reductions than incineration of BLO vent gases.

The subpart MM NESHAP currently contains one emission limit for new recovery furnaces based on NDCE technology because no new DCE systems are expected to be constructed. However, a consideration in the technology review for existing sources is whether DCE and NDCE recovery furnaces should be treated as separate subcategories. If placed in the same subcategory, then the technology review emission limit would most likely reflect the performance of NDCE technology with a dry-bottom ESP and dry PM return system. However, if DCE and NDCE recovery furnaces were placed in separate subcategories, then both DCE and NDCE recovery furnaces would likely need to make improvements to reduce HAP emissions (*e.g.*, some units may require DCE-to-NDCE conversion/replacement or conversion to a dry-bottom ESP with dry PM return). As a result of these considerations, DCE recovery furnace conversions/replacements and wet-to-dry ESP conversions for NDCE recovery furnaces are recommended for further analysis under the technology review.

3. Black Liquor Gasification

Black liquor gasification was noted as an emerging technology to replace conventional recovery furnace systems at the time when subpart MM was promulgated. A definition of BLG[7] was added to subpart MM and included in the definitions of "recovery furnace," "kraft recovery furnace," "semichemical combustion unit," and "soda recovery furnace." The preamble to the final rule (66 FR 3187, January 12, 2001) explained that:

> *It is possible that black liquor gasification is a means of reducing gaseous organic HAP emissions from chemical recovery operations that provides environmental benefits (notably energy savings) which are superior to those provided by NDCE recovery furnaces (whether equipped with wet or dry ESP systems). Compared with NDCE recovery furnace performance, development of the proposed gasification technology promises reduced consumption of fossil fuel, increased efficiency in energy conversion and chemical recovery, elimination of the smelt-water explosion hazard (inherent to the*

[7] Black liquor gasification is defined in §63.861 as "the thermochemical conversion of black liquor into a combustible gaseous product."

operation of conventional recovery furnaces), reduced maintenance costs, and significantly lower environmental emissions of criteria pollutants (PM, SO_2, NOx, VOC precursors to ozone, and CO) and greenhouse gases (63 FR 26607, May 8, 2000, Proposed Final Project Agreement for Georgia-Pacific XL Project).

Deployment of BLG technologies was underway at two U.S. pulp mills at the time when subpart MM was promulgated, and was being considered by a third company. Under a Project XL, the Georgia-Pacific stand-alone semichemical pulp mill in Big Island, Virginia began operation of a ThermoChem Recovery International (TRI) low-temperature, steam reforming gasification system in 2004. The system was designed to process 200 tons BLS/day. The concentrated black liquor was pyrolyzed to liberate a combustible gas (primarily hydrogen) which was burned as an energy source to drive the pyrolysis and to produce steam for use elsewhere in the mill. Sodium carbonate pellets were recovered from the process for reuse in fresh pulping liquor. (63 FR 26607, May 8, 2000) This project permanently ceased operation in October 2006 due to reliability issues, and a new NDCE semichemical combustion unit was installed in 2009.[8]

The Weyerhaeuser kraft pulp mill in New Bern, North Carolina began operation of a Chemrec high-temperature gasification unit in 1996 to help meet the chemical recovery needs for the mill. The BLG unit was sized to process 330 metric tons of BLS/day (360 tons BLS/day) and represented an addition of approximately 15 percent to the mill's black liquor recovery capacity. Green liquor produced from the gasifier is used to recover inorganic pulping chemicals in the causticizing process. The fuel gas generated from the BLG unit was burned together with fuel oil and non-condensable gases in a multi-fuel fired boiler. Periods of downtime were part of the operating strategy for the BLG unit. Because the BLG unit only processed a fraction of the mill's black liquor, periods of downtime without upsetting mill production were part of the operating strategy for the BLG. Numerous improvements were made to various systems and components of the BLG to increase efficiency, capacity, availability, and to reduce maintenance costs. For example, new refractory lining material was added to the original reactor vessel in 1999, and a new reactor vessel and lining system were installed in 2003. After 12 years and over 47,000 hours of operation processing 490,000 tons of BLS, the BLG system was idled in 2008[9] and has since been removed from the list of permitted equipment at the mill.

Installation of another BLG demonstration system was explored by the former New Page Escanaba, Michigan kraft pulp mill (now Escanaba Paper Company), but the engineering feasibility project was discontinued after one year (in 2009). The Escanaba system was under consideration for purposes of using the BLG synthesis gas for producing biofuels such as methanol and dimethyl ether (DME).[10,11]

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[8] http://www.netl.doe.gov/research/coal/energy-systems/gasification/gasifipedia/blackliquor

[9] Brown, C., D. Barry, I. Landalv, and R. Stare. *Chemrec Installation at New Bern, NC Mill Demonstrates Benefits of Black Liquor Gasification*. 2009.

[10] Willis, F. *NewPage Joins the Biofuels Set*. Pulp & Paper Magazine, RISI, January 30, 2008. Available at http://legacy.risiinfo.com/magazines/January/2008/PP/NewPage-joins-the-biofuels-set-pp-jan08.html. Accessed April 2016.

[11] *NewPage Opts Out of Biofuel Project at Escanaba Mill*. Paper Age, July 17, 2009. Available at http://www.paperage.com/2009news/07_17_2009newpage_escanaba.html. Accessed April 2016.

Black liquor gasification systems have also been installed outside the U.S., including (1) a TRI mill-scale unit at the Norampac containerboard mill in Trenton, Ontario; and (2) a Chemrec pilot-scale unit at the Smurfit Kappa Kraftliner mill in Piteå, Sweden. (Wisconsin 2004) There are no known full-scale replacements of a kraft recovery furnace system either domestically or internationally. (NCASI 2007) The 2011 ICR sent to all U.S. pulp mills asked for information on BLG systems in operation, but no information was received. A web search was performed to determine if full-scale BLG systems are in the planning or construction stages at U.S. mills, and no indications of planned BLG systems were found. The U.S. Department of Energy (DOE), National Energy Technology Laboratory's Gasification Plant Databases for the U.S. and the world were searched for pending BLG projects and no proposed projects were identified.[12]

Because there are no BLG systems operating at pulp mills in the U.S., actual emissions from BLG systems are not available to analyze for purposes of the 2016 subpart MM technology review. However, efforts to implement full-scale commercialization of black liquor gasification technology are ongoing. The national trade association of the forest products industry, American Forest & Paper Association (AF&PA), has created a special project known as the Agenda 2020 Technology Alliance and aims to improve and accelerate research, and demonstrate and deploy breakthrough technologies. (Agenda-2020 2010) The Agenda 2020 Technology Alliance is in partnership with DOE to improve energy efficiency in the industry's manufacturing process. (Agenda-2020 2010)

Regulatory options for BLG. Should BLG systems come online at U.S. mills in the future, these systems would either replace or supplement the spent liquor processing capacity of existing chemical recovery furnaces or chemical recovery combustion units. Black liquor gasification is defined within subpart MM as part of the 2001-promulgated subpart MM source category. However, continued application of the subpart MM emission limits designed for conventional chemical recovery systems may not be appropriate for the emission points from future BLG systems. For example, the PM emission limit for new kraft recovery furnaces (0.015 gr/dscf at 8 percent O_2) may not be representative of the gas flow conditions at emission point(s) from future BLG systems. The BLG systems explored in the U.S. to date had different designs and end-uses for the syngas produced. The emission point from a future BLG system may be at the outlet of a multi-fuel fired boiler or combustion turbine already subject to emission limits under a separate NESHAP, or there could be one or more BLG system emission points with no currently applicable standards. Permitting authorities reviewing applications for BLG systems may be in the best position to evaluate the magnitude of emissions and applicable control technologies, and to develop case-by-case emission limits for emission points from future BLG systems with various designs and syngas end-uses. Thus, one option to consider for the subpart MM technology review is to remove reference to black liquor gasification from the recovery furnace definitions. Black liquor gasification systems could be addressed in the next 8-year technology review performed by the EPA for subpart MM, should any BLG systems be installed before that time.

[12] United States Proposed Gasification Plant Database (Last Update: March 2016); available at http://www.netl.doe.gov/research/coal/energy-systems/gasification/gasification-plant-databases.

B. Kraft and Soda SDTs

Molten smelt is one of the main products from the combustion of black liquor. Smelt, which is predominantly Na_2S and Na_2CO_3, is formed in the bottom of the recovery furnace. Smelt, at approximately 1900° to 2100°F, filters through the char bed and is continuously discharged through water-cooled smelt spouts into the SDT. In the SDT, smelt is mixed with weak wash water from the recausticizing area to form green liquor, an aqueous solution of Na_2CO_3 and Na_2S. The green liquor is subsequently transferred to the recausticizing area for reprocessing into pulping liquor (*i.e.*, white liquor). (Note: Because soda pulping is a nonsulfur process, the molten smelt and green liquor at soda mills predominantly includes Na_2CO_3.) (EPA 2001)

The SDT is a large, covered vessel located below the recovery furnace. Green liquor is maintained in the tank at a level of about half the depth of the tank. Smelt exiting the recovery furnace is shattered by high-pressure steam or shatter sprays of recirculated green liquor. The steam or shatter sprays break the smelt flow into small droplets and cool the smelt before it falls into and reacts with the liquid in the SDT to form green liquor. Large volumes of steam are generated when the molten smelt and liquid mix. The vapor space above the liquid level provides an opportunity for water vapor and PM resulting from the quenching of smelt to settle out of suspension into the green liquor. An induced-draft fan constantly draws the vapor and entrained PM through an add-on PM control device, generally a wet scrubber. Scrubber water is sprayed into the scrubber and allowed to drain directly into the SDT, where it reacts with smelt to form green liquor. (EPA 2001)

The 2011 ICR, as updated with more recent information from the industry, indicates that there are 161 kraft and soda SDTs in the U.S. The updated ICR data indicate that 153 SDTs have wet scrubbers, and 4 SDTs have mist eliminators (demisters). The remaining 4 SDTs (typically new sources) have vent gases routinely routed through the recovery furnace for incineration control of gaseous pollutants prior to exhausting through the recovery furnace ESP. Two of these 4 SDTs maintain a wet scrubber exhaust vent as an alternative recovery furnace bypass (backup) control method. No organic HAP emissions test data are available for the SDTs controlled by recovery furnaces because emissions from the SDT and recovery furnace are comingled.

The subpart MM PM emission limit (surrogate for HAP metals) for existing SDTs is 0.2 lb/ton BLS. The subpart MM PM limit for new sources with initial startup in 2001 or later is 0.12 lb/ton BLS based on use of a high-efficiency wet scrubber. According to subpart MM §63.860, an SDT is only considered to be new or reconstructed under the NESHAP (subpart MM) if the associated recovery furnace is also new or reconstructed. Permit limits, information from the RBLC and recent stack test data were reviewed to evaluate the SDT PM limit under the current NESHAP technology review. The results of these reviews are summarized in the paragraphs below.

PM permit limits. A separate memorandum documents review of PM permit limits for the SDTs. (EPA 2016b) The existing source NESHAP requires SDTs to limit their PM emissions to 0.2 lb/ton BLS. Of the 161 SDTs for which permits were reviewed, 84 are permitted to meet 0.2 lb/ton BLS, 20 units are permitted to meet the new source NESHAP limit of 0.12 lb/ton BLS, and 3 SDTs are permitted below the new source limit of 0.12 lb/ton BLS (2 of which are credit sources under the PM bubble). Nineteen additional SDTs are permitted with PM limits between 0.12 and 0.2 lb/ton BLS, and many of these are located at facilities that utilize the PM bubble compliance alternative. Twenty-one SDTs that are debit sources under the PM bubble compliance alternative are permitted with a limit above the 0.2 lb/ton BLS subpart MM existing source limit. The limits for SDTs venting to the recovery furnace for incineration control vary depending on the operating mode (*e.g.*, 0.12 or 0.2 lb/ton BLS, or the applicable recovery furnace PM limit). Limits for the remaining units were presented in gr/dscf and were not directly comparable to the subpart MM PM limits.

RBLC. Filterable PM limits lower than the NSPS limit of 0.2 lb/ton BLS were identified for four SDTs listed in the RBLC results. These permit limits were associated with wet scrubber controls and ranged from 0.133 to 0.199 lb/ton BLS. (RTI 2016c)

PM stack test data for kraft SDTs. A sample of 175 SDT filterable PM stack tests performed on 133 SDTs from 2001 to 2011 were compiled to assess the performance of SDTs for the 2014 NSPS technology review. (RTI 2013) These data are relevant for the subpart MM NESHAP technology review and were analyzed in the context of new and existing sources under subpart MM. Most of the filterable PM tests reviewed were conducted using EPA Method 5. A few of the tests reviewed were conducted using ORDEQ5. The sample of PM stack tests reviewed included tests of 5 mist eliminators, 21 packed bed scrubbers, and 148 scrubbers. The test results are presented in Figures C-1 and C-2 in Appendix C. Figure C-1 shows all of the PM stack tests reviewed broken out by control device type and Figure C-2 shows only those SDTs for which multiple tests were available and tabulated. Based on Figure C-1 (and consistent with prior regulatory conclusions), it is apparent that mist eliminators are challenged to meet the subpart MM existing source limit of 0.2 lb/ton BLS and are unable to meet the subpart MM new source limit of 0.12 lb/ton BLS. Packed-bed scrubbers performed within the range of performance for other types of scrubbers and achieved 0.12 lb/ton BLS in most cases. As shown in Figure C-2, most scrubber-controlled SDTs achieved 0.2 lb/ton BLS, with the exception of a few SDTs that are either included as debit sources in the subpart MM PM bubble compliance approach or were tested or retested under different conditions. Many SDTs with scrubbers or packed-bed scrubbers also achieved the new source MACT limit of 0.12 lb/ton BLS. Some of the scrubber-controlled SDTs achieved less than 0.12 lb/ton BLS but did so inconsistently (*e.g.*, in some tests but not in others). It should be noted that most of the SDTs depicted in the figures are not currently subject to limits lower than 0.2 lb/ton BLS.

PM stack test data for the soda SDT. The one remaining soda recovery SDT is a new unit subject to a PM limit of 0.12 lb/ton BLS. Two emission tests are available for this unit. In 2004, recovery furnace and SDT emissions were combined and vented through the recovery furnace ESP during the emissions test, and the system achieved 0.078 lb/ton BLS. The SDT was retested in 2008, when the SDT emissions were routed to their own wet scrubber and no longer combined with the recovery furnace emissions and achieved 0.014 lb/ton BLS.

Regulatory options for PM. Wet scrubbers remain the most-utilized control system for SDTs. Emissions test data for SDTs show that nearly all SDTs have achieved the subpart MM existing source limit of 0.20 lb/ton BLS (with the exception of a few SDTs with mist eliminators and SDTs included as debit sources in the PM bubble compliance option under subpart MM). There were many existing scrubber-controlled SDTs with emissions between the new source limit of 0.12 lb/ton BLS and the existing source limit of 0.20 lb/ton BLS. A review of permit limits indicates that the majority of SDTs were permitted at the existing source limit of 0.20 lb/ton BLS, while many of the units with limits below 0.20 lb/ton BLS were included in calculations for the PM bubble compliance alternative. (EPA 2016b) The practice of routing SDT emissions through the recovery furnace currently has an unquantified effect on PM emissions because no emission test data are available to differentiate SDT emissions from the recovery furnace emissions in systems where the SDT vents through the recovery furnace. Thus, no practices, processes, or controls were identified for further consideration to reduce PM HAP metals emissions from existing or new SDTs.

C. Kraft and Soda Lime Kilns

In kraft and soda pulp mills, the lime kiln is part of the causticizing process, the process in which green liquor from the SDT is converted to white liquor. The function of the lime kiln is to oxidize lime mud (calcium carbonate, $CaCO_3$) to reburned lime (calcium oxide, CaO, known as "quicklime") in a process known as calcining. The CaO produced in the lime kiln is used in the causticizing reactions that take place in the green liquor slaker and causticizers to produce the NaOH used in the kraft white liquor. (EPA 2001)

Prior to calcining, lime mud from the causticizing tanks is washed and dewatered. Lime mud washers reduce the sodium and sulfide content of the lime mud, which lowers TRS emissions from the lime kiln (not applicable for lime kilns at soda pulp mills, which are nonsulfur-based). The lime mud is typically dewatered to about 70 to 85 percent solids using a rotary vacuum precoat drum filter. Rotary lime kilns are commonly used in kraft pulp mills. (EPA 2001)

According to the 2011 ICR, as updated with more recent information from the industry, 130 lime kilns are currently operating in the U.S., including 129 rotary lime kilns and 1 calciner (with an additional lime kiln operating as a backup and using the same control device as one of these kilns).

In a rotary lime kiln, lime mud from the precoat filter is introduced at the feed end (cold end) and flows downward towards the discharge end (hot end). (EPA 2001) Natural gas or residual or distillate fuel oil, either alone or in combination, are the most common fuels used in lime kilns. Solid petroleum coke, waste oil, and tall oil are also burned in some lime kilns as primary or supplemental fuels. In addition, the majority of lime kilns at kraft pulp mills (97 of 130) also burn noncondensable gases (NCGs) from various process vents, and a smaller fraction burn stripper off-gases (SOGs), alone or in combination with NCGs. (RTI 2016d)

The majority of existing lime kilns operate with wet scrubber controls, most of which are venturi scrubbers. The updated ICR data indicate that 89 lime kilns have wet scrubbers, 31 have ESPs, and 10 have ESP-scrubber combinations.

Particulate matter in the exhaust gas from lime kilns is mainly sodium salts, $CaCO_3$ (lime mud), and CaO (lime). (EPA 2001) The NESHAP subpart MM requires PM emissions to be limited to 0.064 gr/dscf at 10 percent O_2 for existing lime kilns and 0.010 gr/dscf at 10 percent O_2 for new and reconstructed lime kilns. In addition to the 2011 ICR data base, permit limits, information from the RBLC and other sources, and stack test data were reviewed in order to evaluate the lime kiln PM limits. The results of these reviews are summarized in the paragraphs below.

PM permit limits.[13] The permit limits for PM from 130 lime kilns were reviewed as described in a separate document. (EPA 2016b) Three kilns are permitted at the subpart MM new source limit of 0.010 gr/dscf. Nearly half of the kilns (59) are permitted to meet the NESHAP PM limit of 0.064 gr/dscf for existing sources. Nineteen kilns have PM limits below the existing source limit of 0.064 gr/dscf, ranging from 0.015 to 0.059 gr/dscf. Even though the NESHAP removed the distinction between kiln fuel types, 17 kilns are permitted with separate limits for periods of gas-fired and liquid fuel-fired burning. The remaining 32 kilns have PM limits above the existing source limit of 0.064 gr/dscf. Kilns with limits extending above 0.064 gr/dscf are debit sources under the PM bubble compliance alternative.

The range of permit limits encompassed all controls, though, in general, lime kilns with ESP or ESP-scrubber controls were more likely to be permitted below the existing source limit of 0.064 gr/dscf than lime kilns with wet scrubbers. Permit limits for lime kilns with scrubbers ranged from 0.010 to above 0.064 gr/dscf. Permit limits for lime kilns with ESPs ranged from 0.010 to 0.13 gr/dscf when fuel oil is used. Permit limits for lime kilns with ESP-scrubber systems ranged from 0.018 to 0.065 gr/dscf. (EPA 2016b)

RBLC and other information sources (RTI 2016c).[14] The RBLC search results found that four lime kilns have filterable PM emission limits below the existing source NESHAP limits ranging from 0.01 to 0.05 gr/dscf based on use of a wet scrubber (0.05 gr/dscf limit), ESP (0.01 and 0.03 gr/dscf limits), and combination ESP-scrubber (0.033 gr/dscf limit). Similarly, STAPPA 2006 and the EC BAT document discussed ESPs and scrubbers as applicable control technologies for lime kilns. The RBLC, EC BAT, and STAPPA documents did not identify any new control technologies beyond those noted in the ICR responses.

PM stack test data.[15] Kraft lime kiln PM stack test data received with the 2011 ICR responses were compiled for analysis as part of the 2014-promulgated NSPS review. (RTI 2013) These data are relevant for the subpart MM technology review. Data from 259 filterable PM stack tests, including several repeat tests, on 116 lime kilns in the U.S. were compiled and analyzed.[16] Test dates ranged from 2001 to 2011. The majority of the tests were performed using

[13] All of the lime kiln PM concentrations in this section are filterable PM concentrations corrected to 10 percent O_2.
[14] *Ibid*.
[15] *Ibid*.
[16] It is noted that additional PM stack test data were received with the 2011 ICR. Generally, the most recent data for each lime kiln were compiled in order to ensure coverage of the population of lime kilns. Additional data were compiled for lime kilns with controls of interest (*e.g.*, ESPs and ESP-scrubber combinations) to understand emissions variability and determine the performance of these systems.

EPA Method 5, though a few were based on ORDEQ5. Test data were reviewed for lime kilns combusting multiple fuels and employing a variety of PM emission controls. The sample of test results included 120 tests of wet scrubbers, 113 tests of ESPs, and 26 tests of ESP-scrubber combinations. The PM tests included 112 tests of gas-fired kilns, 58 tests of oil-fired kilns, 9 tests of gas and oil combined, 13 tests of petroleum coke and gas combined, and 67 additional tests where the kiln fuel type was unspecified.

Appendix B presents graphs of the lime kiln test data. All of the lime kiln tests are shown in Figure B-1 grouped by control system.[17] Figure B-1 shows that ESP and ESP-scrubber combinations often out-perform scrubbers, and that scrubbers would not be expected to meet the MACT new limit of 0.010 gr/dscf. It also shows that ESP-scrubber combinations do not necessarily out-perform ESPs on PM. Figures B-2 through B-4 provide additional resolution of lime kiln PM emissions by process unit and control device type.

Figure B-2 presents the 113 PM stack test results tabulated for 27 ESP-controlled kilns. Test averages (*e.g.*, average of 3 test runs) for each kiln are represented on a separate vertical line, and the x-axis provides a numerical reference for the kiln data table in Appendix D. All of the ESP-controlled kilns achieved compliance with the MACT limit for existing sources. Several of the ESP systems consistently achieved the MACT new source limit of 0.010 gr/dscf. However, some existing ESP systems performed above or both above and below 0.010 gr/dscf in multiple tests. Emissions from existing ESP-controlled lime kilns extended up to 0.058 gr/dscf.

Filterable PM test results (26 tests) for nine lime kilns with ESP-scrubber combination controls are presented in Figure B-3. Like for the ESP-controlled kilns, all of the ESP-scrubber controlled kilns met the MACT limit for existing sources. While several kilns repeatedly achieved 0.010 gr/dscf, there were three kilns that performed both above and below 0.010 gr/dscf. One of these kilns performed below 0.010 gr/dscf when operating both an ESP and scrubber, but performed above 0.010 gr/dscf when operating the scrubber only. Emissions from existing ESP-scrubber controlled lime kilns extended up to 0.057 gr/dscf.

Figure B-4 presents 120 PM test results for 80 scrubber-controlled lime kilns. Most of the scrubber-controlled kilns achieved the existing source MACT limit (0.064 gr/dscf) and the NSPS limit for gas-fired kilns (0.066 gr/dscf). There were some results above the MACT limit; several lime kilns participate as debit sources in the PM bubble compliance alternative. Based on the data in Figure B-4, scrubber-controlled kilns would not be expected to meet a new source limit of 0.010 gr/dscf.

Figures B-5 through B-9 contain the same PM emissions data shown in Figure B-1, and repeated in Figures B-2 through B-4, but show lime kiln PM emissions by both control device and by fuel type. It was necessary to use multiple graphs for a given control system to fit the data on the charts. Some kilns were tested using different fuels and appear in more than one series on the graphs.

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[17] No data table or labels are provided in Figure B-1 because they would be difficult to read with so many data points. The graphs discussed in the remainder of this section show the same data with greater resolution.

Figures B-5 and B-6 show no discernible distinction by fuel type for ESP-controlled kilns firing gas, oil, combinations of gas and oil or gas and petroleum coke, or for unspecified fuels. The oil-fired kilns (and all other kilns) in Figures B-5 and B-6 perform far below the NSPS limit of 0.13 gr/dscf for oil firing. The kilns co-firing petroleum coke had emissions in the same range of the gas and oil-fired kilns. Similarly, in Figure B-7, there appears to be little (if any) difference in the PM emissions by fuel type for kilns with ESP-scrubber combination controls.

Figures B-8 and B-9 present PM emissions by fuel type for scrubber-controlled kilns. The PM emissions from some oil-fired kilns do appear to be slightly higher than for gas-fired kilns in Figure B-8. The kilns co-firing petroleum coke with gas do not reflect PM emissions any higher than the kilns firing gas only. The kilns firing unspecified fuels during emissions testing generally emitted less than the MACT existing source limit of 0.064 gr/dscf.

Table 10 contains PM test data for individual lime kilns that were tested under separate conditions using either gas or oil. Emissions from oil-firing exceeded those from gas firing in three tests of ESP-controlled kilns. No difference in the emissions from gas or oil firing was observed in a test of an ESP-scrubber controlled kiln. Emissions from gas firing exceeded those from oil firing for a scrubber-controlled kiln. Considering all of the data in Table 10 along with the data presented in Figures B-5 through B-9, it appears that control device type has a more significant impact on PM emissions than fuel type combusted. The data are somewhat inconclusive as to whether fuel type plays a significant role in PM emissions.

Table 10. Comparison of Method 5 PM Test Results for Individual Kilns Tested Using Separate Fuels (Gas and Oil)

Description	Test date	PM, gr/dscf at 10 O_2	Duplicate test notes	RTI+EUID	Control device type	% diff. (oil-gas/gas)
Lime Kiln - Cond II	8/6/2009	0.0055	Separate conditions: Cond 2 = gas	111.G-35	ESP	116%
Lime Kiln - Cond. I	8/4/2009	0.0119	Separate conditions: Cond 1 = fuel oil			
Lime Kiln	12/13/2005	0.0039	Separate conditions: No. 6 fuel oil	114.U800	ESP	18%
Lime Kiln	12/14/2005	0.0033	Separate conditions: Natural gas			
Lime Kiln	12/16/2008	0.0011	Separate conditions: gas	114.U800	ESP	64%
Lime Kiln	12/16/2008	0.0018	Separate conditions: oil			
No. 3 Lime Kiln	10/20/2009	0.034	Separate conditions: gas	172.LK03	SCBR	-21%
No. 3 Lime Kiln	10/21/2009	0.028	Separate conditions: oil			
Lime Kiln (Scrubber Outlet) - Firing Gas	5/27/2010	0.005	Separate conditions: gas	178.09P037	ESP/ SCBR	no diff.
Lime Kiln (Scrubber Outlet) - Firing Oil	5/26/2010	0.005	Separate conditions: oil			

Soda lime kiln PM stack test data. One lime kiln is located at a soda pulp mill. The soda lime kiln is a new source under subpart MM subject to a limit of 0.010 gr/dscf at 10 percent O_2. The kiln achieved emissions of 0.00071 gr/dscf at 10 percent O_2 in a 2004 performance test.

Regulatory options for PM.[18] Review of stack test data showed that the subpart MM existing source limit of 0.064 gr/dscf has been demonstrated to be achieved by lime kilns with scrubbers as well as lime kilns with ESPs or ESP-scrubber combinations. Scrubber-controlled kilns would not be expected to meet the subpart MM new source limit of 0.010 gr/dscf. The ESP and ESP-wet scrubber controls typically reduce PM to lower levels than wet scrubbers alone. The ESP-wet scrubber systems did not necessarily perform better on filterable PM than the ESPs alone. Several existing ESP and ESP-wet scrubber controlled kilns consistently met the 0.064 gr/dscf existing source limit, and often met the new source limit of 0.010 gr/dscf. Test results between the existing and new source limit were observed for existing sources with ESP and ESP-wet scrubber systems. No new practices, processes, or controls were identified to provide a technological justification for considering limits for new or existing sources lower than the promulgated subpart MM limits. The emissions data do not support a distinction among fuel types. Thus, no regulatory options for lime kiln PM were identified for further consideration under the subpart MM technology review.

D. Sulfite Combustion Units

The number of U.S. sulfite pulp mills has sharply declined over the past two decades. When subpart MM was proposed in 1998, there were 15 sulfite pulp mills. Today there remain only 3 sulfite mills. No new sulfite mills are projected to come online in the U.S. in the next 5 years. (RTI 2016e)

Of the three remaining sulfite mills, two mills use the NH_3-based sulfite process, and one mill uses the Mg-based sulfite process. One of the NH_3-based sulfite mills is a small business. (RTI 2016b) Based on a review of permits (EPA 2016b) and the ICR data collected by EPA (RTI 2016d), a total of eight sulfite combustion units are currently operated in the U.S. All of these units were installed before 1990, with the oldest installed in 1957 and the most recent installation in 1987. Table 11 summarizes the permit limits and actual performance data reviewed for sulfite combustion units for purposes of the subpart MM technology review.

As shown in Table 11 below, each mill has unique configurations of sulfite combustion units and corresponding site-specific limits. No advances in practices, processes or controls since promulgation of subpart MM were identified for sulfite combustion unit PM. Thus, no regulatory options for sulfite combustion units were identified for further consideration under the subpart MM technology review.

[18] All of the lime kiln PM concentrations in this section are filterable PM concentrations corrected to 10 percent O_2.

Table 11. Summary of Sulfite Combustion Unit PM Permit Limits and Actual Performance

Mill	Sulfite process	Sulfite combustion units	Air pollution control	PM limit[1]	Actual performance[1]
241	NH_3	RF06	Scrubber followed by a series of mist eliminators	0.04 gr/dscf	0.050 gr/dscf (2001) 0.014 gr/dscf (2011) 0.011 gr/dscf (PM CEMS, 2009)
193	NH_3	No. 6 RB (00309) No. 7 RB (00310) No. 8 RB (00311) No. 10 RB (00312)	The 4 recovery boilers vent to 3 absorption towers (where SO_2 is contacted with NH_3 and collected as acid for pulp digestion). The absorbers each vent through a mist eliminator for PM control. According to the 2009 stack test report, RBs 8 and 10 normally operate, while RBs 6 and 7 are used as backup.	0.04 gr/dscf	0.002 gr/dscf (2009) RBs 8 and 10 were tested; RBs 6 and 7 were not operating
700	Mg	RB1 RB2 RB3	RB1 and RB2 flue gases flow from multiclones (for MgO capture) to separate cooling towers, three SO_2 absorption towers in series. RB3 flue gas flows from the multiclones to a cooler/cyclone evaporator, and three venturi SO_2 absorbers in series. Flue gases from all three boilers combine through a common educted venturi scrubber and a common stack (AP-10).[2]	0.10 gr/dscf	0.054 gr/dscf @ 8% O_2, on average[2]
		Hogged fuel dryer (HD-14)	Baghouse A site-specific rule was promulgated on May 19, 2003 under subpart MM to control PM from the hogged fuel dryer in exchange for higher PM permit limit on the RBs. Continuous compliance with the hogged fuel dryer limit is shown with a bag leak detector.	10.0 lb/hr (dryer)	1.21 and 1.51 lb/hr (2012)[2]

1. All gr/dscf values are reported at 8% O_2 unless otherwise specified.
2. Support Document for the Air Operating Permit issued to Cosmo Specialty Fibers, Cosmopolis, WA. State of Washington Department of Ecology. 2013
3. Based on 2009 PM CEMS 1-hour averages recorded in mg/m^3. The values were converted to represent gr/dscf, but it is not clear if the gas flow reported in m^3 was under dry standard conditions, and the concentrations provided are uncorrected for O_2. Thus, actual gr/dscf at 8% O_2 may vary. The maximum value 0.0237 gr/dscf occurred during startup, though it is noted that average emissions during startup and shutdown periods were generally similar to the average emissions under normal operation.

E. Semichemical Combustion Units

When subpart MM was originally proposed, there were 14 semichemical combustion units at stand-alone semichemical pulp mills. Today, there are seven semichemical combustion units in the U.S., six of which are operating. One unit is at a mill that recently closed in November 2015. No new stand-alone semichemical mills are projected to come online in the U.S. in the next 5 years. (RTI 2016e) The following three different types of semichemical combustion units are currently operated (EPA 2001, RTI 2016d):

- *Fluidized-bed reactor.* (2 units, 1 operating) In the fluidized-bed reactor, concentrated black liquor is fired from a single spray gun located at the top of the reactor. As the liquor falls towards the bed, evaporation and some combustion occurs, causing the liquor to pelletize. Fluidizing gas rises through the bed of solid pellets, setting the bed in fluid motion. Soda ash (Na_2CO_3) pellets are recovered from the reactor and stored in silos, until the chemicals are needed to make fresh cooking liquor.

- *Recovery furnace.* (4 units) Semichemical recovery furnaces, like kraft recovery furnaces, are used to recover cooking liquor chemicals by burning concentrated black liquor to produce process steam with the heat of combustion. Semichemical and kraft recovery furnaces are similar in design (with the exception of liquor composition).

- *Rotary liquor kiln.* (1 unit) In the rotary liquor kiln, fuel oil is burned in the lower end. An induced-draft fan at the upper end draws combustion air into the lower end and draws combustion gases through the kiln. Approximately halfway between the lower and upper ends, black liquor is fired into the kiln. Sodium carbonate ash created from contact between black liquor and combustion gases falls to the lower end of the kiln, then is routed to an ash dissolving tank. The combustion gases are routed to a waste heat boiler to produce steam.

Exhaust streams from semichemical combustion units are typically routed through one or more air pollution control devices (APCDs) before being exhausted to the atmosphere. Some APCDs also function as process equipment. For example, venturi scrubbers can also serve as DCEs (which increase the solids content of black liquor). Also, at some mills, the solid material recovered in cyclones and dry ESPs is collected and mixed with black liquor. (EPA 2001)

Table 12 lists the semichemical combustion units by their operating characteristics and presents total hydrocarbon (THC) emissions data from stack test reports. One semichemical mill has installed a thermal oxidizer to reduce HAP emissions from its rotary liquor kiln, and two semichemical mills have installed RTOs to reduce HAP emissions from their fluidized-bed reactors. (RTI 2016d) Unlike a typical thermal oxidizer, the RTO recovers heat from the oxidation of VOC. The heat is recovered by passing the treated gas stream through a bed of ceramic stoneware, prior to exhaust, which heats the bed close to or at the oxidation temperature of the exhaust stream. The gas flow is then reversed, and the inlet gas stream is passed over the heated bed, which preheats the stream prior to oxidation. Oxidation is completed in a central chamber, where a burner system maintains a preset oxidation temperature. (EPA 2001)

The liquor solids production of semichemical combustion units reported in the ICR responses (or in permits) ranged from 0.192 to 1.7 MM lb per day, with a higher heating value of 4,569 to 8,000 Btu/lb. As shown in Table 12, combustion temperatures ranged from 1300 to 1900°F with the fluidized-bed combustors and rotary liquor kiln having lower temperatures, while recovery furnaces had temperatures at the higher end of the range.

A review of permit limits indicated that all semichemical combustion units are subject to the 2.97 lb/ton BLS THC (as carbon) limit specified in subpart MM for existing and new units. As shown in Table 12, performance of the different semichemical combustion units varies considerably for THC. While most units achieve the 2.97 lb/ton BLS THC limit, at least one unit relied on the 90 percent reduction compliance option including in subpart MM to address variability.

No regulatory options were identified for semichemical combustion units for purposes of the subpart MM technology review given that:

- The number of stand-alone semichemical pulp mills and semichemical combustion units in the U.S. is declining (as shown in Table 4);
- The stand-alone semichemical pulping sector represents only a small fraction of the HAP emissions remaining under the subpart MM source category (as shown in Figure 5); and
- No practices, processes, or controls beyond those considered during MACT development have emerged. Several facilities made process or equipment changes to comply with subpart MM. There is considerable site-specific variability in the types of semichemical combustion units, their air pollution controls, and with respect to performance under the current gaseous organic HAP standard for new and existing sources (2.97 lb/ton BLS THC as carbon). Thus, no new options appropriate for application across all semichemical combustion units were identified.

Table 12. Summary of Semichemical Combustion Unit Characteristics and Stack Test Data for THC and PM

Unit ID	Combustion unit type	Evaporator type	DCE type	Combustion temperature (°F)	Control device type	Changes to achieve subpart MM compliance	THC test data, lb/ton BLS as carbon (MM limit = 2.97)
128.N001[1]	FBR	Concentrator	Cyclone	1350	SCBR/PBSCBR/ RTO	No changes required	
141.B25	RF	Concentrator	NA		ESP	High solids firing	0.49, 0.96 (2002)
187.24	RF	BHE/MEE		1500	ESP	Installed new RF with ESP in 2009[2]	0.15 (2009)
244.R7330	Rotary liquor kiln	Concentrator		1300	TO/BH	Added TO	3.5, 92% reduction (2005)
245. X014	RF	Concentrator	NA	1750	DBESP/SCBR/ ABSORBER	No changes required (upgraded in 2001)	0.021 (2006)
247.CPLND	FBR	DCE	Venturi scrubber	1340	SCBR/WESP/ RTO	WESPs and RTO installed	2.59, 1.81, 4.32 (2004) 6.42 (2010)
304.CR05	RF	MEE		1900	ESP		0.053 (2004)

RF = recovery furnace, FBR = fluidized bed reactor, RLK = rotary liquor kiln, SCBR = scrubber, PBSCBR = packed-bed scrubber, RTO = regenerative thermal oxidizer, ESP = electrostatic precipitator, TO = thermal oxidizer, BH = baghouse, DBESP = dry-bottom ESP, WESP = wet ESP

1. Mill closed in November 2015

2. A new recovery furnace system was installed in 2009 to replace a Project XL BLG system.

F. Summary of Technology Review Regulatory Options Recommended for Further Analysis

Section 112(d)(6) of the CAA requires the EPA to "*review, and revise as necessary (taking into account developments in practices, processes, and control technologies), emission standards promulgated under this section no less often than every 8 years.*" This document outlines the section 112(d)(6) review of the subpart MM emission standards promulgated in 2001. Regulatory options recommended for further analysis of costs and impacts as a result of this review are summarized in Table 13.

Table 13. Subpart MM Technology Review Regulatory Options

<table>
<tr><th>Promulgated emission standard</th><th>Existing sources</th><th>New sources</th></tr>
<tr><td>Kraft/soda recovery furnace PM*</td><td colspan="2" rowspan="3">No options. No advances in practices, processes, or controls since promulgation of subpart MM were identified for PM HAP metals. Review of the opacity monitoring limits for recovery furnaces and lime kilns is provided in a separate memorandum (EPA 2016a).</td></tr>
<tr><td>Kraft/soda lime kiln PM*</td></tr>
<tr><td>Kraft/soda SDT PM*</td></tr>
<tr><td>Kraft/soda recovery furnace gaseous organic HAP</td><td>DCE furnaces: DCE-to-NDCE furnace conversions or replacements

NDCE furnaces: Wet-to-dry ESP conversions for NDCE furnaces</td><td>No options. New DCE furnaces are not expected under the promulgated new source standard, and no advances in practices, processes, or controls were identified beyond the basis for the currently promulgated standards (use of an NDCE with a dry ESP system).</td></tr>
<tr><td>Sulfite combustion unit PM</td><td colspan="2">No options. No advances in practices, processes or controls since promulgation of subpart MM were identified for sulfite combustion unit PM.</td></tr>
<tr><td>Semichemical combustion unit gaseous organic HAP</td><td colspan="2">No options. No advances in practices, processes or controls since promulgation of subpart MM were identified for semichemical combustion unit gaseous organic HAP.</td></tr>
</table>

* PM is a surrogate for HAP metals.

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Appendix A. Recovery Furnace PM Emissions Data

List of Figures

*A data table for this figure is provided in Appendix D.

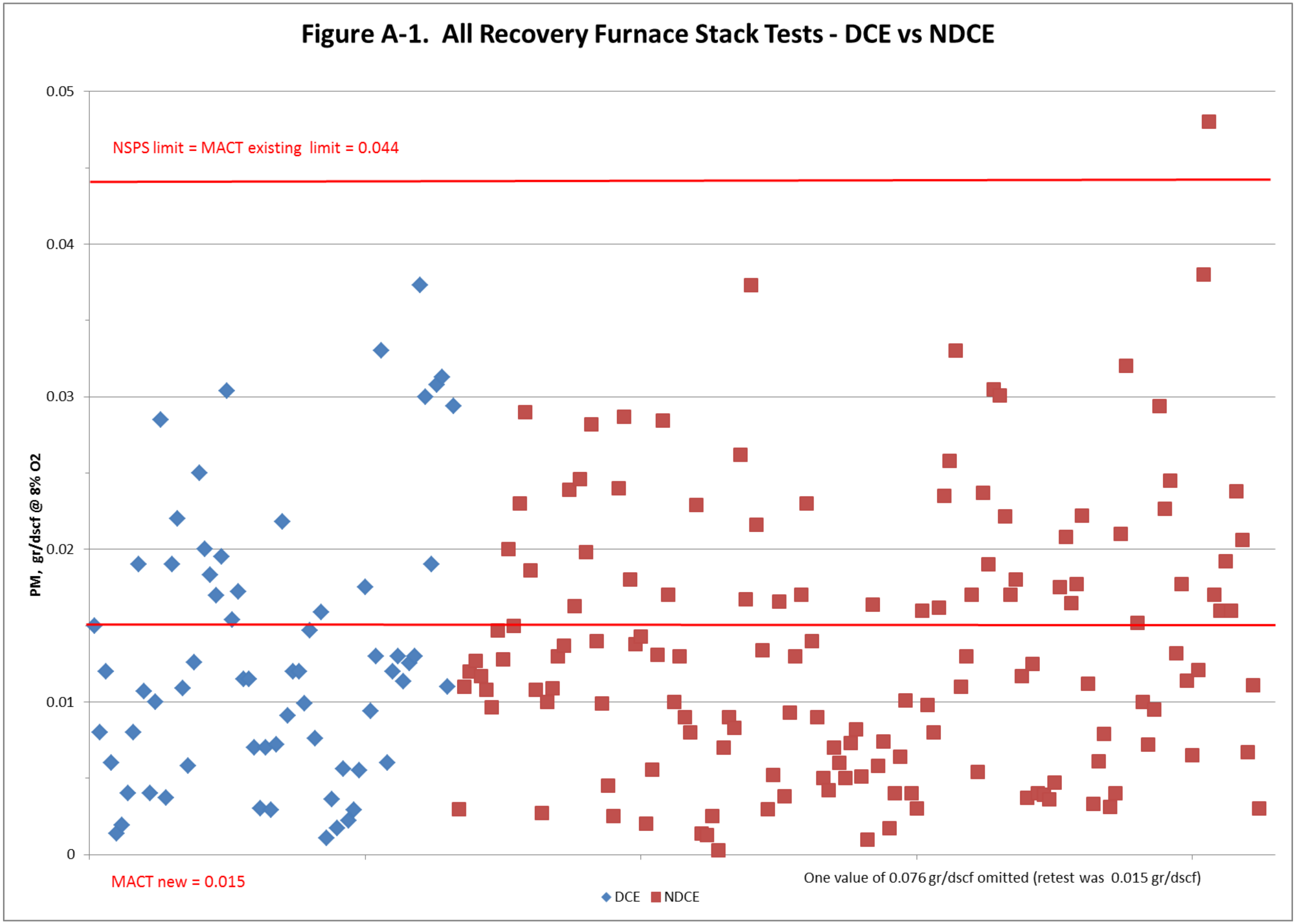
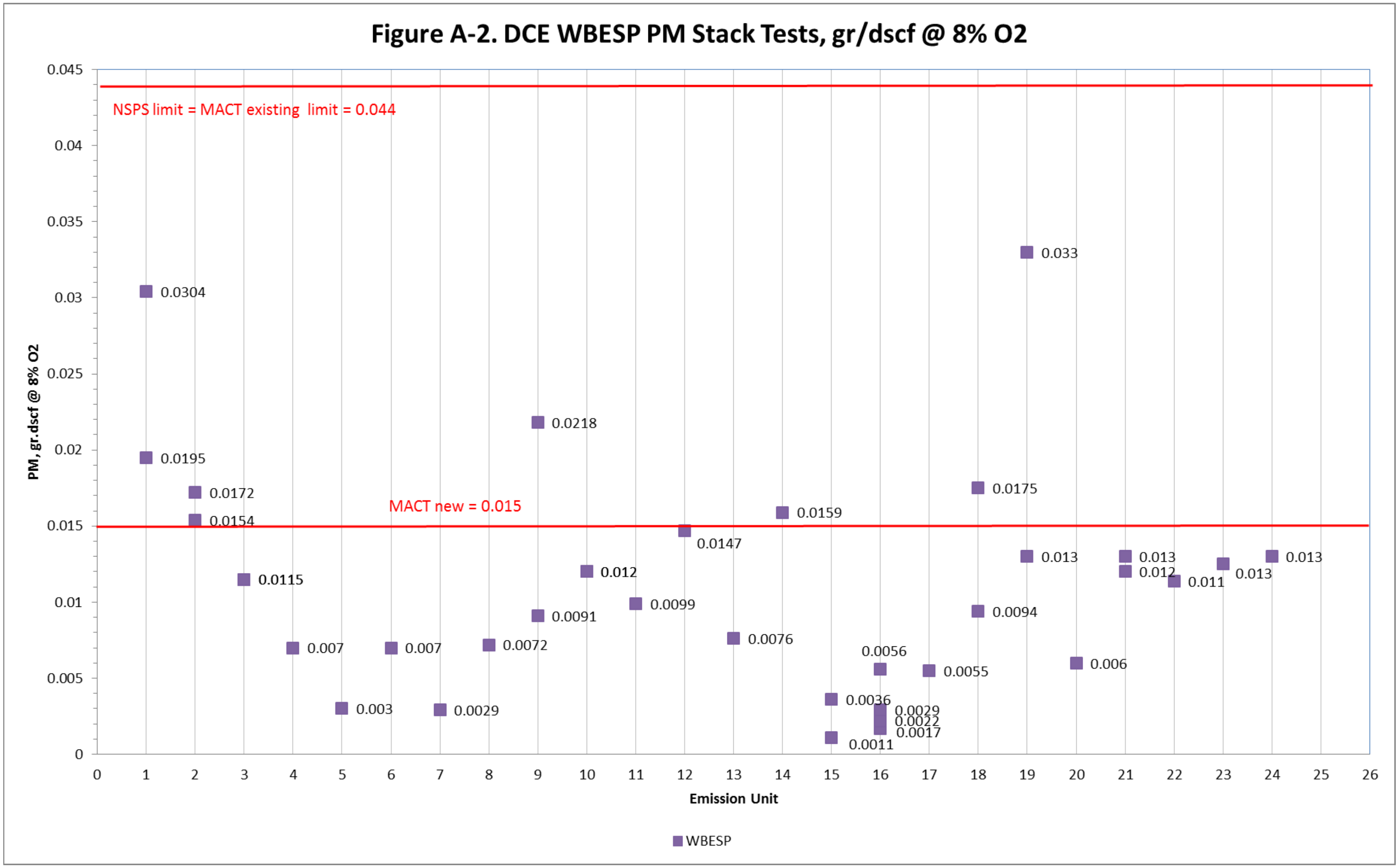
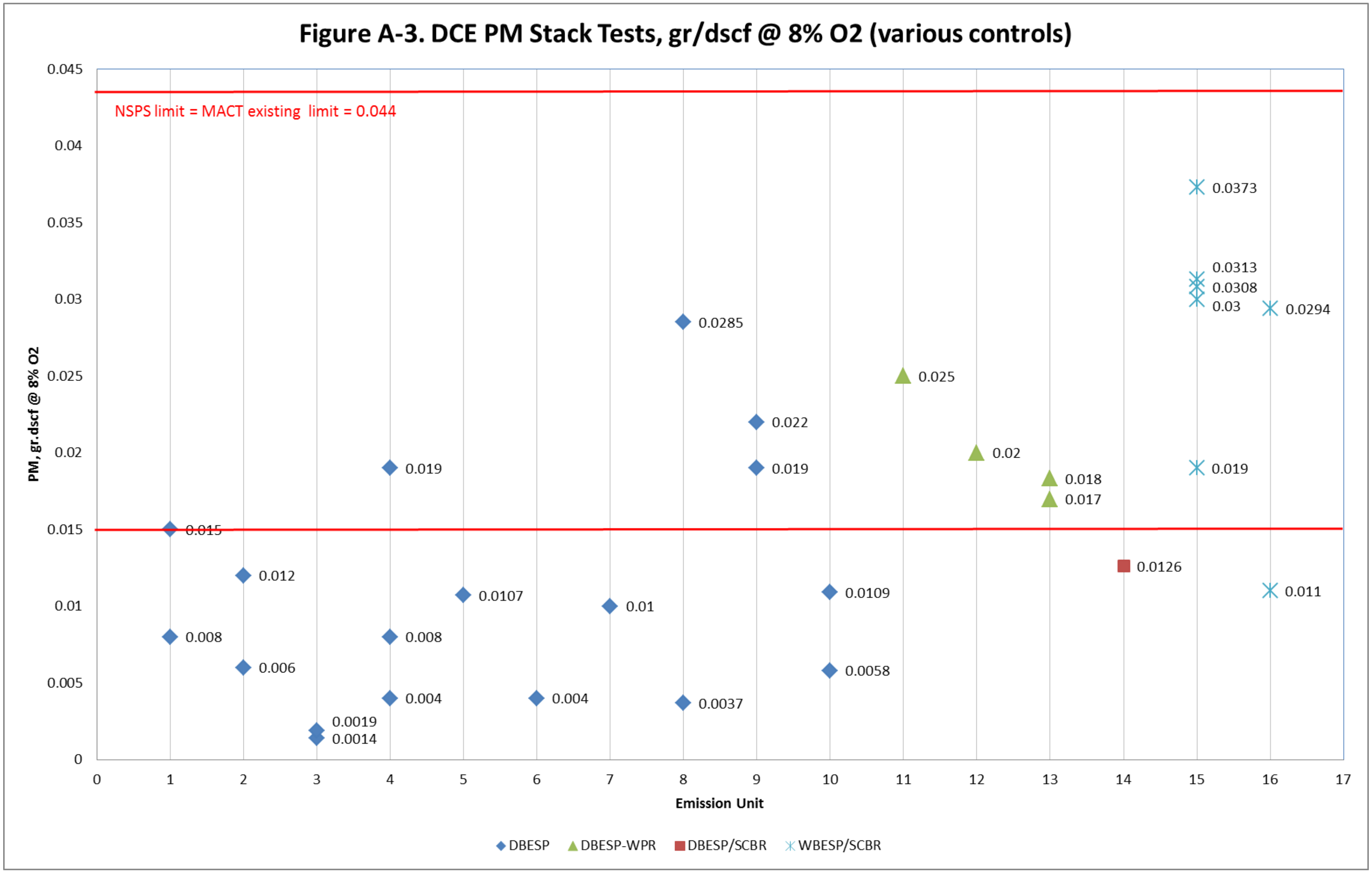


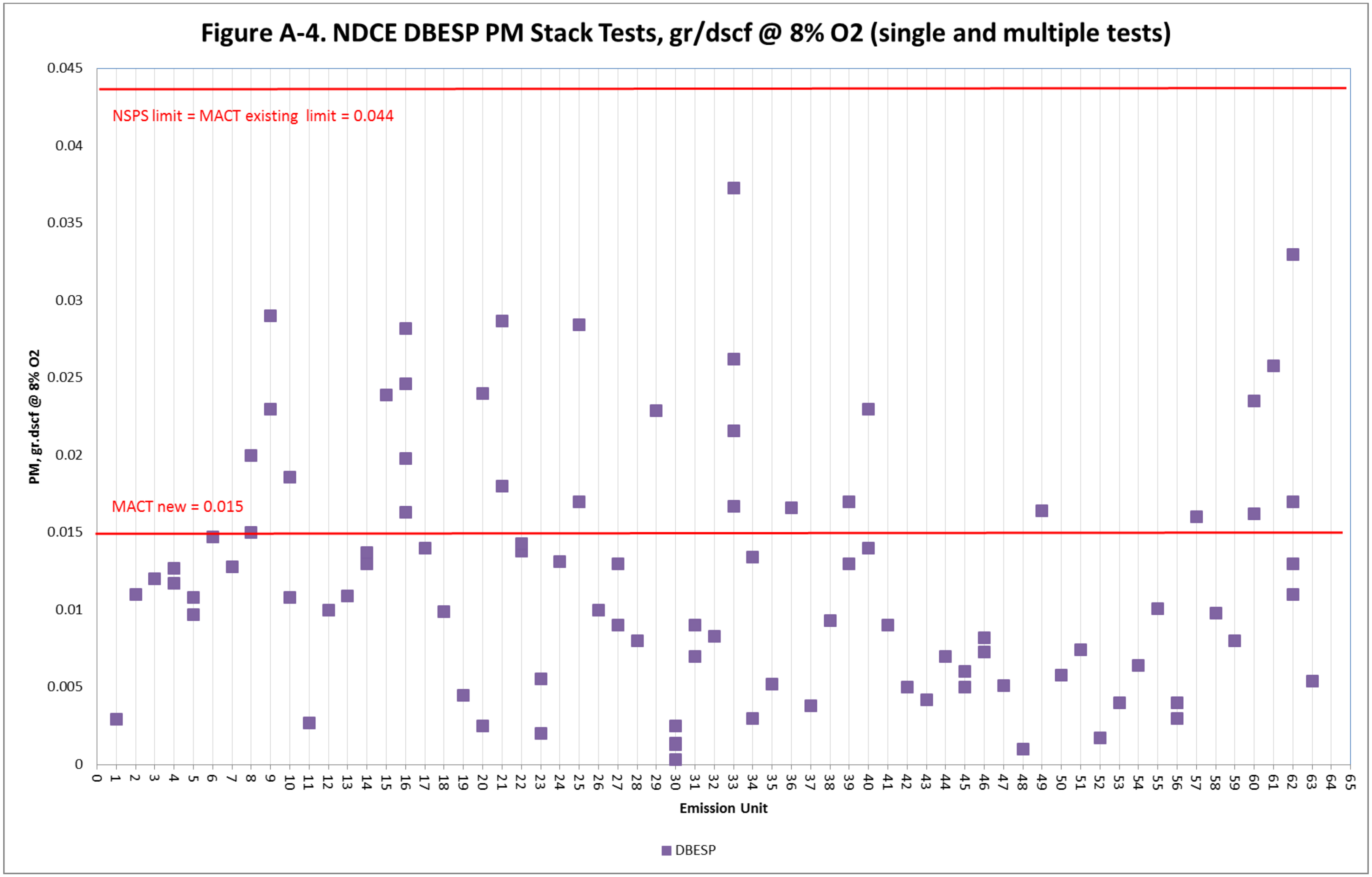
Figure A-1. All Recovery Furnace Stack Tests - DCE vs NDCE
PM, gr/dscf @ 8% O2
0.05
0.04
0.03
0.02
0.01
0
NSPS limit = MACT existing limit = 0.044
MACT new = 0.015
One value of 0.076 gr/dscf omitted (retest was 0.015 gr/dscf)
DCE
NDCE



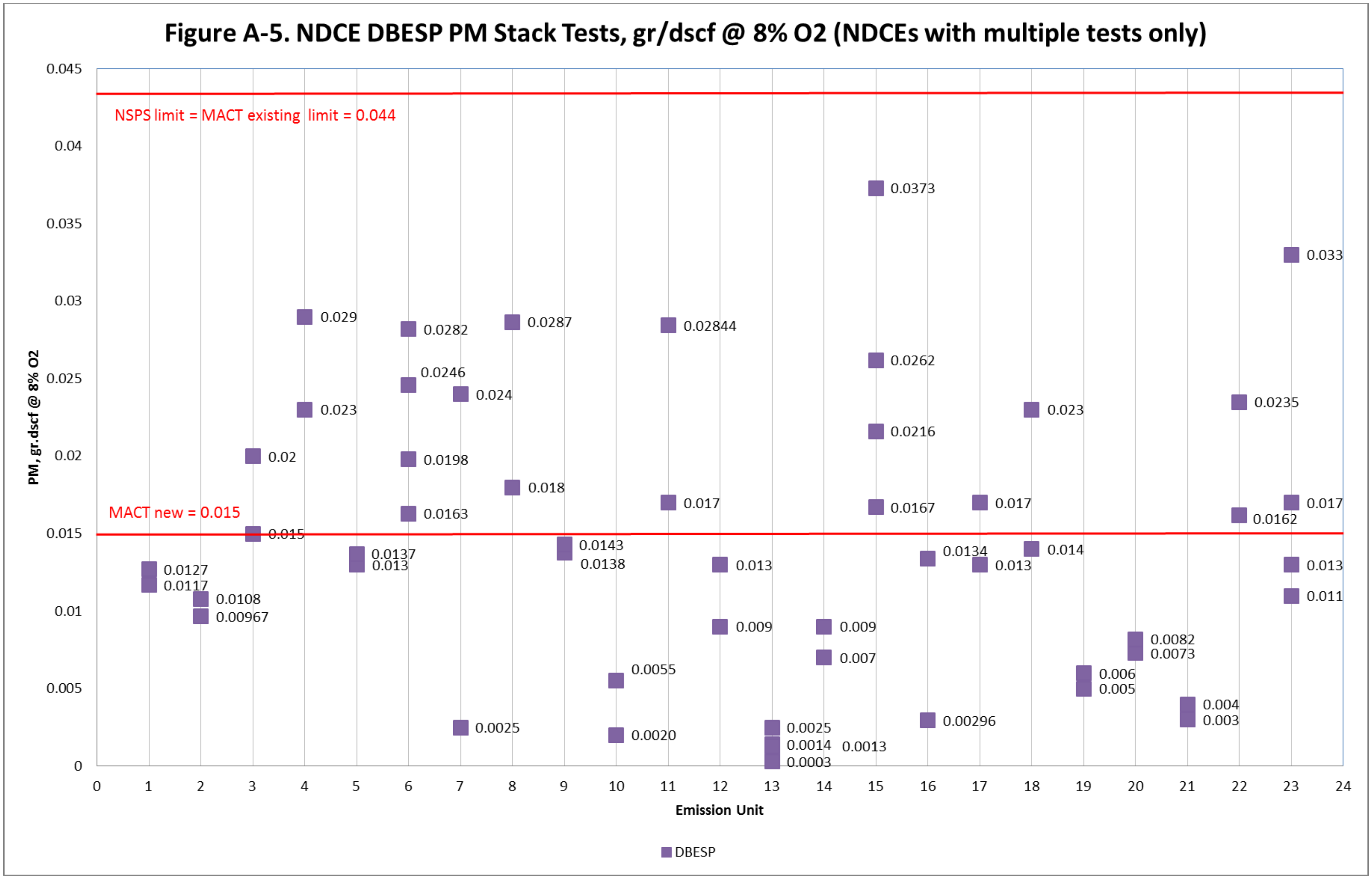
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



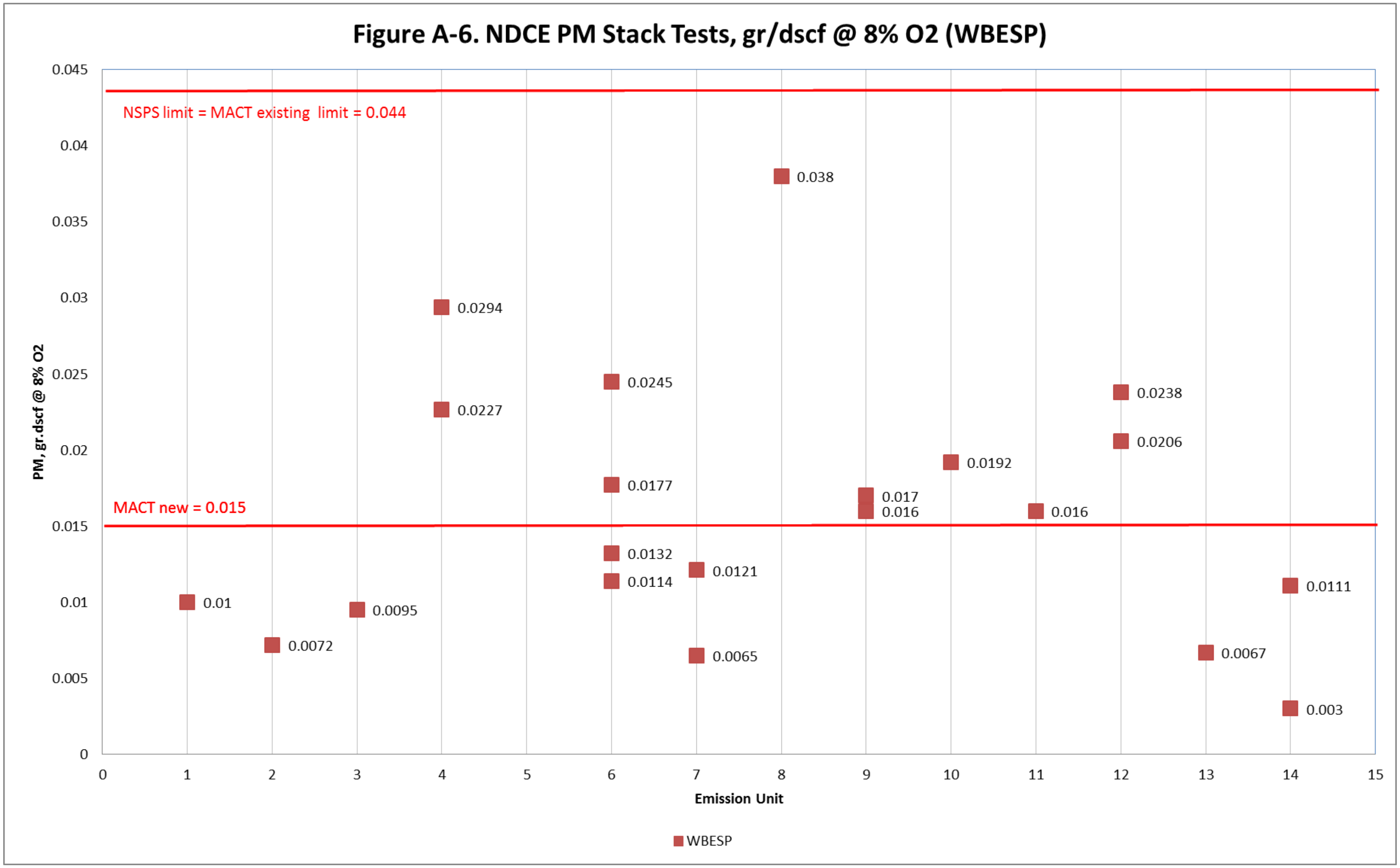
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



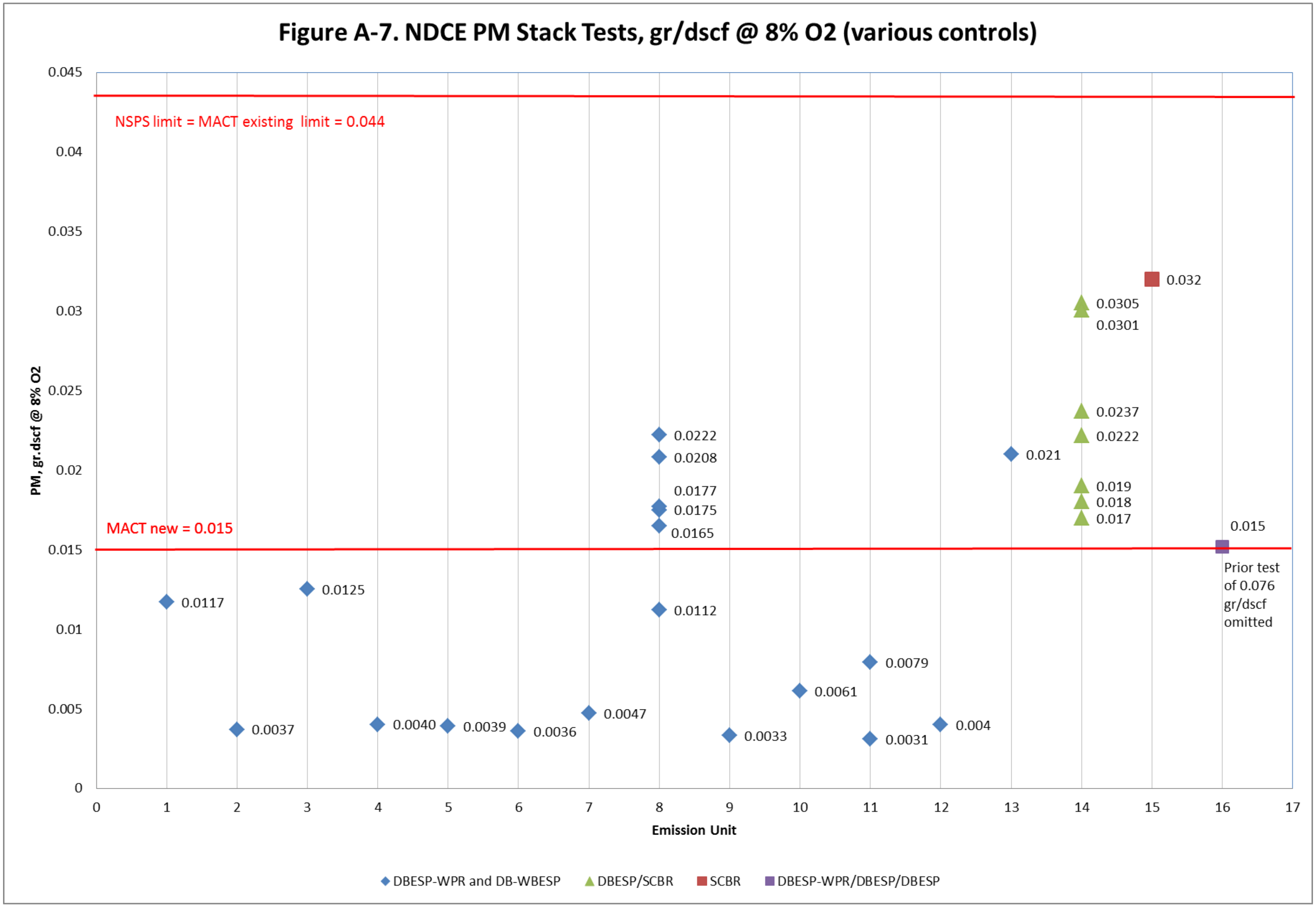
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.

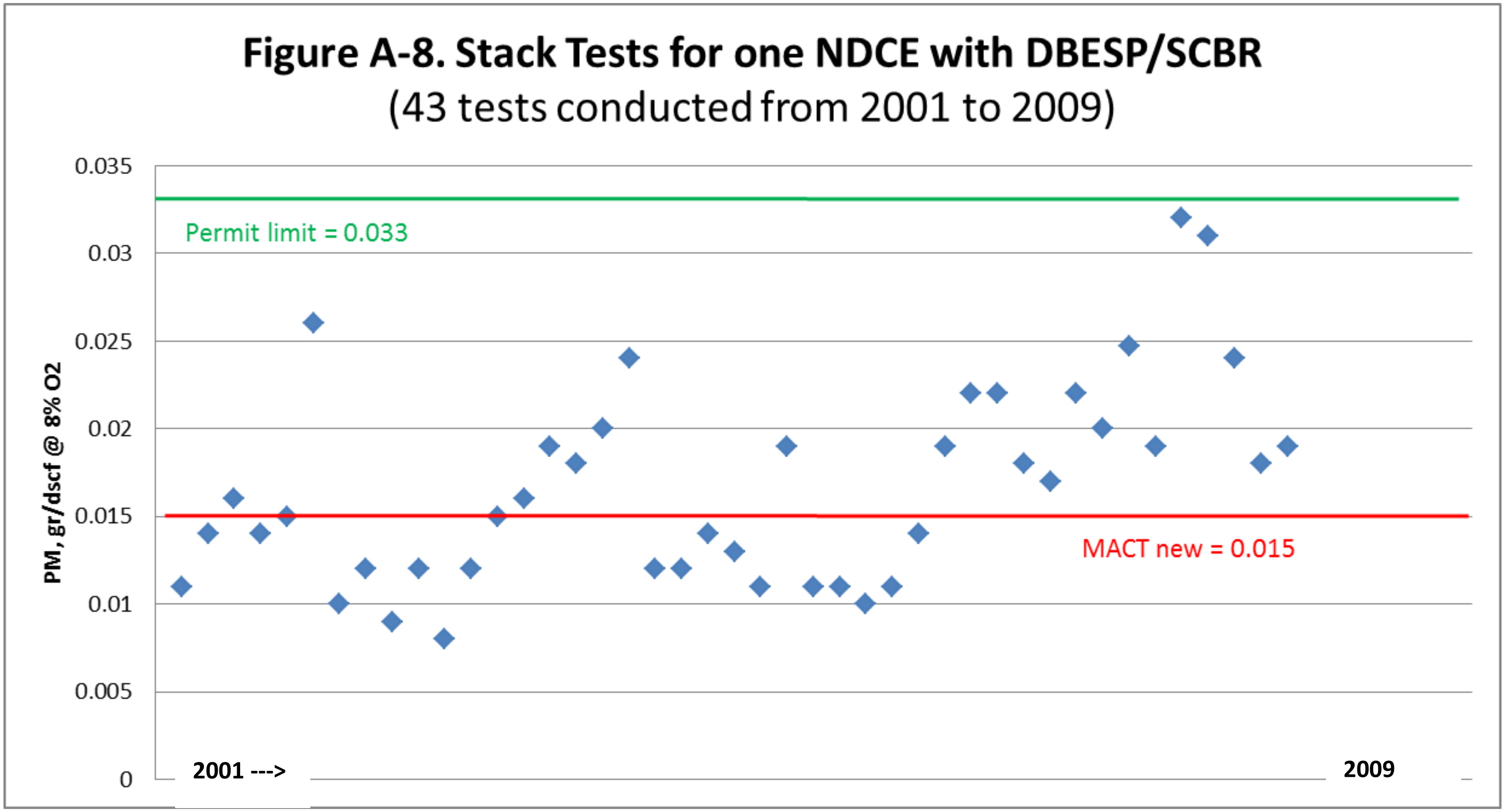


Figure A-8. Stack Tests for one NDCE with DBESP/SCBR
(43 tests conducted from 2001 to 2009)
PM, gr/dscf @ 8% O2
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Permit limit = 0.033
MACT new = 0.015
2001 --->
2009

Appendix B. Lime Kiln PM Emissions Data

List of Figures

*A data table for this figure is provided in Appendix D.

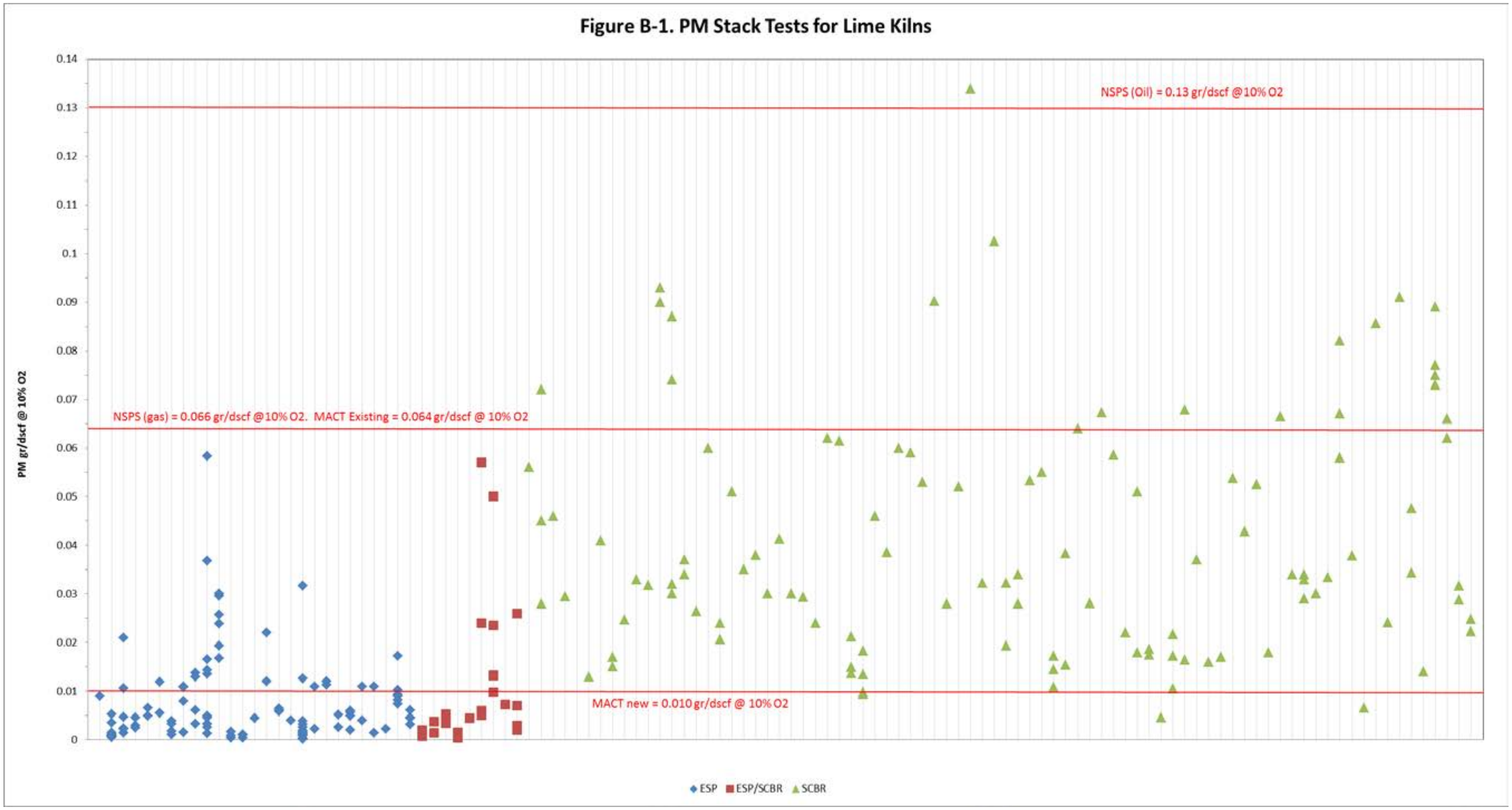
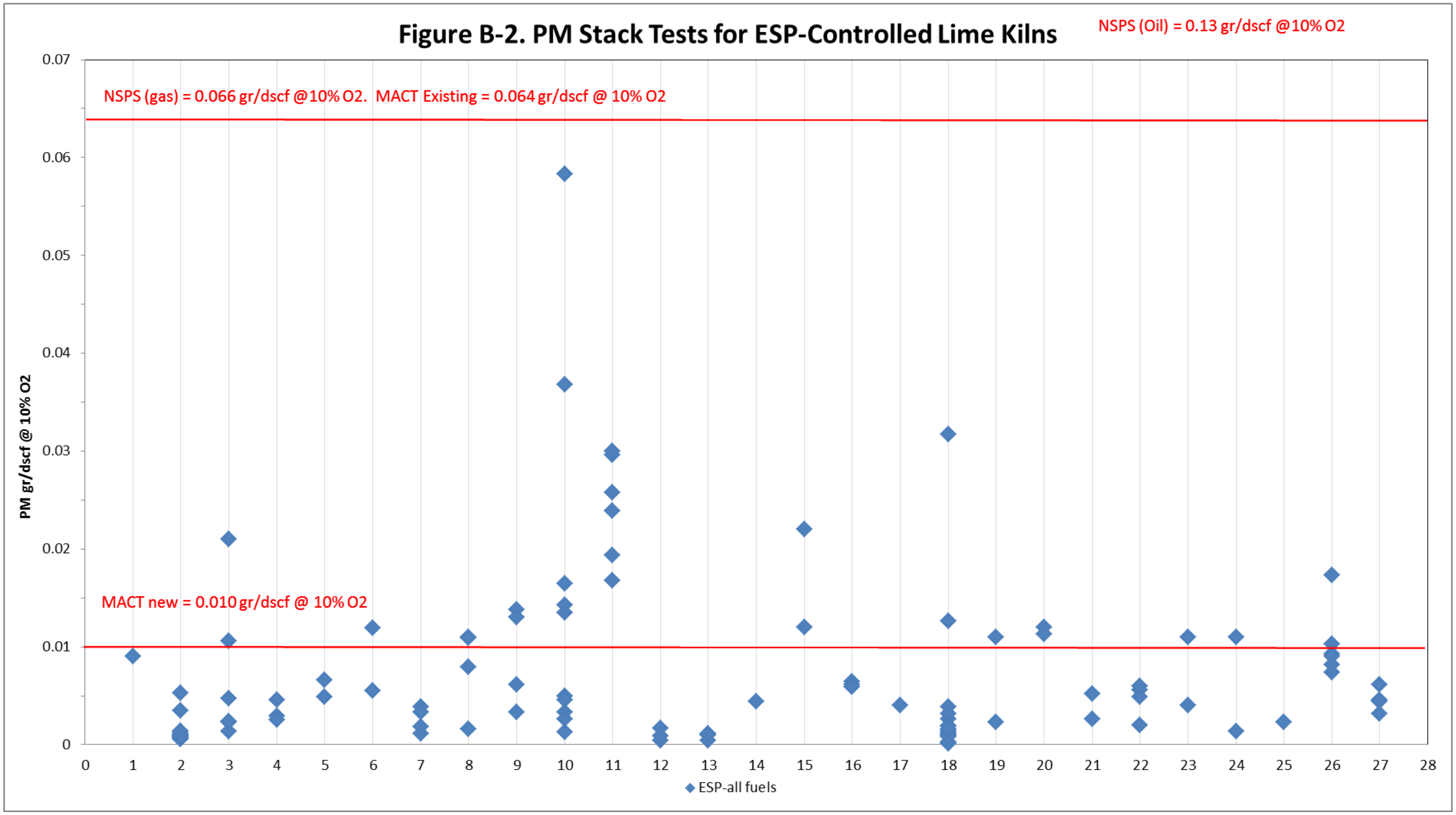
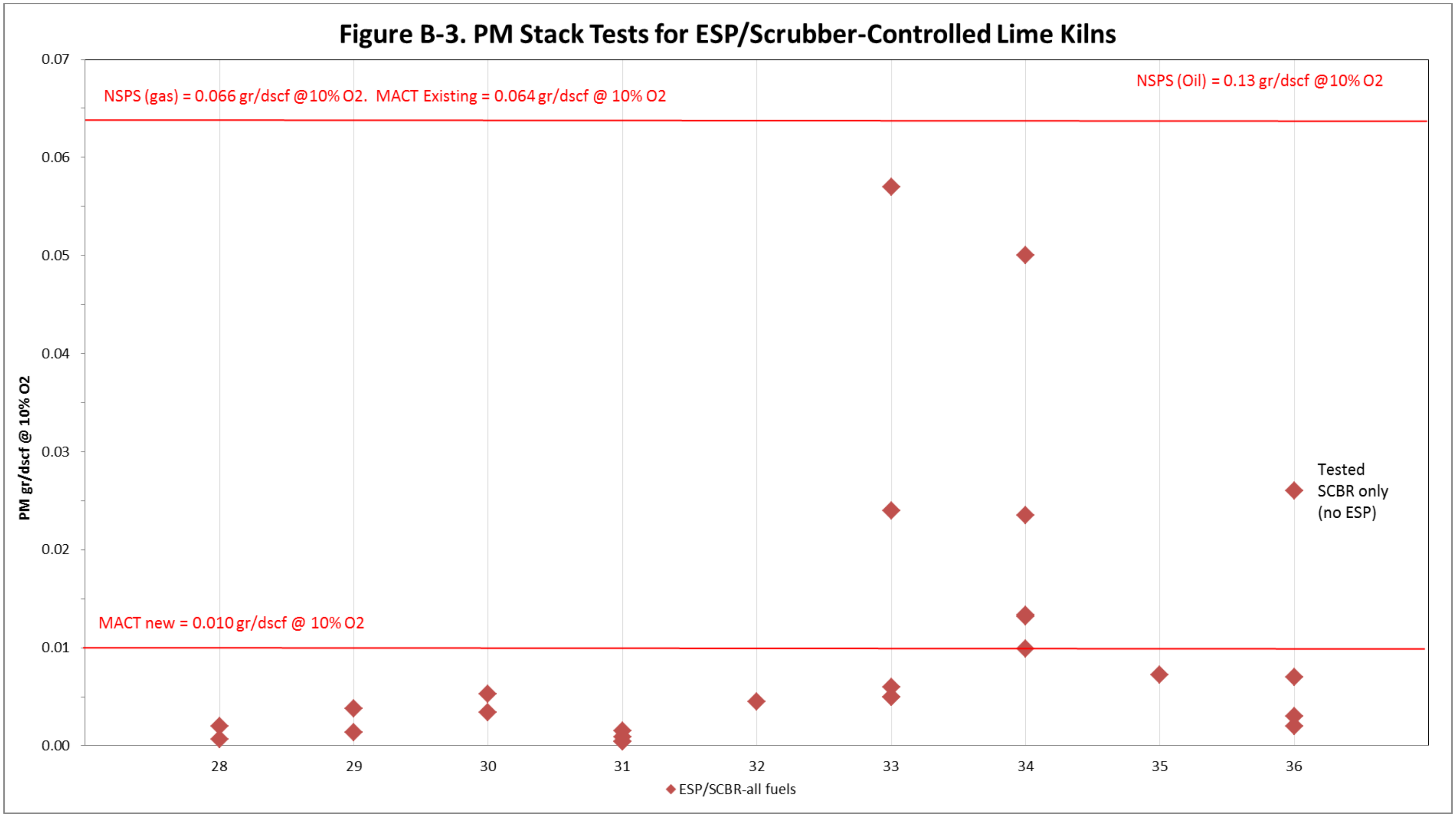


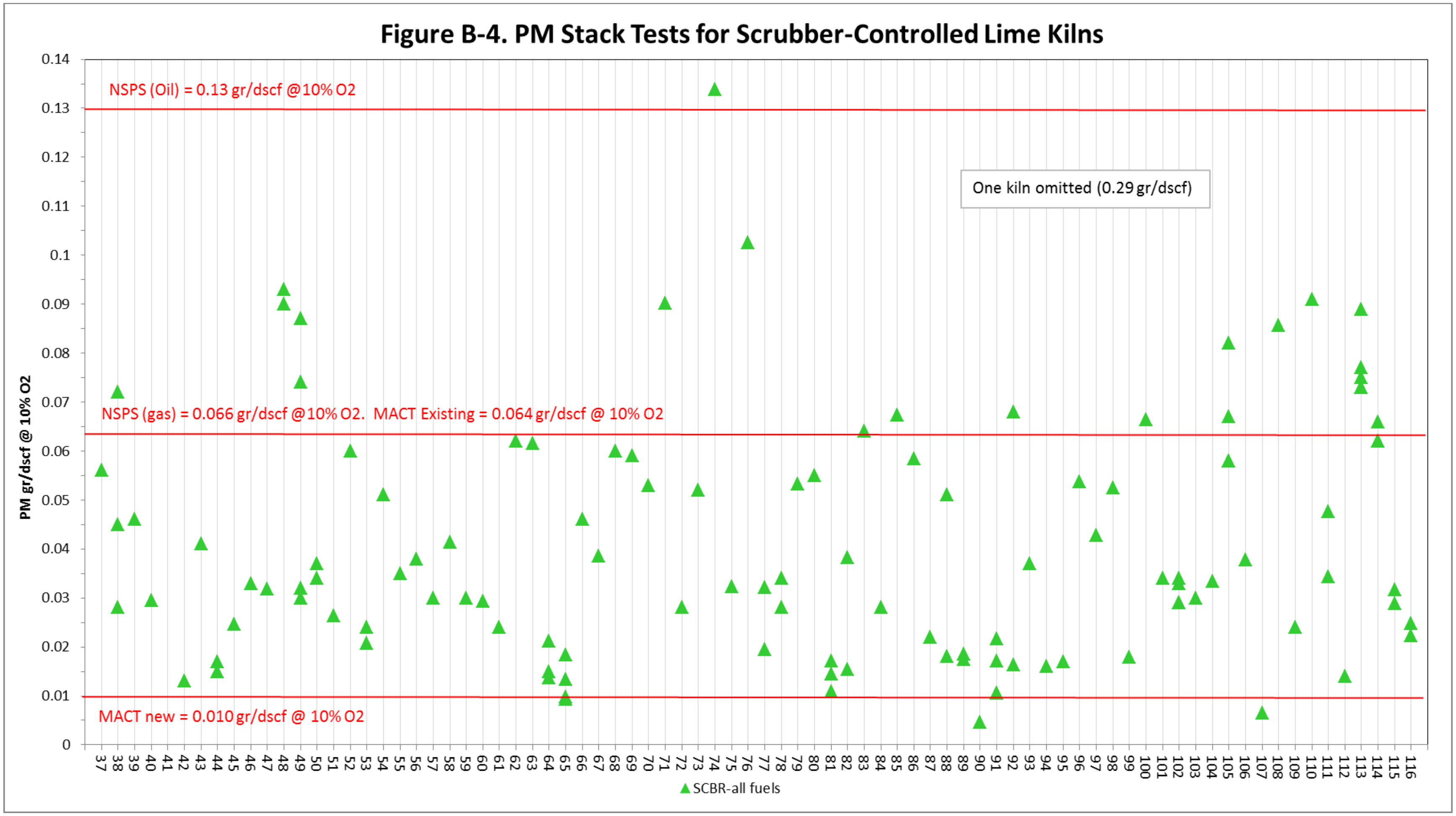
Figure B-1. PM Stack Tests for Lime Kilns
PM gr/dscf @ 10% O2
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
NSPS (Oil) = 0.13 gr/dscf @10% O2
NSPS (gas) = 0.066 gr/dscf @10% O2. MACT Existing = 0.064 gr/dscf @ 10% O2
MACT new = 0.010 gr/dscf @ 10% O2
ESP
ESP/SCBR
SCBR



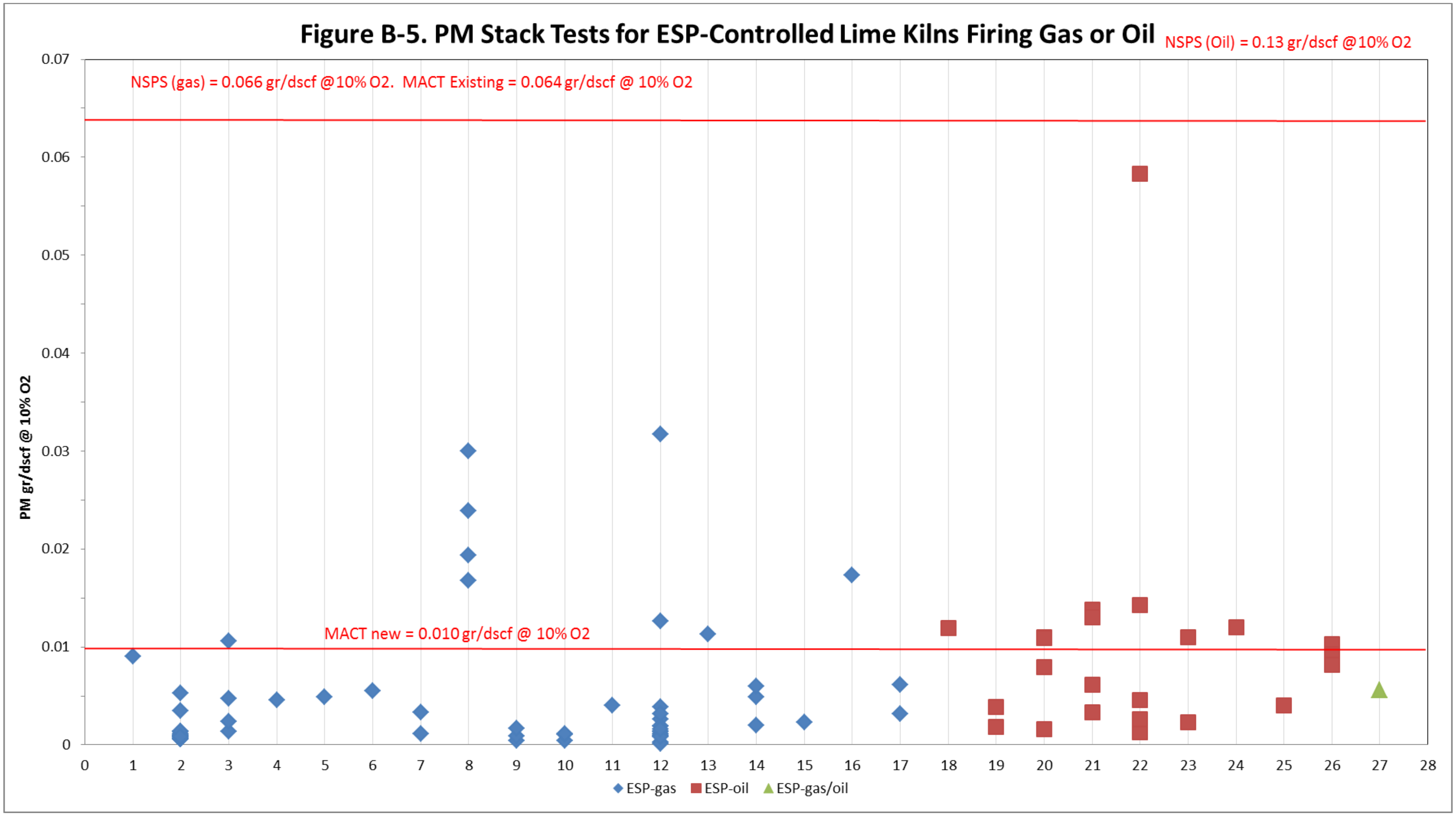
Note: Each vertical line represents one emission unit. Each data point represents each test average (e.g., average of 3 test runs). See Appendix D for a data table.



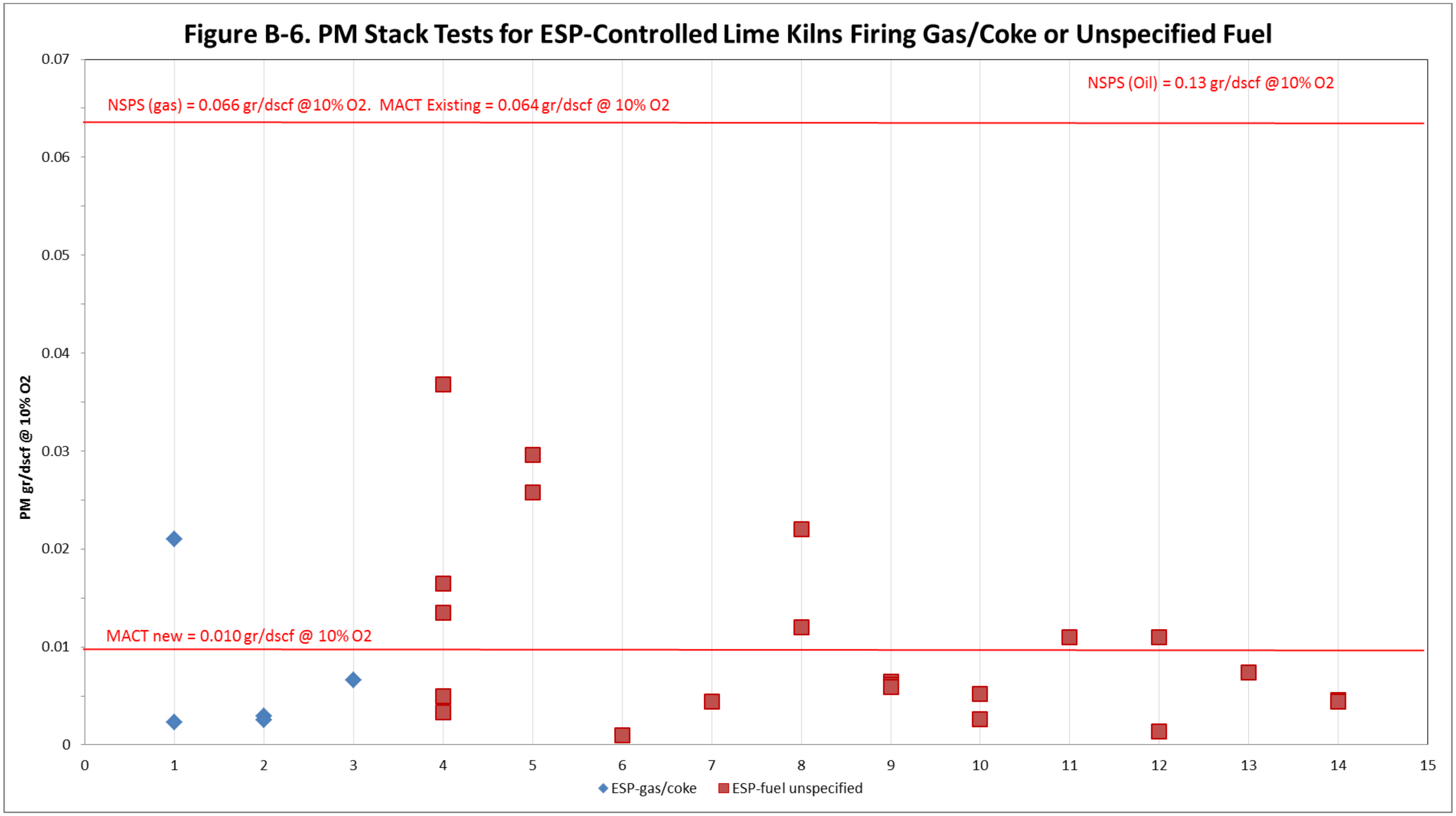
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



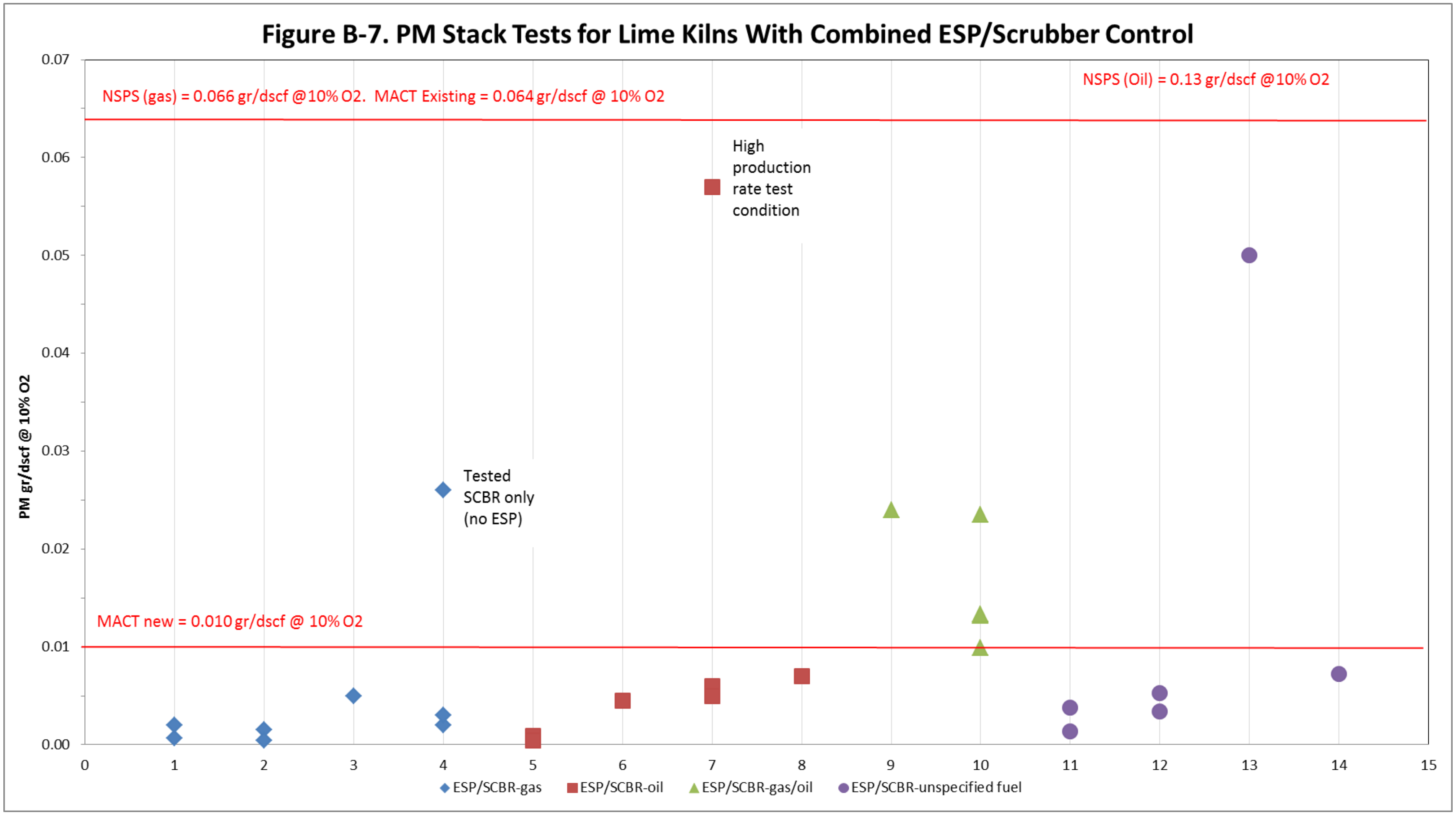
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



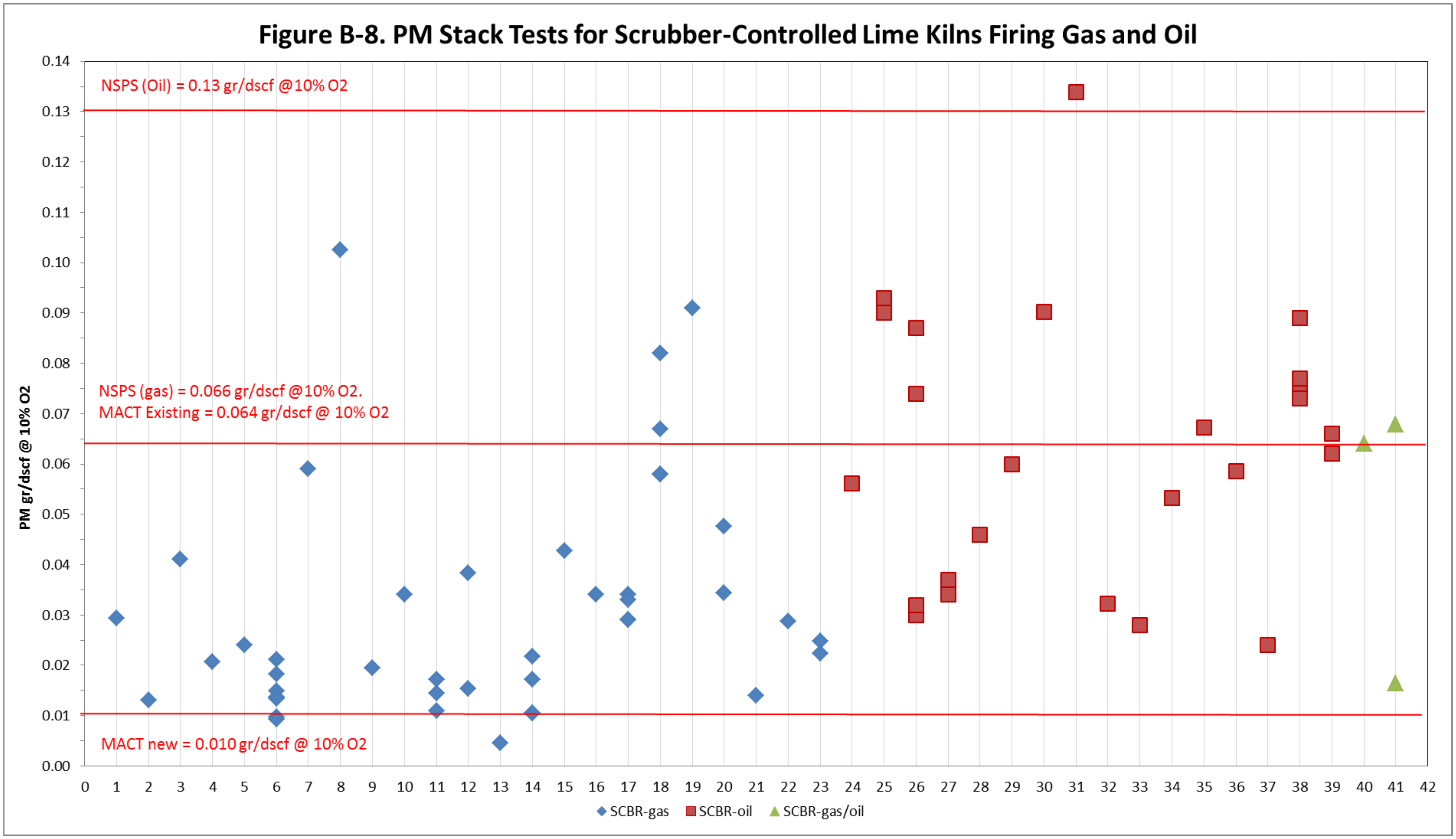
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



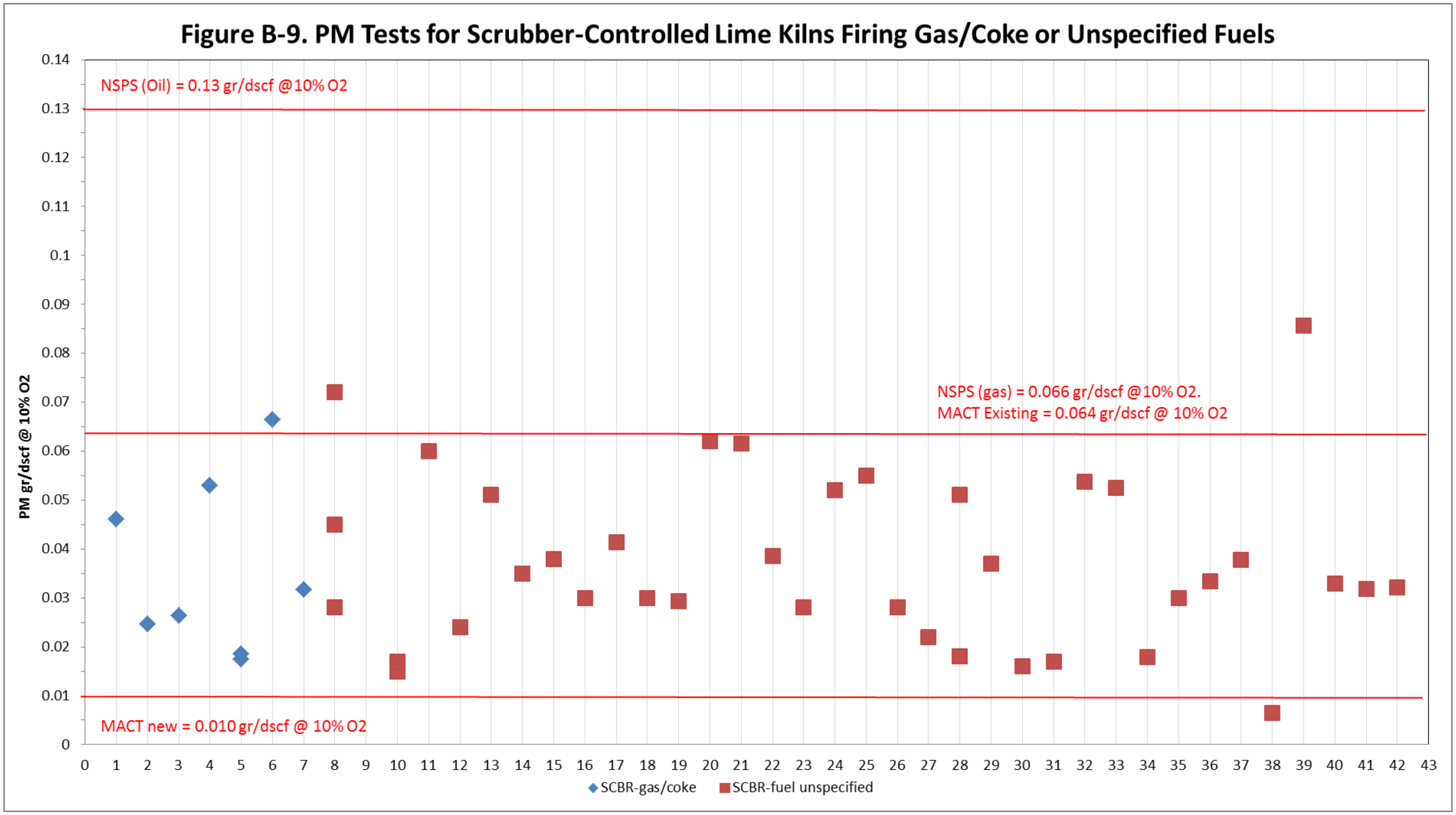
Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table. Note that the same kiln may be represented on multiple vertical lines in Figure B-7 (*e.g.*, separate vertical lines for different fuels).



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.

Appendix C. Smelt Dissolving Tank PM Emissions Data

List of Figures

*A data table for this figure is provided in Appendix D.

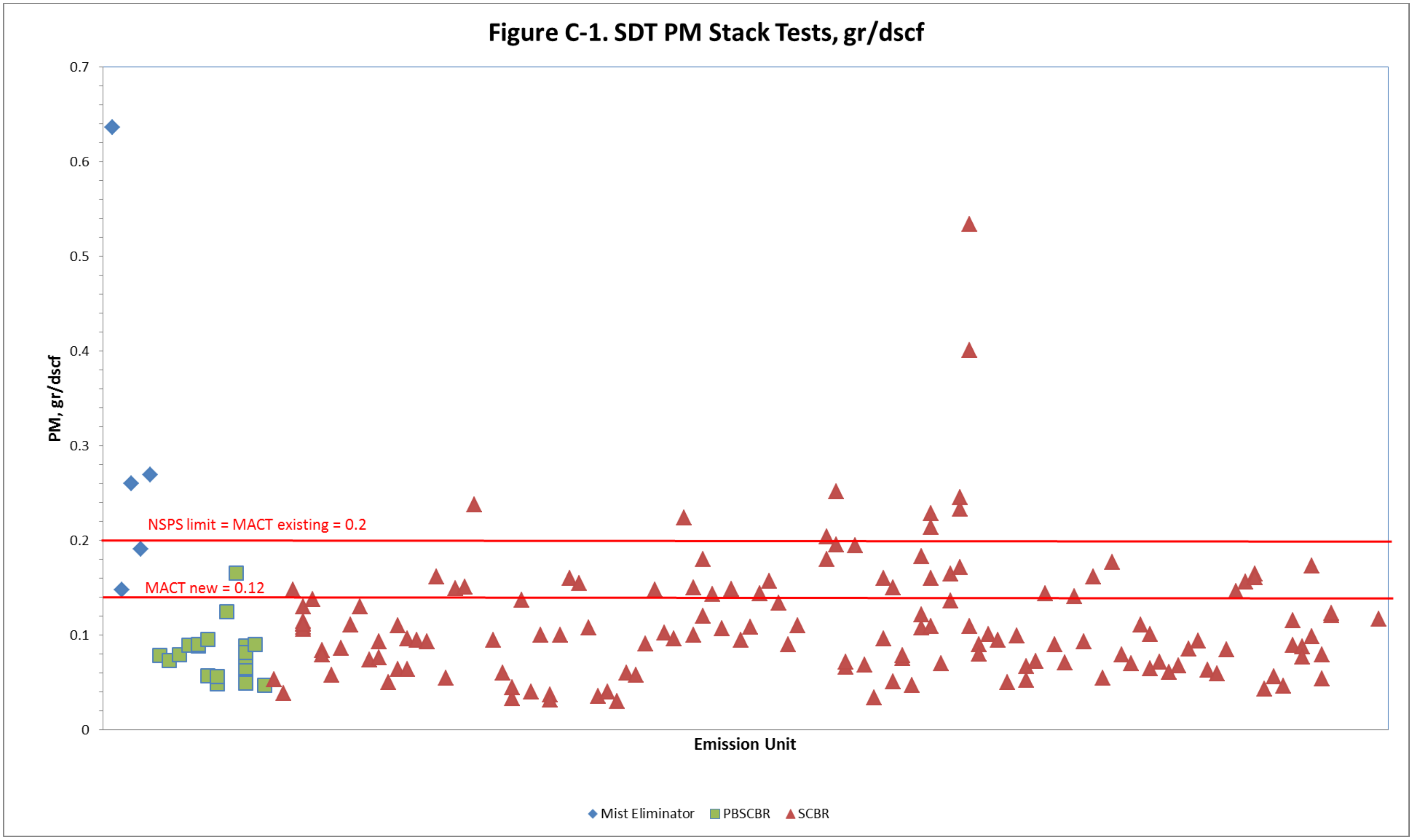
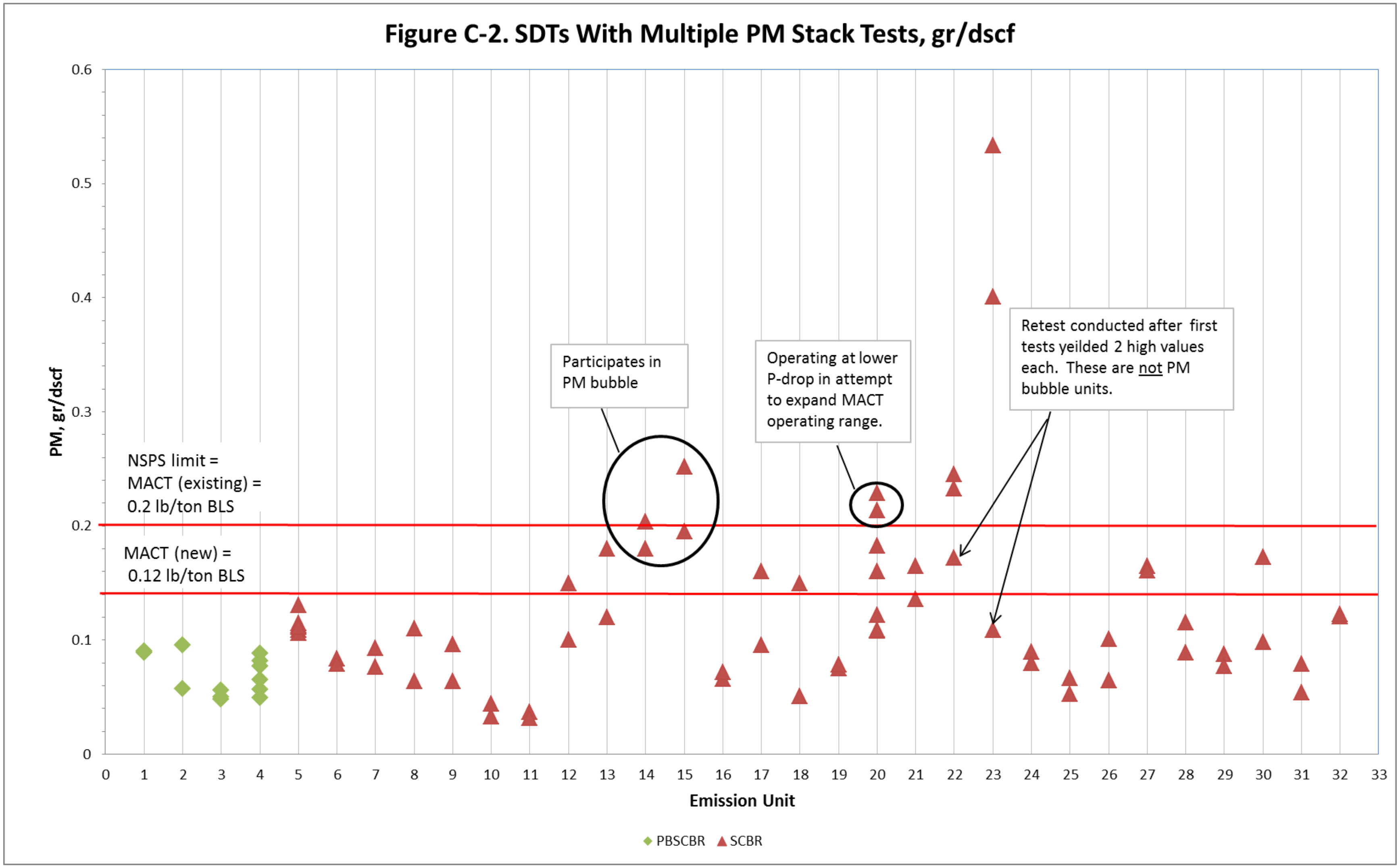


Figure C-1. SDT PM Stack Tests, gr/dscf
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PM, gr/dscf
NSPS limit = MACT existing = 0.2
MACT new = 0.12
Emission Unit
Mist Eliminator
PBSCBR
SCBR



Note: Each vertical line represents one emission unit. Each data point represents each test average (*e.g.*, average of 3 test runs). See Appendix D for a data table.

Appendix D. Data Tables for Selected Figures in Appendices A through C

List of Tables

Data Table for Figure A-2. PM Emissions Test Data for DCE Recovery Furnaces with Wet Bottom ESP (WBESP)

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
RB2 - 2A South stack	11/4/2010	M5	0.0195	3	0	Separate stacks	124.019	1
RB2 - 2B North stack	11/4/2010	M5	0.0304	3	0	Separate stacks	124.019	1
No. 1 RF North stack	6/23/2011	M5	0.0154	3	0	Separate stacks	130.1	2
No. 1 RF South stack	6/23/2011	M5	0.0172	3	0	Separate stacks	130.1	2
No. 2 RF North stack	6/22/2011	M5	0.0115	3	0	Separate stacks	130.2	3
No. 2 RF South stack	6/22/2011	M5	0.0115	3	0	Separate stacks	130.2	3
No. 1 RB	11/3/2009	M5	0.007	3	0		143.7000	4
No. 2 Recovery Furnace	11/3/2009	M5	0.003	3	0		143.7010	5
No. 3 Recovery Furnace	11/4/2009	M5	0.007	3	0		143.7020	6
No. 2 Recovery Boiler	4/22/2009	M5	0.0029	3	0		145.54	7
No. 3 Recovery Boiler	4/22/2009	M5	0.0072	3	0		145.55	8
No. 1 Recovery Furnace Upriver Stack	4/13/2011	M5	0.0218	3	0	separate stacks	146.8	9
No. 1 Recovery Furnace Downriver Stack	4/13/2011	M5	0.0091	3	0	separate stacks	146.8	9
RB North	7/21/2010	M5	0.012	3	0	Separate stacks	205.009	10
RB South	7/21/2010	M5	0.012	3	0	Separate stacks	205.009	10
# 3 Recovery Boiler	2/21/2008	M5	0.0099	3	0		105.EU445A	11
Recovery Boiler 2	9/16/2009	M5	0.0147	4	0		154.P36 - Recovery Furnace 2	12
Recovery Boiler 1	6/21/2011	M5	0.0076	3	0		154.P39 - Recovery Furnace 1	13
RB 1 and RB 3 Common Stack	3/16/2010	M5	0.0159	3	0	Common stack (represents 2 RFs)	154.P39 and P37 - Recovery Furnace 1 and Recovery Furnace 3	14
Recovery Furnace 18	3/4/2010	M5	0.0011	3	0	different dates w/in same year	156.RF18	15
Recovery Furnace 18	7/28/2010	M5	0.0036	3	0	different dates w/in same year	156.RF18	15
Recovery Furnace 19	5/12/2010	M5	0.0017	3	0	different dates w/in same year	156.RF19	16
Recovery Furnace 19	9/22/2010	M5	0.0056	3	0	different dates w/in same year	156.RF19	16
Recovery Furnace 19	11/4/2010	M5	0.0022	3	0	Two 3-run tests on same day - reason unspecified	156.RF19	16
Recovery Furnace 19	11/4/2010	M5	0.0029	3	0	Two 3-run tests on same day - reason unspecified	156.RF19	16

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 1 Recovery Furnace	6/1/2011	M5	0.0055	3	0		163.RF1901	17
No. 1 Recovery Furnace Stack A	7/14/2009	M5	0.0175	3	0	separate stacks	166.RB01	18
No. 1 Recovery Furnace Stack B	7/14/2009	M5	0.0094	3	0	separate stacks	166.RB01	18
Recovery Furnace North ESP (Wet bottom)	1/18/2011	M5	0.013	3	0	Separate stacks	167.005RB	19
Recovery Furnace South ESP (Wet bottom)	1/18/2011	M5	0.033	3	0	Separate stacks	167.005RB	19
Recovery Boiler 1	6/9/2011	M5	0.006	3	0		188.014RB1	20
Recovery Boiler 2	9/14/2010	M5	0.012	3	0	Separate methods (M5)	188.016RB2	21
Recovery Boiler 2	9/14/2010	OR DEQ M5	0.013	3	0	Separate methods (ORDEQ5)	188.016RB2	21
Recovery Boiler 10	11/14/2007	M5	0.011	3	0		206.G-31	22
Recovery Boiler 11	11/15/2007	M5	0.013	3	0		206.G-32	23
No. 2 Recovery Furnace	11/2/2010	M5	0.013	3	0		600.G0803*	24

*Facility closed.

Data Table for Figure A-3. PM Emissions Test Data for DCE Recovery Furnaces with Various Controls

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
No. 1 Recovery Furnace	10/29/2002	M5	0.015	3	0		121.000013	DBESP	1
No. 1 Recovery Furnace	8/23/2004	M5	0.008	3	0	different years	121.000013	DBESP	1
No. 2 Recovery Furnace	10/30/2002	M5	0.012	3	0		121.000014	DBESP	2
No. 2 Recovery Furnace	8/19/2004	M5	0.006	3	0	different years	121.000014	DBESP	2
No. 1 Recovery Boiler (South 1A)	11/3/2010	M5	0.0014	3	0	separate stacks	124.001	DBESP	3
No. 1 Recovery Boiler (North 1B)	11/3/2010	M5	0.0019	3	0	separate stacks	124.001	DBESP	3
Recovery Furnace 4 (two chambers operating) (Condition #1)	12/2/2003	M5	0.004	3	0	Separate conditions: Recovery Furnace 4 (both ESP chambers and all fields operating) (Condition #1)	131.5	DBESP	4
Recovery Furnace 4 (one chamber operating) (Condition #2 and #3)	12/3/2003	M5	0.008	3	0	Separate conditions: Recovery Furnace 4 (1-2 fields out of service) (Condition #2 and #3)	131.5	DBESP	4
Recovery Furnace 4	12/5/2003	M5	0.019	4	0	Separate conditions: Recovery Furnace 4	131.5	DBESP	4
No. 20 Recovery Boiler	12/1/2010	M5	0.0107	3	0		119.EQT008	DBESP	5
No. 2 Recovery Boiler	6/26/2003	M5	0.004	3	0		142.CU7214	DBESP	6
No 2 Recovery Boiler	6/9/2009	M5	0.01	3	0		175.RB2A	DBESP	7
Recovery Boiler 3	10/25/2010	M5	0.0285	3	0	Separate conditions	606.RB3	DBESP	8
Recovery Boiler 3	10/26/2010	M5	0.0037	3	0	Separate conditions	606.RB3	DBESP	8
No. 1 RB ESP - Left Side ESP	10/28/2009	M5	0.019	3	0	Separate stacks	613.001L	DBESP	9
No. 1 RB ESP - Right Side ESP	10/28/2009	M5	0.022	3	0	Separate stacks	613.001R	DBESP	9
No. 2 RB ESP - Left Side	10/27/2009	M5	0.0109	3	0	Separate stacks	613.002L	DBESP	10
No. 2 RB ESP - Right Side	10/27/2009	M5	0.0058	3	0	Separate stacks	613.002R	DBESP	10
Recovery Boiler 2	7/8/2009	M5	0.025	3	0		171.002	DBESP-WPR	11
Recovery Boiler 3	7/9/2009	M5	0.02	3	0		171.003	DBESP-WPR	12
Recovery Boiler - East	12/16/2010	M5	0.018	3	0	Separate stacks	171.004	DBESP-WPR	13

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Recovery Boiler - West	12/16/2010	M5	0.017	3	0	Separate stacks	171.004	DBESP-WPR	13
Recovery Boiler	9/19/2008	M5	0.0126	3	0		197.2	DBESP/SCBR	14
Recovery Furnace - Condition 1 (Operating 5 ESPs)	3/7/2007	M5	0.0373	3	0	Separate conditions: Recovery Furnace - Condition 1 (Operating 5 ESPs)	152.03	WBESP/SCBR	15
Recovery Furnace - Condition 2 (Operating 6 ESPs)	3/9/2007	M5	0.03	3	0	Separate conditions: Recovery Furnace - Condition 2 (Operating 6 ESPs)	152.03	WBESP/SCBR	15
Recovery furnace scrubber inlet and outlet	3/29/2001	M5	0.019	3	0	different dates	152.03	WBESP/SCBR	15
Recovery furnace	9/1/2004	M5	0.0308	3	0	different dates	152.03	WBESP/SCBR	15
Recovery furnace	9/24/2002	M5	0.0313	3	0	different dates	152.03	WBESP/SCBR	15
No. 2 Recovery Furnace	6/15/2004	M5	0.011	3	0	different dates	166.RB02	WBESP/SCBR	16
No. 2 Recovery Furnace	7/16/2009	M5	0.0294	3	0		166.RB02	WBESP/SCBR	16

Data Table for Figure A-4. PM Emissions Test Data for NDCE Recovery Furnaces with Dry Bottom ESPs (DBESP)

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 3 Recovery Furnace	6/21/2011	M5	0.00295	3	0		130.3	1
Recovery Furnace 5	12/9/2003	M5	0.011	3	0		131.6	2
RFEU	1/27/2011	M5	0.012	3	0		140.55	3
No. 3 Recovery Furnace - North	4/30/2008	M5	0.0127	3	0	separate stacks	147.14	4
No. 3 Recovery Furnace - South	4/30/2008	M5	0.0117	3	0	separate stacks	147.14	4
No. 4 Recovery Furnace	7/17/2008	M5	0.0108	3	0	different years	147.5	5
No. 4 Recovery Furnace - Front Half	1/28/2009	M5	0.00967	3	0	different years	147.5	5
No. 1 Recovery Furnace	7/21/2010	M5	0.0147	3	0		148.001	6
No. 2 Recovery Furnace	7/26/2010	M5	0.0128	3	0		148.007	7
No. 2 Recovery Furnace - East Stack	7/21/2004	M5	0.02	3	0	separate stacks	165.000006	8
No. 2 Recovery Furnace - West Stack	7/21/2004	M5	0.015	3	0	separate stacks	165.000006	8
No. 1 Recovery Furnace - North Stack	7/24/2004	M5	0.023	3	0	separate stacks	165.000013	9
No. 1 Recovery Furnace - South Stack	7/24/2004	M5	0.029	3	0	separate stacks	165.000013	9
No. 5 Recovery Boiler - North Stack	2/17/2009	M5	0.0186	3	0	Same emission unit as 181.50 (separate stacks)	181.49	10
No. 5 Recovery Boiler - South Stack	2/17/2009	M5	0.0108	3	0	Same emission unit as 181.49 (separate stacks)	181.50	10
Recovery Boiler No. 3	8/24/2009	M5	0.0027	3	0		182.037	11
Recovery Furnace 3	7/27/2004	M5	0.01	3	0		198.019	12
No. 3 Recovery Furnace	6/15/2011	M5	0.0109	3	0		199.002	13
#3 Recovery Boiler - West Exhaust Stack	4/22/2008	M5	0.013	3	0	separate stacks	207.038	14
#3 Recovery Boiler - East Exhaust Stack	4/22/2008	M5	0.0137	3	0	separate stacks	207.038	14
Recovery Boiler, SN-05A	6/22/2005	M5	0.0239	3	0		340.005	15
Chemical Recovery Furnace - West Stack Front Half	2/23/2011	M5	0.0163	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - West Stack Front Half	615.24	16
Chemical Recovery Furnace - East Stack Front Half	2/23/2011	M5	0.0246	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - East Stack Front Half	615.24	16
Chemical Recovery Furnace - West Stack ODEQ 5	2/23/2011	ODEQ5	0.0198	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - West Stack ODEQ 5	615.24	16
Chemical Recovery Furnace - East Stack ODEQ 5	2/23/2011	ODEQ5	0.0282	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - East Stack ODEQ 5	615.24	16
Chemical Recovery Furnace	6/15/2004	M5	0.014	3	0		100.037A	17
No. 5 Recovery Boiler	4/30/2009	M5	0.0099	3	0		103.G-158	18
Recovery Furnace	7/21/2009	M5	0.0045	3	0		107.08-P1	19
Recovery Boiler No. 3	8/18/2010	M5	0.0025	3	0		108.RB3	20

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Recovery Boiler # 3	7/30/2008	M5	0.024	3	0		109.RB3	20
No. 4 Recovery Boiler	06/02/2004	M5	0.0287	3	0	different years	109.RB4	21
Recovery Boiler No. 4	8/12/2008	M5	0.018	3	0	different years	109.RB4	21
Recovery Furnace (low load)	12/17/2008	M5	0.0138	3	0	Separate conditions: RF (low load; 2 chambers)	114.U500	22
Recovery Furnace (high load)	12/18/2008	M5	0.0143	3	0	Separate conditions: RF (high load; 3 chambers)	114.U500	22
No. 3 Recovery Boiler (West stack)	9/9/2010	M5	0.0020	3	0	separate stacks	115.RE01	23
No. 3 Recovery Boiler (East stack)	9/9/2010	M5	0.0055	3	0	separate stacks	115.RE01	23
#14 Recovery Boiler	7/17/2007	M5	0.0131	3	0		117.B21	24
No. 21 Recovery Furnace	1/5/2010	M5	0.02844	3	0	different dates w/in same year	119.EQT010	25
No. 21 Recovery Boiler	11/30/2010	M5	0.017	3	0	different dates w/in same year	119.EQT010	25
Recovery Furnace 5	7/15/2010	M5	0.01	3	0		120.F7	26
Recovery Boiler (three ESP chamber in Operation)	2/16/2011	M5	0.013	3	0	Separate conditions: Recovery Boiler (three ESP chambers in Operation)	135.003-1	27
Recovery Boiler (two ESP chambers in Operation)	2/17/2011	M5	0.009	3	0	Separate conditions: Recovery Boiler (two ESP chambers in Operation)	135.003-1	27
Recovery Boiler #10	5/18/2010	M5	0.008	3	0		136.EU 005	28
No. 10 Recovery Furnace	9/2/2004	M5	0.0229	3	0		155.RECOVER Y FURNACE	29
Recovery Furnace 22	2/16/2010	M5	0.0014	3	0	different dates w/in same year	156.RF22	30
Recovery Furnace 22	4/28/2010	M5	0.0013	3	0	different dates w/in same year	156.RF22	30
Recovery Furnace 22	9/14/2010	M5	0.0025	3	0	different dates w/in same year	156.RF22	30
Recovery Furnace 22	12/1/2010	M5	0.0003	3	0	different dates w/in same year	156.RF22	30
No. 1 Recovery Furnace	8/6/2008	M5	0.007	3	0	different dates w/in same year	162.381A	31
No. 1 Recovery Furnace	12/3/2008	M5	0.009	3	0	different dates w/in same year	162.381A	31
No. 2 Recovery Furnace	5/23/2007	M5	0.0083	3	0		162.382A	32
Recovery Boiler 8 & 10 ESP side B	6/8/2008	M5	0.0262	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	33
Recovery Boiler 8 & 10 ESP side A	6/8/2008	M5	0.0167	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	33

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Recovery Boiler 8 & 10 ESP side B	11/10/2010	M5	0.0373	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	33
Recovery Boiler 8 & 10 ESP side A	11/10/2010	M5	0.0216	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	33
Recovery Boiler - Old Stack	9/30/2004	M5	0.0134	3	0	Separate stacks	173.RECOVB	34
Recovery Boiler - New Stack	9/30/2004	M5	0.00296	3	0	Separate stacks	173.RECOVB	34
No. 5 Recovery Furnace	10/20/2004	M5	0.0052	3	0		174.G-32	35
No. 3 Recovery Boiler	3/22/2010	M5	0.0166	3	0		175.RB3A	36
No. 7 Recovery Boiler	7/27/2010	M5	0.0038	3	0		176.RB7	37
Recovery Boiler	3/24/2011	M5	0.0093	3	0		177.EU0804	38
No. 1 Recovery Furnace	09/07/2004	M5	0.013	3	0	different years	178.08P012	39
Recovery Furnace No. 1	6/21/2011	M5	0.017	3	0	different years	178.08P012	39
No. 2 Recovery Furnace	9/8/2004	M5	0.023	3	0	different years	178.08P013	40
Recovery Furnace No. 2	6/22/2011	M5	0.014	4	0	different years	178.08P013	40
No. 3 Recovery Furnace	6/2/2010	M5	0.009	3	0		179.RF3	41
No. 3 Recovery Furnace	3/24/2010	M5	0.005	3	0		180.D001	42
No. 4 Recovery Furnace	7/13/2009	M5	0.0042	3	0		186.RB15	43
No. 2 Recovery Furnace	10/1/2010	M5	0.007	3	0		190.R401	44
No. 3 Recovery Furnace - North	9/21/2010	M5	0.006	3	0	separate stacks	190.R402	45
No. 3 Recovery Furnace - South	9/21/2010	M5	0.005	3	0	separate stacks	190.R402	45
No. 2 Recovery Furnace	9/7/2004	M5	0.0073	3	0	different years	196.SN-06	46
No. 2 Recovery Furnace	4/20/2010	M5	0.0082	3	0	different years	196.SN-06	46
No. 3 Recovery Furnace	9/2/2004	M5	0.0051	3	0		196.SN-14	47
Recovery Furnace No. 2	3/31/2010	M5	0.001	3	0		200.007RF2	48
Recovery Boiler	10/26/2010	M5	0.0164	3	0		201.SR0001	49
Recovery Furnace EU320	7/20/2011	M5	0.0058	3	0		202.Recovery Furnace EU320	50
#2 Recovery Furnace	8/25/2009	M5	0.0074	3	0		203.RF#2	51
Recovery Furnace #3	8/5/2009	M5	0.0017	3	0		203.RF#3	52
No. 5 Recovery Furnace	5/25/2010	M5	0.004	3	0		240.RF01	53
No. 6 Recovery Furnace	7/27/2010	M5	0.0064	3	0		240.RF04	54
Recovery Furnace	9/15/2010	M5	0.0101	3	0		242.AA-011	55
#5 Recovery Boiler (R401) - North	11/3/2009	M5	0.004	3	0	separate stacks	243.R401	56
#5 Recovery Boiler (R401) - South	11/3/2009	M5	0.003	3	0	separate stacks	243.R401	56
#6 Recovery Boiler (R407)	10/27/2009	M5	0.016	3	0		243.R407	57
No. 15 Recovery Boiler	5/4/2011	M5	0.0098	3	0		531.RF15	58
No. 3 Recovery Furnace	6/8/2010	M5	0.008	3	0		600.G0806*	59

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Recovery Boiler 2 -Scenario 1	4/5/2011	M5	0.0162	4	0	Separate conditions	606.RB2	60
Recovery Boiler 2 -Scenario 2	4/5/2011	M5	0.0235	3	0	Separate conditions	606.RB2	60
Recovery Boiler 4	10/25/2010	M5	0.0258	3	0		606.RB4	61
Combined Recovery Boiler Stack - Condition 4: *One ESP Side Down Maximum Liquor Rec. Boiler 2, Oil Fire Rec. Boiler 1*	11/10/2008	M5	0.033	3	0	Combined stacks and separate conditions	610.4, 5	62
Combined Recovery Boiler Stack - Condition 1: *Max Liquor Rec. Boilers 1 & 2*	11/11/2008	M5	0.011	3	0	Combined stacks and separate conditions	610.4, 5	62
Combined Recovery Boiler Stack - Condition 2: *1 ESP Bank down, Maximum Liquor Rec. Boilers 1 & 2 One ESP Side Down Max Liquor Rec. Boiler 2, Oil Fire Rec. Boiler 1*	11/12/2008	M5	0.013	3	0	Combined stacks and separate conditions	610.4, 5	62
Combined Recovery Boiler Stack - Condition 3: *2 ESP Banks Down, Controlled Liquor Firing Rec. Boilers 1 & 2*	11/15/2008	M5	0.017	3	0	Combined stacks and separate conditions	610.4, 5	62
Recovery Boiler (S20)	3/15/2011	M5	0.0054	3	0		617.B14	63

*Facility closed.

Data Table for Figure A-5. PM Emissions Test Data for NDCE Recovery Furnaces with DBESPs and Multiple Emissions Tests

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 3 Recovery Furnace - North	4/30/2008	M5	0.0127	3	0	separate stacks	147.14	1
No. 3 Recovery Furnace - South	4/30/2008	M5	0.0117	3	0	separate stacks	147.14	1
No. 4 Recovery Furnace	7/17/2008	M5	0.0108	3	0	different years	147.5	2
No. 4 Recovery Furnace - Front Half	1/28/2009	M5	0.00967	3	0	different years	147.5	2
No. 2 Recovery Furnace - East Stack	7/21/2004	M5	0.02	3	0	separate stacks	165.000006	3
No. 2 Recovery Furnace - West Stack	7/21/2004	M5	0.015	3	0	separate stacks	165.000006	3
No. 1 Recovery Furnace - North Stack	7/24/2004	M5	0.023	3	0	separate stacks	165.000013	4
No. 1 Recovery Furnace - South Stack	7/24/2004	M5	0.029	3	0	separate stacks	165.000013	4
#3 Recovery Boiler - West Exhaust Stack	4/22/2008	M5	0.013	3	0	separate stacks	207.038	5
#3 Recovery Boiler - East Exhaust Stack	4/22/2008	M5	0.0137	3	0	separate stacks	207.038	5
Chemical Recovery Furnace - West Stack Front Half	2/23/2011	M5	0.0163	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - West Stack Front Half	615.24	6
Chemical Recovery Furnace - East Stack Front Half	2/23/2011	M5	0.0246	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - East Stack Front Half	615.24	6
Chemical Recovery Furnace - West Stack ODEQ 5	2/23/2011	ODEQ5	0.0198	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - West Stack ODEQ 5	615.24	6
Chemical Recovery Furnace - East Stack ODEQ 5	2/23/2011	ODEQ5	0.0282	3	0	Separate stacks/separate methods: Chemical Recovery Furnace - East Stack ODEQ 5	615.24	6
Recovery Boiler No. 3	8/18/2010	M5	0.0025	3	0		108.RB3	7
Recovery Boiler # 3	7/30/2008	M5	0.024	3	0		109.RB3	7
No. 4 Recovery Boiler	06/02/2004	M5	0.0287	3	0	different years	109.RB4	8
Recovery Boiler No. 4	8/12/2008	M5	0.018	3	0	different years	109.RB4	8
Recovery Furnace (low load)	12/17/2008	M5	0.0138	3	0	Separate conditions: RF (low load; 2 chambers)	114.U500	9
Recovery Furnace (high load)	12/18/2008	M5	0.0143	3	0	Separate conditions: RF (high load; 3 chambers)	114.U500	9
No. 3 Recovery Boiler (West stack)	9/9/2010	M5	0.0020	3	0	separate stacks	115.RE01	10
No. 3 Recovery Boiler (East stack)	9/9/2010	M5	0.0055	3	0	separate stacks	115.RE01	10
No. 21 Recovery Furnace	1/5/2010	M5	0.02844	3	0	different dates w/in same year	119.EQT010	11
No. 21 Recovery Boiler	11/30/2010	M5	0.017	3	0	different dates w/in same year	119.EQT010	11
Recovery Boiler (three ESP chamber in Operation)	2/16/2011	M5	0.013	3	0	Separate conditions: Recovery Boiler (three ESP chambers in Operation)	135.003-1	12
Recovery Boiler (two ESP chambers in Operation)	2/17/2011	M5	0.009	3	0	Separate conditions: Recovery Boiler (two ESP chambers in Operation)	135.003-1	12

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Recovery Furnace 22	2/16/2010	M5	0.0014	3	0	different dates w/in same year	156.RF22	13
Recovery Furnace 22	4/28/2010	M5	0.0013	3	0	different dates w/in same year	156.RF22	13
Recovery Furnace 22	9/14/2010	M5	0.0025	3	0	different dates w/in same year	156.RF22	13
Recovery Furnace 22	12/1/2010	M5	0.0003	3	0	different dates w/in same year	156.RF22	13
No. 1 Recovery Furnace	8/6/2008	M5	0.007	3	0	different dates w/in same year	162.381A	14
No. 1 Recovery Furnace	12/3/2008	M5	0.009	3	0	different dates w/in same year	162.381A	14
Recovery Boiler 8 & 10 ESP side B	6/8/2008	M5	0.0262	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	15
Recovery Boiler 8 & 10 ESP side A	6/8/2008	M5	0.0167	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	15
Recovery Boiler 8 & 10 ESP side B	11/10/2010	M5	0.0373	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	15
Recovery Boiler 8 & 10 ESP side A	11/10/2010	M5	0.0216	3	0	Separate stacks and different years. Flue gases from B08 and B10 recovery furnaces combine and then split off to the two 3 field ESPs, C03 and C04.	164.B08,B10 combined	15
Recovery Boiler - Old Stack	9/30/2004	M5	0.0134	3	0	Separate stacks	173.RECOVB	16
Recovery Boiler - New Stack	9/30/2004	M5	0.00296	3	0	Separate stacks	173.RECOVB	16
No. 1 Recovery Furnace	09/07/2004	M5	0.013	3	0	different years	178.08P012	17
Recovery Furnace No. 1	6/21/2011	M5	0.017	3	0	different years	178.08P012	17
No. 2 Recovery Furnace	9/8/2004	M5	0.023	3	0	different years	178.08P013	18
Recovery Furnace No. 2	6/22/2011	M5	0.014	4	0	different years	178.08P013	18
No. 3 Recovery Furnace - North	9/21/2010	M5	0.006	3	0	separate stacks	190.R402	19
No. 3 Recovery Furnace - South	9/21/2010	M5	0.005	3	0	separate stacks	190.R402	19
No. 2 Recovery Furnace	9/7/2004	M5	0.0073	3	0	different years	196.SN-06	20
No. 2 Recovery Furnace	4/20/2010	M5	0.0082	3	0	different years	196.SN-06	20
#5 Recovery Boiler (R401) - North	11/3/2009	M5	0.004	3	0	separate stacks	243.R401	21
#5 Recovery Boiler (R401) - South	11/3/2009	M5	0.003	3	0	separate stacks	243.R401	21
Recovery Boiler 2 -Scenario 1	4/5/2011	M5	0.0162	4	0	Separate conditions	606.RB2	22
Recovery Boiler 2 -Scenario 2	4/5/2011	M5	0.0235	3	0	Separate conditions	606.RB2	22

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Combined Recovery Boiler Stack - Condition 4: *One ESP Side Down Maximum Liquor Rec. Boiler 2, Oil Fire Rec. Boiler 1*	11/10/2008	M5	0.033	3	0	Combined stacks and separate conditions	610.4, 5	23
Combined Recovery Boiler Stack - Condition 1: *Max Liquor Rec. Boilers 1 & 2*	11/11/2008	M5	0.011	3	0	Combined stacks and separate conditions	610.4, 5	23
Combined Recovery Boiler Stack - Condition 2: *1 ESP Bank down, Maximum Liquor Rec. Boilers 1 & 2 One ESP Side Down Max Liquor Rec. Boiler 2, Oil Fire Rec. Boiler 1*	11/12/2008	M5	0.013	3	0	Combined stacks and separate conditions	610.4, 5	23
Combined Recovery Boiler Stack - Condition 3: *2 ESP Banks Down, Controlled Liquor Firing Rec. Boilers 1 & 2*	11/15/2008	M5	0.017	3	0	Combined stacks and separate conditions	610.4, 5	23

Data Table for Figure A-6. PM Emissions Test Data for NDCE Recovery Furnaces with WBESPs

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 2 Recovery Boiler	9/2/2010	M5	0.01	3	0		116.003	1
No. 1 Recovery Boiler	9/21/2010	M5	0.0072	3	0		169.04	2
No. 2 Recovery Boiler	9/22/2010	M5	0.0095	3	0		169.05	3
No. 4 Recovery Boiler - South Stack	2/25/2009	M5	0.0294	3	0	Same emission unit as 181.9 (separate stacks)	181.10	4
No. 4 Recovery Boiler - North Stack	2/25/2009	M5	0.0227	3	0	Same emission unit as 181.10 (separate stacks)	181.9	4
Recovery Furnace West Stack 1st Set	12/10/2009	M5	0.0245	3	0	Separate conditions: Recovery Furnace West Stack 1st Set	126.RECOV	6
Recovery Furnace East Stack 1st Set	12/10/2009	M5	0.0132	3	0	Separate conditions: Recovery Furnace East Stack 1st Set	126.RECOV	6
Recovery Furnace West Stack 2nd Set	12/10/2009	M5	0.0177	3	0	Separate stacks/conditions: Recovery Furnace West Stack 2nd Set. A second set of particulate tests (3 one-hour runs) was run on the recovery furnace with the west side inlet slide gates closed slightly to balance flue gas flow between the east and west sides.	126.RECOV	6
Recovery Furnace East Stack 2nd Set	12/10/2009	M5	0.0114	3	0	Separate stacks/conditions: Recovery Furnace East Stack 2nd Set. A second set of particulate tests (3 one-hour runs) was run on the recovery furnace with the west side inlet slide gates closed slightly to balance flue gas flow between the east and west sides.	126.RECOV	6
Recovery Boiler North	4/6/2011	M5	0.0065	3	0	separate stacks	127.REC1N	7
Recovery Boiler South	4/6/2011	M5	0.0121	3	0	separate stacks	127.REC1N	7
Recovery Boiler West Stack	10/9/2007	M5	0.038	3	0	Separate stacks	157.RB2*	8
Recovery Boiler East Stack	10/9/2007	M5	0.048	3	0	Separate stacks	157.RB2*	8
No. 2 Recovery Furnace - North Duct	6/2/2011	M5	0.017	3	0	separate stacks	163.RF2904	9
No. 2 Recovery Furnace - South Duct	6/2/2011	M5	0.016	3	0	separate stacks	163.RF2904	9
No. 1 Recovery Boiler	10/26/2010	M5	0.0192	3	0		172.RB01	10
No. 2 Recovery Boiler	10/25/2010	M5	0.016	3	0		172.RB02	11
No. 4 Recovery Furnace North Stack	10/25/2004	M5	0.0238	3	0	separate stacks	174.G-92	12
No. 4 Recovery Furnace - South Stack	10/25/2004	M5	0.0206	3	0	separate stacks	174.G-92	12
8R Recovery Furnace	2/23/2011	M5	0.0067	3	0		189.SN26	13
#2 Recovery Furnace - South Stack	11/30/2010	M5	0.0111	3	0	separate stacks	226.RECB1	14
#2 Recovery Furnace - North Stack	11/30/2010	M5	0.003	3	0	separate stacks	226.RECB1	14

*Facility closed.

Data Table for Figure A-7. PM Emissions Test Data for NDCE Recovery Furnaces with Various Controls

Description	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 8% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Recovery Furnace 4	9/16/2010	M5	0.0117	3	0		137.189	DBESP-WPR	1
Recovery Furnace 5	9/15/2010	M5	0.0037	3	0		137.721	DBESP-WPR	2
Recovery Furnace (filterable)	3/6/2009	M5	0.0125	3	0		138.002	DBESP-WPR	3
Recovery Boiler 2	10/16/2008	M5	0.0040	3	0		146.16	DBESP-WPR	4
No. 1 Recovery Furnace	9/28/2010	M5	0.0039	3	0		184.72	DBESP-WPR	5
No. 2 Recovery Furnace	9/29/2010	M5	0.0036	3	0		184.73	DBESP-WPR	6
#10 Recovery Boiler	1/6/2011	M5	0.0047	3	0		102.RB10	DBESP-WPR	7
No. 4 Recovery Boiler	05/16/2007	EPA\ODEQ M5	0.0175	3	0		105.EU445C	DBESP-WPR	8
No. 4 Recovery Boiler	05/20/2008	EPA\ODEQ M5	0.0208	3	0	different dates within same year	105.EU445C	DBESP-WPR	8
No. 4 Recovery Boiler	10/22/2008	EPA\ODEQ M5	0.0165	3	0	different dates within same year	105.EU445C	DBESP-WPR	8
No. 4 Recovery Boiler	06/03/2009	EPA\ODEQ M5	0.0177	3	0	different dates within same year	105.EU445C	DBESP-WPR	8
No. 4 Recovery Boiler	9/24/2009	EPA\ODEQ M5	0.0222	3	0	different dates within same year	105.EU445C	DBESP-WPR	8
No. 4 Recovery Boiler	10/13/2010	M5	0.0112	3	0		105.EU445C	DBESP-WPR	8
Recovery Furnace	1/28/2011	M5	0.0033	3	0		111.G-44	DBESP-WPR	9
Recovery Boiler 4	5/20/2010	M5	0.0061	3	0		132.4RB	DBESP-WPR	10
#5 Recovery Boiler North Stack	5/18/2010	M5	0.0079	3	0	separate stacks	132.5RB	DBESP-WPR	11
#5 Recovery Boiler South Stack	5/18/2010	M5	0.0031	3	0	separate stacks	132.5RB	DBESP-WPR	11
No. 4 Recovery Boiler	4/26/2011	M5	0.004	3	0		525.EU18	DBESP-WPR	12
Recovery Furnace No. 3	4/7/2010	M5	0.021	3	0		200.007RF3	DB-WBESP [2-sided dry and wet]	13
Recovery Boiler	6/7/2011	M5	0.032	3	0		159.F3	SCBR	15
Recovery furnace	8/18/2004	M5	0.076	3	0		139.02	DBESP-WPR/DBESP/DBESP	omit
Recovery furnace	9/9/2004	M5	0.015	3	0		139.02	DBESP-WPR/DBESP/DBESP	16

Data Table for Figure A-8. PM Emissions Test Data for One Existing NDCE Recovery Furnace at Mill 185 with DBESP-Scrubber Control Tested 43 Times Between 2001 and 2009

Test date, year.month	PM test result, gr/dscf @ 8% O_2		Test date, year.month	PM test result, gr/dscf @ 8% O_2
2001.01	0.011		2009.01	0.0247
2001.02	0.014		2009.04	0.019
2001.03	0.016		2009.07	0.032
2001.04	0.014		2009.08	0.031
2001.05	0.015		2009.10	0.024
2001.06	0.026		2009.11	0.018
2001.07	0.01		2009.12	0.019
2001.08	0.012		**Average**	**0.017**
2001.09	0.009		**Stdev**	**0.0057**
2001.10	0.012		**99th percentile**	**0.0300**
2001.11	0.008		**Median**	**0.016**
2001.12	0.012			
2004.01	0.015			
2004.02	0.016			
2004.03	0.019			
2004.04	0.018			
2004.05	0.02			
2004.08	0.024			
2004.09	0.012			
2004.12	0.012			
2005.03	0.014			
2005.06	0.013			
2005.09	0.011			
2005.12	0.019			
2006.03	0.011			
2006.06	0.011			
2006.09	0.01			
2006.12	0.011			
2007.03	0.014			
2007.05	0.019			
2007.08	0.022			
2007.11	0.022			
2008.01	0.018			
2008.05	0.017			
2008.07	0.022			
2008.10	0.02			

Data Table for Figures B-2, B-3, and B-4. PM Emissions Test Data for Lime Kilns

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Lime Kiln	G	6/17/2004	M5	0.009	3	0		100.115	ESP	1
Lime Kiln (No. 1 South Stack)	G	04/11/2008	M5	0.0006	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 2 North Stack)	G	04/11/2008	M5	0.001	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	07/07/2008	M5	0.0008	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 2 North Stack)	G	07/08/2008	M5	0.001	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	07/06/2009	M5	0.0007	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 2 North Stack)	G	07/06/2009	M5	0.0014	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	01/12/2010	M5	0.0035	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 2 North Stack)	G	01/12/2010	M5	0.0053	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	05/04/2010	M5	0.00056	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 2 North Stack)	G	05/04/2010	M5	0.0014	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	08/25/2010	M5	0.00055	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 2 North Stack)	G	08/25/2010	M5	0.0011	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	10/14/2010	M5	0.00091	3	0	Separate stacks	102.LK	ESP	2
Lime Kiln (No. 1 South Stack)	G	10/14/2010	M5	0.0014	3	0	Separate stacks	102.LK	ESP	2
#1 Lime Kiln- South Stack	G	1/4/2011	M5	0.0006	3	0	separate stacks	102.LK	ESP	2
#1 Lime Kiln- North Stack	G	1/4/2011	M5	0.0008	3	0	separate stacks	102.LK	ESP	2
No. 3 Lime Kiln	G	05/15/2007	EPA\ODEQ M5	0.0047	3	0		105.EU455	ESP	3
No. 3 Lime Kiln	GC	05/22/2008	EPA\ODEQ M5	0.021	3	0	different dates within same year	105.EU455	ESP	3
No. 3 Lime Kiln	G	10/21/2008	EPA\ODEQ M5	0.0014	3	0	different dates within same year	105.EU455	ESP	3

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
No. 3 Lime Kiln	GC	06/02/2009	EPA\ODEQ M5	0.0023	3	0	different dates within same year	105.EU455	ESP	3
No. 3 Lime Kiln	G	09/22/2009	EPA\ODEQ M5	0.0024	3	0	different dates within same year	105.EU455	ESP	3
Lime Kiln No.3	G	10/12/2010	M5	0.0106	3	0		105.EU455	ESP	3
Lime Kiln	GC	10/11/2007	M5	0.0029	3	0	different years	107.11-P14	ESP	4
Lime Kiln	G	06/17/2008	M5	0.0046	3	0	different years	107.11-P14	ESP	4
Lime Kiln	GC	7/21/2010	M5	0.0025	3	0		107.11-P14	ESP	4
No. 3 Lime Kiln	GC	06/03/2004	M5	0.0066	3	0	different years	109.LK1	ESP	5
No. 3 Lime Kiln	G	09/03/2008	M5	0.0049	3	0	different years	109.LK1	ESP	5
Lime Kiln - Cond. I	O	8/4/2009	M5	0.0119	3	0	Separate conditions: Cond 1 = fuel oil	111.G-35	ESP	6
Lime Kiln - Cond II	G	8/6/2009	M5	0.0055	3	0	Separate conditions: Cond 2 = gas	111.G-35	ESP	6
Lime Kiln	O	12/13/2005	M5	0.0039	3	0	Separate conditions: No. 6 fuel oil	114.U800	ESP	7
Lime Kiln	G	12/14/2005	M5	0.0033	3	0	Separate conditions: Natural Gas	114.U800	ESP	7
Lime Kiln	G	12/16/2008	M5	0.0011	3	0	Separate conditions: gas	114.U800	ESP	7
Lime Kiln	O	12/16/2008	M5	0.0018	3	0	Separate conditions: oil	114.U800	ESP	7
Lime Kiln No. 1	O	02/16/2005	M5	0.011	3	0	different years	127.LK1	ESP	8
Lime Kiln No. 1	O	04/25/2007	M5	0.0109	3	0	different years	127.LK1	ESP	8
Lime Kiln No. 1	O	04/28/2009	M5	0.0079	3	0	different years	127.LK1	ESP	8
Lime Kiln No. 1	O	4/4/2011	M5	0.0016	3	0	different years	127.LK1	ESP	8
Lime Kiln No. 2	O	02/16/2005	M5	0.0061	3	0	different years	127.LK2	ESP	9
Lime Kiln No. 2	O	04/24/2007	M5	0.0138	3	0	different years	127.LK2	ESP	9
Lime Kiln No. 2	O	04/29/2009	M5	0.013	3	0	different years	127.LK2	ESP	9
Lime Kiln No. 2	O	4/5/2011	M5	0.0033	3	0	different years	127.LK2	ESP	9
No. 4 Lime Kiln	U	05/22/2001	M5	0.0368	unsp	unsp	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	U	05/21/2002		0.0135	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	U	05/19/2003		0.0033	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	U	05/24/2004	M5	0.0165	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	U	6/2/2005	M5	0.00495	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	O	6/15/2006	M5	0.00456	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	O	5/22/2007	M5	0.0013	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	O	6/19/2008	M5	0.0026	3	0	different years	132.21LK4	ESP	10
No. 4 Lime Kiln	O	06/17/2009	M5	0.0143	3	0	different years	132.21LK4	ESP	10

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Lime Kiln 4	O	7/27/2010	M5	0.0583	3	0		132.21LK4	ESP	10
Lime Kiln	G	01/23/2001	M5	0.0168	3	0	different years	136.EU 033	ESP	11
Lime Kiln	U	11/14/2002	M5	0.0258	3	0	different years	136.EU 033	ESP	11
Lime Kiln	G	10/28/2004	M5	0.0194	3	0	different years	136.EU 033	ESP	11
Lime Kiln	G	07/12/2006	M5	0.0239	3	0	different years	136.EU 033	ESP	11
Lime Kiln	U	07/07/2008	M5	0.0296	3	0	different years	136.EU 033	ESP	11
Rotary Lime Kiln	G	2/10/2010	M5	0.03	3	0		136.EU 033	ESP	11
No. 3 Lime Kiln	G	8/12/2004	M5	0.0004	3	0	different years	137.511	ESP	12
No. 3 Lime Kiln	G	6/15/2005	M5	0.0009	3	0	different years	137.511	ESP	12
No. 3 Lime Kiln	G	05/14/2008	M5	0.0017	3	0	different years	137.511	ESP	12
No. 4 Lime Kiln	U	07/18/2002	M5	0.00098	3	0	Separate conditions: Tested ESP only (inlet and outlet)	137.512	ESP	13
No. 4 Lime Kiln	G	08/12/2004	M5	0.0004	3	0	Separate conditions (tested ESP only); different years	137.512	ESP	13
No. 4 Lime Kiln	G	04/12/2005	M5	0.00105	6	0	Separate conditions (tested ESP only); different dates w/in same year	137.512	ESP	13
No. 4 Lime Kiln	G	07/15/2005	M5	0.0011	3	0	Separate conditions (tested ESP only); different dates w/in same year	137.512	ESP	13
No. 4 Lime Kiln	U	6/4/2004	M5	0.0044	3	0		143.6063	ESP	14
No. 7 Lime Kiln	U	9/23/2010	M5	0.022	3	0	different dates w/in same year	147.55	ESP	15
No. 7 Lime Kiln	U	10/22/2010	M5	0.012	3	0	different dates w/in same year	147.55	ESP	15
No. 2 Lime Kiln	U	10/29/2007	M5	0.00647	3	0	different years	148.009	ESP	16
No. 2 Lime Kiln	U	05/14/2008	M5	0.0061	3	0	different years	148.009	ESP	16
No. 2 Lime Kiln	U	06/16/2009	M5	0.00588	3	0	different years	148.009	ESP	16
Lime Kiln	G	10/30/2003	M5	0.0040	3	0	Separate condition: only ESP tested. different years	154.P30 - Lime Kiln	ESP	17
Lime Kiln No. 5 - North	G	03/27/2009	M5	0.0003	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln No. 5 - South	G	03/27/2009	M5	0.0001	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln No. 5 - North	G	06/03/2009	M5	0.0014	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln No. 5 - South	G	06/03/2009	M5	0.0011	2	0	Separate stacks	156.LK5	ESP	18

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Lime Kiln No. 5 - North	G	08/27/2009	M5	0.0317	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln No. 5 - South	G	08/27/2009	M5	0.0039	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln No. 5 - North	G	10/22/2009	M5	0.001	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln No. 5 - South	G	10/22/2009	M5	0.0009	2	0	Separate stacks	156.LK5	ESP	18
Lime Kiln 5 - North Stack	G	3/30/2010	M5	0.0019	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - South Stack	G	3/30/2010	M5	0.0026	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - North Stack	G	6/8/2010	M5	0.0014	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - South Stack	G	6/8/2010	M5	0.0008	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - North Stack	G	8/12/2010	M5	0.0019	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - South Stack	G	8/12/2010	M5	0.0126	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - North Stack	G	10/5/2010	M5	0.0032	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
Lime Kiln 5 - South Stack	G	10/5/2010	M5	0.0016	2	0	separate stacks and different dates w/in same year	156.LK5	ESP	18
No. 2 Lime Kiln	O	08/03/2006	M5	0.0023	3	0	different years	162.372A	ESP	19
No. 2 Lime Kiln	O	8/5/2008	M5	0.011	3	0	different years	162.372A	ESP	19
No. 3 Lime Kiln	O	09/26/2001	M5	0.012	3	0	different years	179.LK3	ESP	20
No. 3 Lime Kiln	G	10/12/2010	M5	0.0113	3	0	different years	179.LK3	ESP	20
No. 3 Lime Kiln	U	09/01/2004	M5	0.0026	3	0	different years	196.SN-02	ESP	21
No. 3 Lime Kiln	U	4/23/2010	M5	0.0052	3	0	different years	196.SN-02	ESP	21
No. 2 Lime Kiln	GO	08/06/2004	M5	0.0056	3	0	different years	200.007_10	ESP	22
No. 2 Lime Kiln	G	08/22/2006	M5	0.0049	3	0	different years	200.007_10	ESP	22
No. 2 Lime Kiln	G	08/28/2006	M5	0.006	3	0	different years	200.007_10	ESP	22
No. 2 Lime Kiln	G	3/30/2010	M5	0.002	3	0		200.007_10	ESP	22
No. 2 Lime Kiln	U	05/01/2008	M5	0.011	3	0	different years	208228535.009	ESP	23

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
No. 2 Lime Kiln	O	04/30/2009	M5	0.004	3	0	different years	208228535.009	ESP	23
"D" Lime Kiln	U	09/23/2003	M5	0.011	2	0	different years	240.CA81	ESP	24
D Lime Kiln	U	3/16/2010	M5	0.0014	3	0	different years	240.CA81	ESP	24
No. 7 Lime Kiln	G	5/4/2011	M5	0.0023	3	0		531.LK7	ESP	25
No. 4 Lime Kiln	G	05/30/2008	M5	0.0173	3	0	different years	606.LK4	ESP	26
No. 4 Lime Kiln	O	04/21/2009	M5	0.0103	3	0	different years	606.LK4	ESP	26
No. 4 Lime Kiln	O	04/23/2010	M5	0.0093	3	0	Separate conditions; different years	606.LK4	ESP	26
No. 4 Lime Kiln	O	04/24/2010	M5	0.009	3	0	Separate conditions; different years	606.LK4	ESP	26
No. 4 Lime Kiln	O	04/25/2010	M5	0.0082	3	0	Separate conditions; different years	606.LK4	ESP	26
Lime Kiln 4	U	4/6/2011	M5	0.0074	3	0		606.LK4	ESP	26
Lime Kiln	U	08/08/2006	M5	0.0046	3	0	different years	617.P22	ESP	27
Lime Kiln	G	08/21/2007	M5	0.0061	3	0	different years	617.P22	ESP	27
Lime Kiln	G	03/17/2010	M5	0.0032	3	0	different years	617.P22	ESP	27
S22 Lime Kiln	U	3/17/2011	M5	0.0044	3	0		617.P22	ESP	27
No. 4 Lime Kiln	G	07/18/2002	M5	0.00069	3	0	Separate conditions: Tested with ESP/SCBR	137.512	ESP/PBSCB R	28
Lime Kiln 4	G	5/13/2008	M5	0.002	3	0		137.512	ESP/PBSCB R	28
Lime Kiln	U	2/5/2004	M5	0.00378	3	0		126.LK	ESP/SCBR	29
Lime Kiln	U	12/11/2009	M5	0.0014	3	0		126.LK	ESP/SCBR	29
No. 2 Lime Kiln	U	02/18/2004	M5	0.0034	3	0		146.30	ESP/SCBR	30
No. 2 Lime Kiln	U	10/15/2008	M5	0.0053	3	0		146.30	ESP/SCBR	30
Lime Kiln	G	08/01/2007	M5	0.0015	3	0	different years	154.P30 - Lime Kiln	ESP/SCBR	31
Lime Kiln	O	12/04/2008	M5	0.0009	3	0	different years	154.P30 - Lime Kiln	ESP/SCBR	31
Lime Kiln	O	12/8/2010	M5	0.0004	3	0		154.P30 - Lime Kiln	ESP/SCBR	31
Lime Kiln	G	8/25/2009	M5	0.0004	3	0	different years	154.P30 - Lime Kiln	ESP/SCBR	31
No. 4 Lime Kiln	O	10/27/2004	M5	0.0045	3	0		174.G-18	ESP/SCBR	32
Lime Kiln	O	09/08/2004	M5	0.057	3	0	Separate conditions: 18.6 ton CaO/hr	178.09P037	ESP/SCBR	33
Lime Kiln - low load	O	09/09/2004	M5	0.006	3	0	Separate conditions: 2.9 ton CaO/hr	178.09P037	ESP/SCBR	33

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Lime Kiln - Retest	GO	11/18/2004	M5	0.024	3	0		178.09P037	ESP/SCBR	33
Lime Kiln (Scrubber Outlet) - Firing Oil	O	5/26/2010	M5	0.005	3	0	Separate conditions: oil	178.09P037	ESP/SCBR	33
Lime Kiln (Scrubber Outlet) - Firing Gas	G	5/27/2010	M5	0.005	3	0	Separate conditions: gas	178.09P037	ESP/SCBR	33
No. 3 Lime Kiln	GO	11/22/2005	M5	0.0132	3	0	different years	186.LK	ESP/SCBR	34
No. 3 Lime Kiln	GO	07/26/2006	M5	0.0235	3	0	different years	186.LK	ESP/SCBR	34
No. 3 Lime Kiln	GO	09/05/2007	M5	0.00986	3	0	different years	186.LK	ESP/SCBR	34
Lime Kiln	U	10/15/2008	M5	0.050	3	0	different years	186.LK	ESP/SCBR	34
No. 3 Lime Kiln	GO	7/14/2009	M5	0.0133	3	0		186.LK	ESP/SCBR	34
Lime Kiln	U	9/1/2010	M5	0.0072	3	0		242.AA-013	ESP/SCBR	35
No. 5 Lime Kiln	O	11/01/2005	M5	0.007	3	0	different years	243.LG07	ESP/SCBR	36
No. 5 Lime Kiln	G	10/30/2007	M5	0.002	3	0	different years	243.LG07	ESP/SCBR	36
No. 5 Lime Kiln - Condition I	G	10/29/2009	M5	0.003	3	0	Separate conditions: No. 5 Lime Kiln - Condition I (SCBR/ESP)	243.LG07	ESP/SCBR	36
No. 5 Lime Kiln - Condition II	G	10/29/2009	M5	0.026*	3	0	Separate conditions: No. 5 Lime Kiln - Condition II (SCBR only)	243.LG07	ESP/SCBR	36
No. 5 Lime Kiln	O	8/28/2008	M5	0.0561	3	0		103.G-165	SCBR	37
Lime Kiln - Performance Engineering Test cond. I	U	3/9/2004	M5	0.072	3	0	Separate conditions: Performance Engineering Test cond. I (Scrubber P-drop = 8 in. H2O)	108.LK1	SCBR	38
Lime Kiln - Performance Engineering Test cond. II	U	3/10/2004	M5	0.045	3	0	Separate conditions: Performance Engineering Test cond. II (Scrubber P-drop = 9.2 in. H2O)	108.LK1	SCBR	38
Lime Kiln - MACT II Compliance Test	U	6/19/2004	M5	0.028	6	0	different dates w/in same year (MACT compliance test)	108.LK1	SCBR	38
Lime Kiln	GC	8/30/2010	M5	0.046	3	0		116.001	SCBR	39
Lime Kiln	G	3/13/2001	M5	0.029	3	0		117.P36	SCBR	40
Lime Kiln	U	4/3/2008	M5	0.293	3	0		119.EQT006	SCBR	41
Lime Kiln 1A	G	7/21/2009	M5	0.013	3	0		120.M18	SCBR	42
Lime Kiln 2A	G	7/20/2009	M5	0.041	3	0		120.M19	SCBR	43

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Lime Kiln	U	10/31/2002	M5	0.015	3	0	different years	121.000011	SCBR	44
Lime Kiln	U	8/24/2004	M5	0.017	3	0	different years	121.000011	SCBR	44
Lime Kiln	GC	11/2/2010	M5	0.0247	3	0		124.004-1	SCBR	45
No. 1 Lime Kiln	U	06/24/2011	M5	0.033	3	0		130.4	SCBR	46
No. 2 Lime Kiln	U	06/24/2011	M5	0.0318	3	0		130.5	SCBR	47
No. 2 Lime Kiln	O	12/11/2003	M5	0.09	3	0	Tested on 2 different days; report did not specify why (unclear of separate conditions)	131.16	SCBR	48
No. 2 Lime Kiln	O	12/12/2003	M5	0.093	3	0	Tested on 2 different days; report did not specify why (unclear of separate conditions)	131.16	SCBR	48
Lime Kiln 1	O	1/19/2004	M5	0.03	3	0	different dates w/in same year	131.18	SCBR	49
Lime Kiln 1	O	1/20/2004	M5	0.032	3	0	different dates w/in same year	131.18	SCBR	49
Lime Kiln 1	O	3/9/2004	M5	0.074	3	0	different dates w/in same year	131.18	SCBR	49
Lime Kiln 1	O	3/10/2004	M5	0.087	3	0	different dates w/in same year	131.18	SCBR	49
Lime Kiln	O	7/13/2004	M5	0.034	3	0	Separate conditions	135.004-1	SCBR	50
Lime Kiln	O	7/14/2004	M5	0.037	3	0	Separate conditions	135.004-1	SCBR	50
Lime Kiln (SN-01)	GC	5/23/2007	M5	0.0264	3	0		138.001	SCBR	51
Lime Kiln	U	9/9/2004	M5	0.06	3	0		139.04	SCBR	52
Lime Kiln	G	10/22/2009	M5	0.0207	3	0	different years	140.32	SCBR	53
Lime Kiln	U	5/16/2011	Oregon M5	0.024	3	0	different years	140.32	SCBR	53
LIME KILN #2	U	7/14/2003	M5	0.051	3	0		142.P6009	SCBR	54
LIME KILN #1	U	7/30/2003	M5	0.035	3	0		142.P6025	SCBR	55
Lime Kiln - filterable	U	10/23/2002	M5	0.038	3	0		145.001	SCBR	56
No. 1 Lime Kiln	U	4/20/2009	M5	0.03	3	0		146.6	SCBR	57
No. 1 Lime Kiln	U	6/15/2010	M5	0.0413	3	0		147.3	SCBR	58
No.1 Lime Kiln	U	5/25/2010	M5	0.03	4	0		148.003	SCBR	59
Rotary Lime Kiln	U	4/2/2009	M5	0.0293	3	0		149.P001	SCBR	60
Lime Kiln	G	10/13/2009	M5	0.024	3	0		150.CAU-12	SCBR	61

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
lime kiln	U	3/8/2007	mod. M5 (Texas ACB Procedure - cyclonic flow)	0.062	3	0		152.08	SCBR	62
Lime Kiln	U	2/18/2004	M5	0.0615	3	0		155.LIME KILN	SCBR	63
Lime Kiln 3	G	1/28/2010	M5	0.0137	3	0	different dates w/in same year	156.143100	SCBR	64
Lime Kiln 3	G	2/9/2010	M5	0.0149	3	0	different dates w/in same year	156.143100	SCBR	64
Lime Kiln 3	G	11/24/2010	M5	0.0212	3	0	different dates w/in same year	156.143100	SCBR	64
Lime Kiln 4	G	2/18/2010	M5	0.0183	3	0	different dates w/in same year	156.145000	SCBR	65
Lime Kiln 4	G	4/22/2010	M5	0.0098	3	0	different dates w/in same year	156.145000	SCBR	65
Lime Kiln 4	G	9/3/2010	M5	0.0093	3	0	different dates w/in same year	156.145000	SCBR	65
Lime Kiln 4	G	12/15/2010	M5	0.0134	3	0	different dates w/in same year	156.145000	SCBR	65
Lime Kiln	O	07/18/2007	M5	0.046	3	0		157.KILN**	SCBR	66
Lime Kiln	U	12/3/2010	M5	0.0385	3	0		159.F4	SCBR	67
No. 1 Lime Kiln	O	5/20/2009	M5	0.06	3	0		162.371A	SCBR	68
No. 1 Lime Kiln	G	6/9/2011	M5	0.059	3	0		163.LK1501	SCBR	69
No. 2 Lime Kiln	GC	6/8/2011	M5	0.053	3	0		163.LK2502	SCBR	70
Lime Kiln - Front Half only	O	8/17/2010	M5	0.0902	3	0		164.P12	SCBR	71
No. 2 Lime Kiln (LK02)	U	7/26/2004	M5	0.028	3	0		165.000002	SCBR	72
No. 1 Lime Kiln (LK01)	U	7/23/2004	M5	0.052	3	0		165.000019	SCBR	73
No. 1 Lime Kiln	O	7/24/2009	M5	0.1338	3	0		166.LK01	SCBR	74
No. 2 Lime Kiln	O	7/23/2009	M5	0.0323	3	0		166.LK02	SCBR	75
Lime Kiln	G	1/20/2011	M5	0.102	3	0		167.004LK	SCBR	76
No. 1 Lime Kiln	U	7/7/2009	M5	0.0322	3	0	different dates	171.009	SCBR	77
No. 1 Lime Kiln	G	7/20/2005	M5	0.0194	3	0	different dates	171.009	SCBR	77
No. 3 Lime Kiln	G	10/20/2009	M5	0.034	3	0	Separate conditions: gas	172.LK03	SCBR	78
No. 3 Lime Kiln	O	10/21/2009	M5	0.028	3	0	Separate conditions: oil	172.LK03	SCBR	78

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
lime kiln	O	9/29/2004	M5	0.0533	3	0		173.LK1	SCBR	79
No. 3 Lime Kiln	U	6/3/2003	M5	0.055	3	0		174.G-95	SCBR	80
No. 1 Lime Kiln - Shutdown	G	2/4/2010	M5	0.0172	3	0	Separate conditions: No. 1 Lime Kiln - Shutdown	175.LK1A	SCBR	81
No. 1 Lime Kiln - Startup	G	2/4/2010	M5	0.0145	3	0	Separate conditions: No. 1 Lime Kiln - Startup	175.LK1A	SCBR	81
No. 1 Lime Kiln	G	8/9/2010	M5	0.0109	3	0	different dates w/in same year (No. 1 Lime Kiln)	175.LK1A	SCBR	81
No. 2 Lime Kiln - Shutdown	G	1/12/2010	M5	0.0383	3	0	Separate conditions: No. 2 Lime Kiln - Shutdown	175.LK2A	SCBR	82
No. 2 Lime Kiln - Startup	G	1/14/2010	M5	0.0154	3	0	Separate conditions: No. 2 Lime Kiln - Startup	175.LK2A	SCBR	82
Lime Kiln	GO	9/15/2010	M5	0.064	3	0		176.G-5	SCBR	83
Lime Kiln	U	3/31/2011	M5	0.0281	3	0		177.EU0905	SCBR	84
No. 1 Lime Kiln	O	3/24/2010	M5	0.0673	3	0		180.L001	SCBR	85
No. 2 Lime Kiln	O	3/25/2010	M5	0.0585	3	0		180.L002	SCBR	86
No. 1 Lime Kiln	U	3/12/2009	M5	0.022	3	0		181.1	SCBR	87
No. 2 Lime Kiln - W/O NCGs	U	2/10/2009	M5	0.018	3	0	Separate conditions: Without NCGs	181.14	SCBR	88
No. 2 Lime Kiln - W/ NCGs	U	2/11/2009	M5	0.051	3	0	Separate conditions: With NCGs	181.14	SCBR	88
No. 1 Lime Kiln - High CaO Production	GC	3/4/2010	M5	0.0175	3	0	Separate conditions: No. 1 Lime Kiln - High CaO Production	184.LK1	SCBR	89
No. 1 Lime Kiln - Low CaO Production	GC	3/4/2010	M5	0.0186	3	0	Separate conditions: No. 1 Lime Kiln - Low CaO Production	184.LK1	SCBR	89
No. 2 Lime Kiln - Condition I	G	10/22/2004	M5	0.0045	3	0	Separate conditions: No. 2 Lime Kiln - Condition I (gas)	184.LK2	SCBR	90
No. 4 Lime Kiln	G	1/23/2009	M5	0.0172	3	0	different dates w/in same year	185.07	SCBR	91

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
No. 4 Lime Kiln	G	4/15/2009	M5	0.0217	3	0	different dates w/in same year	185.07	SCBR	91
No. 4 Lime Kiln	G	7/23/2009	M5	0.0105	3	0	different dates w/in same year	185.07	SCBR	91
No. 4 Lime Kiln	G	10/7/2009	M5	0.01055	3	0	different dates w/in same year	185.07	SCBR	91
No. 4 Lime Kiln	GO	3/22/2011	M5	0.0679	3	0	different dates w/in same year	189.SN25	SCBR	92
No. 4 Lime Kiln	GO	4/1/2011	M5	0.0164	3	0	different dates w/in same year	189.SN25	SCBR	92
Lime Kiln No. 1	U	2/23/2011	M5	0.037	3	0		190.L600	SCBR	93
Lime Kiln No. 2	U	9/24/2010	M5	0.016	3	0		190.L601	SCBR	94
Lime Kiln	U	11/15/2010	M5	0.017	3	0		195.002	SCBR	95
#2 Lime Kiln	U	9/12/2004	M5	0.0538	4	0		196.SN-09	SCBR	96
Lime Kiln	G	9/16/2008	M5	0.0428	3	0		197.1	SCBR	97
Lime Kiln	U	9/9/2005	M5	0.0525	3	0		198.004	SCBR	98
No. 3 Lime Kiln	U	7/7/2011	M5	0.0179	3	0		199.011	SCBR	99
Lime Kiln	GC	5/8/2007	M5	0.0664	3	0		201.SR0003	SCBR	100
Lime Kiln	G	7/21/2011	M5	0.034	3	0		202.Lime Kiln EU340	SCBR	101
Lime Kiln	G	2/8/2011	M5	0.034	3	0	different dates w/in same year	203.LKScr	SCBR	102
Lime Kiln	G	3/22/2011	M5	0.029	3	0	different dates w/in same year	203.LKScr	SCBR	102
Lime Kiln	G	4/5/2011	M5	0.033	3	0	different dates w/in same year	203.LKScr	SCBR	102
Lime Kiln	G	4/22/2011	M5	0.029	3	0	different dates w/in same year	203.LKScr	SCBR	102
Lime Kiln	U	1/26/2011	M5	0.03	3	0		205.008	SCBR	103
Lime Kiln #5	U	11/13/2007	M5	0.0334	3	0		206.G-38	SCBR	104
Lime Kiln - Normal Condition	G	6/7/2011	M5	0.058	3	0	Separate conditions: Lime Kiln - Normal Condition	207.103A	SCBR	105
Lime Kiln -Condition I	G	6/7/2011	M5	0.058	3	0	Separate conditions: Lime Kiln - Condition I (scrubber p-drop =18 in H2O, recirc = 400 gpm)	207.103A	SCBR	105

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Control	Graph order
Lime Kiln - Condition II	G	6/8/2011	M5	0.067	3	0	Separate conditions: Lime Kiln - Condition II (scrubber p-drop =20 in H2O, recirc = 300 gpm)	207.103A	SCBR	105
Lime Kiln - Condition III	G	6/8/2011	M5	0.082	3	0	Separate conditions: Lime Kiln - Condition III (scrubber p-drop =18 in H2O, recirc = 295 gpm)	207.103A	SCBR	105
Lime Kiln #1	U	8/10/2004	M5	0.0378	3	0		226.LK1	SCBR	106
Lime Kiln #2	U	1/16/2004	M5	0.0065	3	0		226.LK2	SCBR	107
Lime kiln	U	6/23/2005	M5	0.0856	3	0		340.008	SCBR	108
No. 4 Lime Kiln	O	4/27/2011	M5	0.0241	3	0		525.EU17	SCBR	109
No. 1 Lime Kiln	G	11/3/2010	M5	0.091	3	0		600.G0903**	SCBR	110
No. 2 Lime Kiln	G	6/9/2010	M5	0.0476	3	0	different years	600.G0905**	SCBR	111
No. 2 Lime Kiln	G	6/16/2011	M5	0.0344	3	0	different years	600.G0905**	SCBR	111
No. 3 Lime Kiln	G	11/14/2010	M5	0.014	3	0		600.G0908**	SCBR	112
A Lime Kiln	O	6/18/2009	M5	0.075	3	0	Separate conditions	610.7	SCBR	113
A Lime Kiln	O	6/18/2009	M5	0.089	3	0	Separate conditions	610.7	SCBR	113
A Lime Kiln	O	6/22/2009	M5	0.077	3	0	Separate conditions	610.7	SCBR	113
A Lime Kiln	O	6/15/2010	M5	0.073	3	0	Separate conditions	610.7	SCBR	113
A Lime Kiln	O	6/16/2010	M5	0.073	3	0	Separate conditions	610.7	SCBR	113
B Lime Kiln	O	6/17/2009	M5	0.066	3	0	Separate conditions	610.8	SCBR	114
B Lime Kiln	O	6/17/2009	M5	0.062	3	0	Separate conditions	610.8	SCBR	114
B Lime Kiln	O	6/19/2009	M5	0.062	3	0	Separate conditions	610.8	SCBR	114
Lime Kiln	G	12/3/2009	M5	0.0288	3	0	Separate conditions	613.009	SCBR	115
Lime Kiln	GC	12/4/2009	M5	0.0317	3	0	Separate conditions	613.009	SCBR	115
Lime Kiln - Front Half	G	10/22/2009	M5	0.0223	3	0	Separate methods: Lime Kiln - Front Half	615.21	SCBR	116
Lime Kiln - ODEQ 5	G	10/22/2009	M5	0.0248	3	0	Separate methods: Lime Kiln - ODEQ 5	615.21	SCBR	116

unsp = unspecified
*Only the scrubber in the ESP/scrubber system was tested.
**Facility closed.

Fuel type codes:
G = natural gas
O = fuel oil (no. 2 or no. 6) and/or waste oil
GC = natural gas and pet coke
GO = gas and fuel oil
U = unspecified

Data Table for Figure B-5. PM Emissions Test Data for ESP-Controlled Lime Kilns Firing Gas or Oil

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Lime Kiln	G	6/17/2004	M5	0.009	3	0		100.115	1
Lime Kiln (No. 1 South Stack)	G	04/11/2008	M5	0.0006	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 2 North Stack)	G	04/11/2008	M5	0.001	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	07/07/2008	M5	0.0008	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 2 North Stack)	G	07/08/2008	M5	0.001	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	07/06/2009	M5	0.0007	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 2 North Stack)	G	07/06/2009	M5	0.0014	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	01/12/2010	M5	0.0035	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 2 North Stack)	G	01/12/2010	M5	0.0053	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	05/04/2010	M5	0.00056	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 2 North Stack)	G	05/04/2010	M5	0.0014	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	08/25/2010	M5	0.00055	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 2 North Stack)	G	08/25/2010	M5	0.0011	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	10/14/2010	M5	0.00091	3	0	Separate stacks	102.LK	2
Lime Kiln (No. 1 South Stack)	G	10/14/2010	M5	0.0014	3	0	Separate stacks	102.LK	2
#1 Lime Kiln- South Stack	G	1/4/2011	M5	0.0006	3	0	separate stacks	102.LK	2
#1 Lime Kiln- North Stack	G	1/4/2011	M5	0.0008	3	0	separate stacks	102.LK	2
No. 3 Lime Kiln	G	05/15/2007	EPA\ODEQ M5	0.0047	3	0		105.EU455	3
No. 3 Lime Kiln	G	10/21/2008	EPA\ODEQ M5	0.0014	3	0	different dates within same year	105.EU455	3
No. 3 Lime Kiln	G	09/22/2009	EPA\ODEQ M5	0.0024	3	0	different dates within same year	105.EU455	3
Lime Kiln No.3	G	10/12/2010	M5	0.0106	3	0		105.EU455	3
Lime Kiln	G	06/17/2008	M5	0.0046	3	0	different years	107.11-P14	4
No. 3 Lime Kiln	G	09/03/2008	M5	0.0049	3	0	different years	109.LK1	5
Lime Kiln - Cond II	G	8/6/2009	M5	0.0055	3	0	Separate conditions: Cond 2 = gas	111.G-35	6
Lime Kiln	G	12/14/2005	M5	0.0033	3	0	Separate conditions: Natural Gas	114.U800	7
Lime Kiln	G	12/16/2008	M5	0.0011	3	0	Separate conditions: gas	114.U800	7
Lime Kiln	G	01/23/2001	M5	0.017	3	0	different years	136.EU 033	8
Lime Kiln	G	10/28/2004	M5	0.019	3	0	different years	136.EU 033	8
Lime Kiln	G	07/12/2006	M5	0.024	3	0	different years	136.EU 033	8
Rotary Lime Kiln	G	2/10/2010	M5	0.03	3	0		136.EU 033	8
No. 3 Lime Kiln	G	8/12/2004	M5	0.0004	3	0	different years	137.511	9
No. 3 Lime Kiln	G	6/15/2005	M5	0.0009	3	0	different years	137.511	9

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 3 Lime Kiln	G	05/14/2008	M5	0.0017	3	0	different years	137.511	9
No. 4 Lime Kiln	G	08/12/2004	M5	0.0004	3	0	Separate conditions (tested ESP only); different years	137.512	10
No. 4 Lime Kiln	G	04/12/2005	M5	0.00105	6	0	Separate conditions (tested ESP only); different dates w/in same year	137.512	10
No. 4 Lime Kiln	G	07/15/2005	M5	0.0011	3	0	Separate conditions (tested ESP only); different dates w/in same year	137.512	10
Lime Kiln	G	10/30/2003	M5	0.0040	3	0	Separate condition: only ESP tested. different years	154.P30 - Lime Kiln	11
Lime Kiln No. 5 - North	G	03/27/2009	M5	0.0003	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - South	G	03/27/2009	M5	0.0001	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - North	G	06/03/2009	M5	0.0014	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - South	G	06/03/2009	M5	0.0011	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - North	G	08/27/2009	M5	0.0317	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - South	G	08/27/2009	M5	0.0039	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - North	G	10/22/2009	M5	0.001	2	0	Separate stacks	156.LK5	12
Lime Kiln No. 5 - South	G	10/22/2009	M5	0.0009	2	0	Separate stacks	156.LK5	12
Lime Kiln 5 - North Stack	G	3/30/2010	M5	0.0019	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - South Stack	G	3/30/2010	M5	0.0026	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - North Stack	G	6/8/2010	M5	0.0014	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - South Stack	G	6/8/2010	M5	0.0008	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - North Stack	G	8/12/2010	M5	0.0019	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - South Stack	G	8/12/2010	M5	0.0126	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - North Stack	G	10/5/2010	M5	0.0032	2	0	separate stacks and different dates w/in same year	156.LK5	12
Lime Kiln 5 - South Stack	G	10/5/2010	M5	0.0016	2	0	separate stacks and different dates w/in same year	156.LK5	12
No. 3 Lime Kiln	G	10/12/2010	M5	0.0113	3	0	different years	179.LK3	13
No. 2 Lime Kiln	G	08/22/2006	M5	0.0049	3	0	different years	200.007_10	14
No. 2 Lime Kiln	G	08/28/2006	M5	0.006	3	0	different years	200.007_10	14

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 2 Lime Kiln	G	3/30/2010	M5	0.002	3	0		200.007_10	14
No. 7 Lime Kiln	G	5/4/2011	M5	0.0023	3	0		531.LK7	15
No. 4 Lime Kiln	G	05/30/2008	M5	0.0173	3	0	different years	606.LK4	16
Lime Kiln	G	08/21/2007	M5	0.0061	3	0	different years	617.P22	17
Lime Kiln	G	03/17/2010	M5	0.0032	3	0	different years	617.P22	17
Lime Kiln - Cond. I	O	8/4/2009	M5	0.0119	3	0	Separate conditions: Cond 1 = fuel oil	111.G-35	18
Lime Kiln	O	12/13/2005	M5	0.0039	3	0	Separate conditions: No. 6 fuel oil	114.U800	19
Lime Kiln	O	12/16/2008	M5	0.0018	3	0	Separate conditions: oil	114.U800	19
Lime Kiln No. 1	O	02/16/2005	M5	0.011	3	0	different years	127.LK1	20
Lime Kiln No. 1	O	04/25/2007	M5	0.0109	3	0	different years	127.LK1	20
Lime Kiln No. 1	O	04/28/2009	M5	0.0079	3	0	different years	127.LK1	20
Lime Kiln No. 1	O	4/4/2011	M5	0.0016	3	0	different years	127.LK1	20
Lime Kiln No. 2	O	02/16/2005	M5	0.0061	3	0	different years	127.LK2	21
Lime Kiln No. 2	O	04/24/2007	M5	0.0138	3	0	different years	127.LK2	21
Lime Kiln No. 2	O	04/29/2009	M5	0.013	3	0	different years	127.LK2	21
Lime Kiln No. 2	O	4/5/2011	M5	0.0033	3	0	different years	127.LK2	21
No. 4 Lime Kiln	O	6/15/2006	M5	0.0046	3	0	different years	132.21LK4	22
No. 4 Lime Kiln	O	5/22/2007	M5	0.0013	3	0	different years	132.21LK4	22
No. 4 Lime Kiln	O	6/19/2008	M5	0.0026	3	0	different years	132.21LK4	22
No. 4 Lime Kiln	O	06/17/2009	M5	0.0143	3	0	different years	132.21LK4	22
Lime Kiln 4	O	7/27/2010	M5	0.0583	3	0		132.21LK4	22
No. 2 Lime Kiln	O	08/03/2006	M5	0.0023	3	0	different years	162.372A	23
No. 2 Lime Kiln	O	8/5/2008	M5	0.011	3	0	different years	162.372A	23
No. 3 Lime Kiln	O	09/26/2001	M5	0.012	3	0	different years	179.LK3	24
No. 2 Lime Kiln	O	04/30/2009	M5	0.004	3	0	different years	208228535.009	25
No. 4 Lime Kiln	O	04/21/2009	M5	0.0103	3	0	different years	606.LK4	26
No. 4 Lime Kiln	O	04/23/2010	M5	0.0093	3	0	Separate conditions; different years	606.LK4	26
No. 4 Lime Kiln	O	04/24/2010	M5	0.009	3	0	Separate conditions; different years	606.LK4	26
No. 4 Lime Kiln	O	04/25/2010	M5	0.0082	3	0	Separate conditions; different years	606.LK4	26
No. 2 Lime Kiln	GO	08/06/2004	M5	0.0056	3	0	different years	200.007_10	27

Data Table for Figure B-6. PM Emissions Test Data for ESP-Controlled Lime Kilns Firing Gas/Coke or Unspecified Fuel

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 3 Lime Kiln	GC	05/22/2008	EPA\ODEQ M5	0.021	3	0	different dates within same year	105.EU455	1
No. 3 Lime Kiln	GC	06/02/2009	EPA\ODEQ M5	0.0023	3	0	different dates within same year	105.EU455	1
Lime Kiln	GC	10/11/2007	M5	0.0029	3	0	different years	107.11-P14	2
Lime Kiln	GC	7/21/2010	M5	0.0025	3	0		107.11-P14	2
No. 3 Lime Kiln	GC	06/03/2004	M5	0.0066	3	0	different years	109.LK1	3
No. 4 Lime Kiln	U	05/22/2001	M5	0.0368	unsp	unsp	different years	132.21LK4	4
No. 4 Lime Kiln	U	05/21/2002		0.0135	3	0	different years	132.21LK4	4
No. 4 Lime Kiln	U	05/19/2003		0.0033	3	0	different years	132.21LK4	4
No. 4 Lime Kiln	U	05/24/2004	M5	0.0165	3	0	different years	132.21LK4	4
No. 4 Lime Kiln	U	6/2/2005	M5	0.0050	3	0	different years	132.21LK4	4
Lime Kiln	U	11/14/2002	M5	0.0258	3	0	different years	136.EU 033	5
Lime Kiln	U	07/07/2008	M5	0.030	3	0	different years	136.EU 033	5
No. 4 Lime Kiln	U	07/18/2002	M5	0.00098	3	0	Separate conditions: Tested ESP only (inlet and outlet)	137.512	6
No. 4 Lime Kiln	U	6/4/2004	M5	0.0044	3	0		143.6063	7
No. 7 Lime Kiln	U	9/23/2010	M5	0.022	3	0	different dates w/in same year	147.55	8
No. 7 Lime Kiln	U	10/22/2010	M5	0.012	3	0	different dates w/in same year	147.55	8
No. 2 Lime Kiln	U	10/29/2007	M5	0.00647	3	0	different years	148.009	9
No. 2 Lime Kiln	U	05/14/2008	M5	0.0061	3	0	different years	148.009	9
No. 2 Lime Kiln	U	06/16/2009	M5	0.00588	3	0	different years	148.009	9
No. 3 Lime Kiln	U	09/01/2004	M5	0.0026	3	0	different years	196.SN-02	10
No. 3 Lime Kiln	U	4/23/2010	M5	0.0052	3	0	different years	196.SN-02	10
No. 2 Lime Kiln	U	05/01/2008	M5	0.011	3	0	different years	208228535.009	11
"D" Lime Kiln	U	09/23/2003	M5	0.011	2	0	different years	240.CA81	12
D Lime Kiln	U	3/16/2010	M5	0.0014	3	0	different years	240.CA81	12
Lime Kiln 4	U	4/6/2011	M5	0.0074	3	0		606.LK4	13
Lime Kiln	U	08/08/2006	M5	0.0046	3	0	different years	617.P22	14
S22 Lime Kiln	U	3/17/2011	M5	0.0044	3	0		617.P22	14

unsp = unspecified

Data Table for Figure B-7. PM Emissions Test Data for Lime Kilns with Combined ESP/Scrubber Control

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Lime Kiln 4	G	5/13/2008	M5	0.002	3	0		137.512	1
Lime Kiln	G	08/01/2007	M5	0.0015	3	0	different years	154.P30 - Lime Kiln	2
Lime Kiln	G	8/25/2009	M5	0.0004	3	0	different years	154.P30 - Lime Kiln	2
Lime Kiln (Scrubber Outlet) - Firing Gas	G	5/27/2010	M5	0.005	3	0	Separate conditions: gas	178.09P037	3
No. 5 Lime Kiln	G	10/30/2007	M5	0.002	3	0	different years	243.LG07	4
No. 5 Lime Kiln - Condition I	G	10/29/2009	M5	0.003	3	0	Separate conditions: No. 5 Lime Kiln - Condition I (SCBR/ESP)	243.LG07	4
No. 5 Lime Kiln - Condition II	G	10/29/2009	M5	0.026*	3	0	Separate conditions: No. 5 Lime Kiln - Condition II (SCBR only)	243.LG07	4
Lime Kiln	O	12/04/2008	M5	0.0009	3	0	different years	154.P30 - Lime Kiln	5
Lime Kiln	O	12/8/2010	M5	0.0004	3	0		154.P30 - Lime Kiln	5
No. 4 Lime Kiln	O	10/27/2004	M5	0.0045	3	0		174.G-18	6
Lime Kiln	O	09/08/2004	M5	0.057	3	0	Separate conditions: 18.6 ton CaO/hr	178.09P037	7
Lime Kiln - low load	O	09/09/2004	M5	0.006	3	0	Separate conditions: 2.9 ton CaO/hr	178.09P037	7
Lime Kiln (Scrubber Outlet) - Firing Oil	O	5/26/2010	M5	0.005	3	0	Separate conditions: oil	178.09P037	7
No. 5 Lime Kiln	O	11/01/2005	M5	0.007	3	0	different years	243.LG07	8
Lime Kiln - Retest	GO	11/18/2004	M5	0.024	3	0		178.09P037	9
No. 3 Lime Kiln	GO	11/22/2005	M5	0.0132	3	0	different years	186.LK	10
No. 3 Lime Kiln	GO	07/26/2006	M5	0.0235	3	0	different years	186.LK	10
No. 3 Lime Kiln	GO	09/05/2007	M5	0.00986	3	0	different years	186.LK	10
No. 3 Lime Kiln	GO	7/14/2009	M5	0.0133	3	0		186.LK	10
Lime Kiln	U	2/5/2004	M5	0.003779835	3	0		126.LK	11
Lime Kiln	U	12/11/2009	M5	0.0014	3	0		126.LK	11
No. 2 Lime Kiln	U	02/18/2004	M5	0.0034	3	0		146.30	12
No. 2 Lime Kiln	U	10/15/2008	M5	0.0053	3	0		146.30	12
Lime Kiln	U	10/15/2008	M5	0.050	3	0	different years	186.LK	13
Lime Kiln	U	9/1/2010	M5	0.0072	3	0		242.AA-013	14

Note that the same kiln may be represented on multiple vertical lines in Figure B-7 (*e.g.*, separate vertical lines for different fuels).
*Only the scrubber in the ESP/scrubber system was tested.

Data Table for Figure B-8. PM Emissions Test Data for Scrubber-Controlled Lime Kilns Firing Gas and Oil

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Lime Kiln	G	3/13/2001	M5	0.0294	3	0		117.P36	1
Lime Kiln 1A	G	7/21/2009	M5	0.013	3	0		120.M18	2
Lime Kiln 2A	G	7/20/2009	M5	0.041	3	0		120.M19	3
Lime Kiln	G	10/22/2009	M5	0.0207	3	0	different years	140.32	4
Lime Kiln	G	10/13/2009	M5	0.024	3	0		150.CAU-12	5
Lime Kiln 3	G	1/28/2010	M5	0.0137	3	0	different dates w/in same year	156.143100	6
Lime Kiln 3	G	2/9/2010	M5	0.0149	3	0	different dates w/in same year	156.143100	6
Lime Kiln 3	G	11/24/2010	M5	0.0212	3	0	different dates w/in same year	156.143100	6
Lime Kiln 4	G	2/18/2010	M5	0.0183	3	0	different dates w/in same year	156.145000	6
Lime Kiln 4	G	4/22/2010	M5	0.0098	3	0	different dates w/in same year	156.145000	6
Lime Kiln 4	G	9/3/2010	M5	0.0093	3	0	different dates w/in same year	156.145000	6
Lime Kiln 4	G	12/15/2010	M5	0.0134	3	0	different dates w/in same year	156.145000	6
No. 1 Lime Kiln	G	6/9/2011	M5	0.059	3	0		163.LK1501	7
Lime Kiln	G	1/20/2011	M5	0.102	3	0		167.004LK	8
No. 1 Lime Kiln	G	7/20/2005	M5	0.0194	3	0	different dates	171.009	9
No. 3 Lime Kiln	G	10/20/2009	M5	0.034	3	0	Separate conditions: gas	172.LK03	10
No. 1 Lime Kiln - Shutdown	G	2/4/2010	M5	0.0172	3	0	Separate conditions: No. 1 Lime Kiln - Shutdown	175.LK1A	11
No. 1 Lime Kiln - Startup	G	2/4/2010	M5	0.0145	3	0	Separate conditions: No. 1 Lime Kiln - Startup	175.LK1A	11
No. 1 Lime Kiln	G	8/9/2010	M5	0.0109	3	0	different dates w/in same year (No. 1 Lime Kiln)	175.LK1A	11
No. 2 Lime Kiln - Shutdown	G	1/12/2010	M5	0.0383	3	0	Separate conditions: No. 2 Lime Kiln - Shutdown	175.LK2A	12
No. 2 Lime Kiln - Startup	G	1/14/2010	M5	0.0154	3	0	Separate conditions: No. 2 Lime Kiln - Startup	175.LK2A	12
No. 2 Lime Kiln - Condition I	G	10/22/2004	M5	0.0045	3	0	Separate conditions: No. 2 Lime Kiln - Condition I (gas)	184.LK2	13
No. 4 Lime Kiln	G	1/23/2009	M5	0.0172	3	0	different dates w/in same year	185.07	14

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 4 Lime Kiln	G	4/15/2009	M5	0.0217	3	0	different dates w/in same year	185.07	14
No. 4 Lime Kiln	G	7/23/2009	M5	0.0105	3	0	different dates w/in same year	185.07	14
No. 4 Lime Kiln	G	10/7/2009	M5	0.0106	3	0	different dates w/in same year	185.07	14
Lime Kiln	G	9/16/2008	M5	0.0428	3	0		197.1	15
Lime Kiln	G	7/21/2011	M5	0.034	3	0		202.Lime Kiln EU340	16
Lime Kiln	G	2/8/2011	M5	0.034	3	0	different dates w/in same year	203.LKScr	17
Lime Kiln	G	3/22/2011	M5	0.029	3	0	different dates w/in same year	203.LKScr	17
Lime Kiln	G	4/5/2011	M5	0.033	3	0	different dates w/in same year	203.LKScr	17
Lime Kiln	G	4/22/2011	M5	0.029	3	0	different dates w/in same year	203.LKScr	17
Lime Kiln - Normal Condition	G	6/7/2011	M5	0.058	3	0	Separate conditions: Lime Kiln - Normal Condition	207.103A	18
Lime Kiln -Condition I	G	6/7/2011	M5	0.058	3	0	Separate conditions: Lime Kiln -Condition I (scrubber p-drop =18 in H2O, recirc = 400 gpm)	207.103A	18
Lime Kiln - Condition II	G	6/8/2011	M5	0.067	3	0	Separate conditions: Lime Kiln - Condition II (scrubber p-drop =20 in H2O, recirc = 300 gpm)	207.103A	18
Lime Kiln - Condition III	G	6/8/2011	M5	0.082	3	0	Separate conditions: Lime Kiln - Condition III (scrubber p-drop =18 in H2O, recirc = 295 gpm)	207.103A	18
No. 1 Lime Kiln	G	11/3/2010	M5	0.091	3	0		600.G0903*	19
No. 2 Lime Kiln	G	6/9/2010	M5	0.0476	3	0	different years	600.G0905*	20
No. 2 Lime Kiln	G	6/16/2011	M5	0.0344	3	0	different years	600.G0905*	20
No. 3 Lime Kiln	G	11/14/2010	M5	0.014	3	0		600.G0908*	21
Lime Kiln	G	12/3/2009	M5	0.0288	3	0	Separate conditions	613.009	22
Lime Kiln - Front Half	G	10/22/2009	M5	0.0223	3	0	Separate methods: Lime Kiln - Front Half	615.21	23
Lime Kiln - ODEQ 5	G	10/22/2009	M5	0.0248	3	0	Separate methods: Lime Kiln - ODEQ 5	615.21	23
No. 5 Lime Kiln	O	8/28/2008	M5	0.0561	3	0		103.G-165	24

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 2 Lime Kiln	O	12/11/2003	M5	0.09	3	0	Tested on 2 different days; report did not specify why (unclear of separate conditions)	131.16	25
No. 2 Lime Kiln	O	12/12/2003	M5	0.093	3	0	Tested on 2 different days; report did not specify why (unclear of separate conditions)	131.16	25
Lime Kiln 1	O	1/19/2004	M5	0.03	3	0	different dates w/in same year	131.18	26
Lime Kiln 1	O	1/20/2004	M5	0.032	3	0	different dates w/in same year	131.18	26
Lime Kiln 1	O	3/9/2004	M5	0.074	3	0	different dates w/in same year	131.18	26
Lime Kiln 1	O	3/10/2004	M5	0.087	3	0	different dates w/in same year	131.18	26
Lime Kiln	O	7/13/2004	M5	0.034	3	0	Separate conditions	135.004-1	27
Lime Kiln	O	7/14/2004	M5	0.037	3	0	Separate conditions	135.004-1	27
Lime Kiln	O	07/18/2007	M5	0.046	3	0		157.KILN*	28
No. 1 Lime Kiln	O	5/20/2009	M5	0.06	3	0		162.371A	29
Lime Kiln - Front Half only	O	8/17/2010	M5	0.0902	3	0		164.P12	30
No. 1 Lime Kiln	O	7/24/2009	M5	0.1338	3	0		166.LK01	31
No. 2 Lime Kiln	O	7/23/2009	M5	0.0323	3	0		166.LK02	32
No. 3 Lime Kiln	O	10/21/2009	M5	0.028	3	0	Separate conditions: oil	172.LK03	33
lime kiln	O	9/29/2004	M5	0.0533	3	0		173.LK1	34
No. 1 Lime Kiln	O	3/24/2010	M5	0.0673	3	0		180.L001	35
No. 2 Lime Kiln	O	3/25/2010	M5	0.0585	3	0		180.L002	36
No. 4 Lime Kiln	O	4/27/2011	M5	0.0241	3	0		525.EU17	37
A Lime Kiln	O	6/18/2009	M5	0.075	3	0	Separate conditions	610.7	38
A Lime Kiln	O	6/18/2009	M5	0.089	3	0	Separate conditions	610.7	38
A Lime Kiln	O	6/22/2009	M5	0.077	3	0	Separate conditions	610.7	38
A Lime Kiln	O	6/15/2010	M5	0.073	3	0	Separate conditions	610.7	38
A Lime Kiln	O	6/16/2010	M5	0.073	3	0	Separate conditions	610.7	38
B Lime Kiln	O	6/17/2009	M5	0.066	3	0	Separate conditions	610.8	39
B Lime Kiln	O	6/17/2009	M5	0.062	3	0	Separate conditions	610.8	39
B Lime Kiln	O	6/19/2009	M5	0.062	3	0	Separate conditions	610.8	39
Lime Kiln	GO	9/15/2010	M5	0.064	3	0		176.G-5	40
No. 4 Lime Kiln	GO	3/22/2011	M5	0.0679	3	0	different dates w/in same year	189.SN25	41

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
No. 4 Lime Kiln	GO	4/1/2011	M5	0.0164	3	0	different dates w/in same year	189.SN25	41

*Facility closed.

Data Table for Figure B-9. PM Emissions Test Data for Scrubber-Controlled Lime Kilns Firing Gas/Coke or Unspecified Fuel

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Lime Kiln	GC	8/30/2010	M5	0.046	3	0		116.001	1
Lime Kiln	GC	11/2/2010	M5	0.0247	3	0		124.004-1	2
Lime Kiln (SN-01)	GC	5/23/2007	M5	0.0264	3	0		138.001	3
No. 2 Lime Kiln	GC	6/8/2011	M5	0.053	3	0		163.LK2502	4
No. 1 Lime Kiln - High CaO Production	GC	3/4/2010	M5	0.0175	3	0	Separate conditions: No. 1 Lime Kiln - High CaO Production	184.LK1	5
No. 1 Lime Kiln - Low CaO Production	GC	3/4/2010	M5	0.0186	3	0	Separate conditions: No. 1 Lime Kiln - Low CaO Production	184.LK1	5
Lime Kiln	GC	5/8/2007	M5	0.0664	3	0		201.SR0003	6
Lime Kiln	GC	12/4/2009	M5	0.0317	3	0	Separate conditions	613.009	7
Lime Kiln - Performance Engineering Test cond. I	U	3/9/2004	M5	0.072	3	0	Separate conditions: Performance Engineering Test cond. I (Scrubber P-drop = 8 in. H2O)	108.LK1	8
Lime Kiln - Performance Engineering Test cond. II	U	3/10/2004	M5	0.045	3	0	Separate conditions: Performance Engineering Test cond. II (Scrubber P-drop = 9.2 in. H2O)	108.LK1	8
Lime Kiln - MACT II Compliance Test	U	6/19/2004	M5	0.028	6	0	different dates w/in same year (MACT compliance test)	108.LK1	8
Lime Kiln	U	4/3/2008	M5	0.293	3	0		119.EQT006	9
Lime Kiln	U	10/31/2002	M5	0.015	3	0	different years	121.000011	10
Lime Kiln	U	8/24/2004	M5	0.017	3	0	different years	121.000011	10
Lime Kiln	U	9/9/2004	M5	0.06	3	0		139.04	11
Lime Kiln	U	5/16/2011	Oregon M5	0.024	3	0	different years	140.32	12
LIME KILN #2	U	7/14/2003	M5	0.051	3	0		142.P6009	13
LIME KILN #1	U	7/30/2003	M5	0.035	3	0		142.P6025	14
Lime Kiln - filterable	U	10/23/2002	M5	0.038	3	0		145.001	15
No. 1 Lime Kiln	U	4/20/2009	M5	0.03	3	0		146.6	16
No. 1 Lime Kiln	U	6/15/2010	M5	0.0413	3	0		147.3	17
No.1 Lime Kiln	U	5/25/2010	M5	0.03	4	0		148.003	18
Rotary Lime Kiln	U	4/2/2009	M5	0.0293	3	0		149.P001	19
lime kiln	U	3/8/2007	mod. M5 (Texas ACB Procedure - cyclonic flow)	0.062	3	0		152.08	20

Description	Fuel Type Code	Test Date	Test Method	Outlet Average Conc., gr/dscf @ 10% O_2	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Graph order
Lime Kiln	U	2/18/2004	M5	0.0615	3	0		155.LIME KILN	21
Lime Kiln	U	12/3/2010	M5	0.0385	3	0		159.F4	22
No. 2 Lime Kiln (LK02)	U	7/26/2004	M5	0.028	3	0		165.000002	23
No. 1 Lime Kiln (LK01)	U	7/23/2004	M5	0.052	3	0		165.000019	24
No. 3 Lime Kiln	U	6/3/2003	M5	0.055	3	0		174.G-95	25
Lime Kiln	U	3/31/2011	M5	0.0281	3	0		177.EU0905	26
No. 1 Lime Kiln	U	3/12/2009	M5	0.022	3	0		181.1	27
No. 2 Lime Kiln - W/O NCGs	U	2/10/2009	M5	0.018	3	0	Separate conditions: Without NCGs	181.14	28
No. 2 Lime Kiln - W/ NCGs	U	2/11/2009	M5	0.051	3	0	Separate conditions: With NCGs	181.14	28
Lime Kiln No. 1	U	2/23/2011	M5	0.037	3	0		190.L600	29
Lime Kiln No. 2	U	9/24/2010	M5	0.016	3	0		190.L601	30
Lime Kiln	U	11/15/2010	M5	0.017	3	0		195.002	31
#2 Lime Kiln	U	9/12/2004	M5	0.0538	4	0		196.SN-09	32
Lime Kiln	U	9/9/2005	M5	0.0525	3	0		198.004	33
No. 3 Lime Kiln	U	7/7/2011	M5	0.0179	3	0		199.011	34
Lime Kiln	U	1/26/2011	M5	0.03	3	0		205.008	35
Lime Kiln #5	U	11/13/2007	M5	0.0334	3	0		206.G-38	36
Lime Kiln #1	U	8/10/2004	M5	0.0378	3	0		226.LK1	37
Lime Kiln #2	U	1/16/2004	M5	0.0065	3	0		226.LK2	38
Lime kiln	U	6/23/2005	M5	0.0856	3	0		340.008	39
No. 1 Lime Kiln	U	06/24/2011	M5	0.033	3	0		130.4	40
No. 2 Lime Kiln	U	06/24/2011	M5	0.0318	3	0		130.5	41
No. 1 Lime Kiln	U	7/7/2009	M5	0.0322	3	0	different dates	171.009	42

Data Table for Figures C-1 and C-2. PM Emissions Test Data for Smelt Dissolving Tanks

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
No. 2 RB SDT	10/26/2005	M5	3	0		145.56	0.6360	OTH	1	
Smelt Dissolving Tank	08/23/2005	M5	4	0		157.SDT*	0.1480	OTH	2	
No. 2 Smelt Dissolving Tank	07/08/2009	M5	3	0		171.006	0.2600	OTH	3	
No. 10 Smelt Dissolving Tank	01/25/2005	M5	3	0	different dates	206.G-35	0.1912	OTH	4	
No. 10 Smelt Dissolving Tank	11/17/2005	M5	3	0	different dates	206.G-35	unspecified	OTH		
No. 11 Smelt Dissolving Tank	01/26/2005	M5	4	0	different dates	206.G-36	0.2697	OTH	5	
No. 11 Smelt Dissolving Tank	11/20/2005	M5	3	0	different dates	206.G-36	unspecified	OTH		
Smelt Dissolving Tank	9/23/2010	M5	3	0		138.003	0.0786	PBSCBR	6	
Smelt Dissolving Tank	10/06/2010	M5	3	0	Different dates and methods (M5)	140.57	0.0730	PBSCBR	7	
Smelt Dissolving Tank	03/31/2011	ODEQ M5	3	0	Different dates and methods (ORDEQ5)	140.57	0.0790	PBSCBR	8	
Smelt Dissolving Tank	3/3/2011	M5	5	0		155.SDT	0.0890	PBSCBR	9	
SDT 18	3/17/2010	M5	3	0	different dates within same year	156.SMEL18	0.0889	PBSCBR	10	1
SDT 18	8/4/2010	M5	3	0	different dates within same year	156.SMEL18	0.0901	PBSCBR	10	1
SDT 19	4/6/2010	M5	3	0	different dates within same year	156.SMEL19	0.0572	PBSCBR	11	2
SDT 19	10/27/2010	M5	3	0	different dates within same year	156.SMEL19	0.0954	PBSCBR	11	2
SDT 22	2/11/2010	M5	3	0	different dates within same year	156.SMEL22	0.0501	PBSCBR	12	3
SDT 22	9/10/2010	M5	3	0	different dates within same year	156.SMEL22	0.0483	PBSCBR	12	3
SDT 22	11/18/2010	M5	3	0	different dates within same year	156.SMEL22	0.0564	PBSCBR	12	3
Smelt Dissolving Tank No. 1	9/21/2010	M5	3	0		169.06	0.1251	PBSCBR	13	
Smelt Dissolving Tank No. 2	9/21/2010	M5	3	0		169.07	0.1651	PBSCBR	14	
No. 4 Smelt Dissolver	1/2/2009	M5	3	0	different dates within same year	185.05	0.0567	PBSCBR	15	4
No. 4 Smelt Dissolver	2/4/2009	M5	3	0	different dates within same year	185.05	0.0653	PBSCBR	15	4
No. 4 Smelt Dissolver	3/11/2009	M5	3	0	different dates within same year	185.05	0.0883	PBSCBR	15	4

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
No. 4 Smelt Dissolver	6/3/2009	M5	3	0	different dates within same year	185.05	0.0773	PBSCBR	15	4
No. 4 Smelt Dissolver	8/26/2009	M5	3	0	different dates within same year	185.05	0.0820	PBSCBR	15	4
No. 4 Smelt Dissolver	11/12/2009	M5	3	0	different dates within same year	185.05	0.0493	PBSCBR	15	4
Smelt Tank	9/24/2003	M5	3	0		207.108	0.0900	PBSCBR	16	
S21 SDT	3/16/2011	M5	3	0		617.P21	0.0473	PBSCBR	17	
Smelt Dissolving Tank	8/9/2001	M5	3	0		100.109	0.0533	SCBR	18	
Smelt Dissolver Tank Vent	1/5/2011	M5	3	0		102.SDTV10	0.0388	SCBR	19	
Smelt dissolving tanks, #3 East Vent	2/20/2008	ODEQ M5	3	0	Separate stacks	105.EU445BEast		SCBR		
Smelt dissolving tanks, #3 West Vent	2/20/2008	ODEQ M5	3	0	Separate stacks	105.EU445BWest	0.1481	SCBR	20	
No. 4 Smelt Dissolving Tank	05/16/2007	EPA\ODEQ M5	3	0		105.EU445D	0.1089	SCBR	21	5
No. 4 Smelt Dissolving Tank	05/20/2008	EPA\ODEQ M5	3	0	different dates within same year	105.EU445D	0.1304	SCBR	21	5
No. 4 Smelt Dissolving Tank	10/22/2008	EPA\ODEQ M5	3	0	different dates within same year	105.EU445D	0.1147	SCBR	21	5
No. 4 Smelt Dissolving Tank	06/03/2009	EPA\ODEQ M5	3	0	different dates within same year	105.EU445D	0.1126	SCBR	21	5
No. 4 Smelt Dissolving Tank	09/23/2009	EPA\ODEQ M5	3	0	different dates within same year	105.EU445D	0.1065	SCBR	21	5
#4 Smelt Dissolving Tank	10/13/2010	M5	3	0		105.EU445D	0.1114	SCBR	21	5
Smelt Dissolving Tanks	6/9/2011	M5	3	0		107.09-P2	0.1380	SCBR	22	
No. 3 Smelt Dissolver	5/12/2006	M5	3	0	different years	109.SDT3	0.0840	SCBR	23	6
Smelt Dissolving Tank # 3	7/31/2008	M5	3	0	different years	109.SDT3	0.0790	SCBR	23	6
No. 4 Smelt Dissolver	8/13/2008	M5	3	0		109.SDT4	0.0580	SCBR	24	
South Smelt Tank	1/29/2011	M5	3	0		111.G-127	0.0863	SCBR	25	

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
Smelt Dissolving Tank	3/18/2009	M5	3	0		112.AA-101	0.1108	SCBR	26	
Smelt Dissolving Tank	12/18/2008	M5	3	0		114.U508	0.1300	SCBR	27	
SDT West	9/9/2010	M5	3	0	separate stacks	115.SM01		SCBR		
SDT East	9/9/2010	M5	3	0	separate stacks	115.SM01	0.07392	SCBR	28	
Smelt Dissolving Tank Vent	7/20/2004	M5	3	0	different years	116.004	0.0763	SCBR	29	7
Smelt Dissovling Tank Vent	9/2/2010	M5	3	0	different years	116.004	0.0930	SCBR	29	7
No. 20 SDT	1/3/2007	M5	3	0		119.EQT005	unspecified	SCBR		
No. 21 SDT	3/21/2007	M5	3	0		119.EQT011	unspecified	SCBR		
#5 SDT	7/22/2009	M5	3	0		120.M3	0.0500	SCBR	30	
No. 1 Smelt Dissolving Tank	10/29/2002	M5	3	0	different years	121.000009	0.0641	SCBR	31	8
No. 1 Smelt Dissolving Tank	8/20/2004	M5	3	0	different years	121.000009	0.1103	SCBR	31	8
No. 2 Smelt Dissolving Tank	10/30/2002	M5	3	0	different years	121.000010	0.0965	SCBR	32	9
No. 2 Smelt Dissolving Tank	8/18/2004	M5	3	0	different years	121.000010	0.0641	SCBR	32	9
No. 1 Smelt Dissolver	11/3/2010	M5	3	0		124.020	0.0951	SCBR	33	
No. 2 Smelt Dissolver	11/4/2010	M5	3	0		124.021	0.0929	SCBR	34	
SDT	12/10/2009	M5	3	0		126.SDT	0.1619	SCBR	35	
SDT Vent	2/15/2005	M5	3	0		127.SDT1	0.0547	SCBR	36	
No. 3 Smelt Dissolving Tank	06/21/2011	M5	4	0		130.11	0.1494	SCBR	37	
No. 1 Smelt Dissolving Tank	06/23/2011	M5	3	0		130.6	0.1505	SCBR	38	
No. 2 Smelt Dissolving Tank	06/22/2011	M5	3	0		130.7	0.2380	SCBR	39	
SDT 4N	3/8/2004	M5	3	0		131.SDT4N		SCBR		
SDT 4S	3/8/2004	M5	3	0		131.SDT4S	0.0944	SCBR	40	
SDT 5	12/9/2003	M5	4	0		131.SDT5	0.0604	SCBR	41	
4 SDT	5/20/2010	M5	3	0		132.4SDT	0.0328	SCBR	42	10
SDTV No. 4	6/15/2009	M5	3	0		132.4SDT	0.0444	SCBR	42	10
5 SDT	5/18/2010	M5	3	0		132.5SDT	0.1370	SCBR	43	

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
Smelt Dissolving Tank	02/16/2011	M5	3	0	Combined stacks given	135.007-1, 007-2	0.0400	SCBR	44	
SDT	5/19/2010	M5	3	0		136.EU 031	0.1000	SCBR	45	
No. 4 Recovery Smelt Dissolver	08/31/2010	M5	2	0		137.157	0.0370	SCBR	46	11
No. 4 Recovery Smelt Dissolver	09/16/2010	M5	3	0	appears to be retest	137.157	0.0317	SCBR	46	11
No. 5 SDT	9/15/2010	M5	3	0		137.204	0.1000	SCBR	47	
Smelt Dissolving Tank	09/10/2004	M5	3	0		139.03	0.1600	SCBR	48	
No. 3 Smelt Dissolving Tank Vent	06/30/2003	M5	3	0		142.P7236	0.1550	SCBR	49	
No. 1 and No. 2 SDTs	7/22/2004	M5	3	0		142.P7413	0.1080	SCBR	50	
No. 1 Smelt Dissolving Tank	11/05/2009	M5	3	0		143.7005	0.0356	SCBR	51	
No. 2 Smelt Dissolving Tank	11/05/2009	M5	3	0		143.7015	0.0400	SCBR	52	
No. 3 Smelt Dissolving Tank	11/04/2009	M5	3	0		143.7025	0.0300	SCBR	53	
No. 1 SDT (upriver vent)	10/16/2008	M5	3	0	separate stacks	146.10		SCBR		
No. 1 SDT (downriver vent)	10/16/2008	M5	3	0	separate stacks	146.10	0.0601	SCBR	54	
No. 2 SDT	10/16/2008	M5	3	0		146.17	0.0575	SCBR	55	
No. 1 SDT	7/21/2010	M5	3	0		148.002	0.0909	SCBR	56	
No. 2 SDT	7/20/2010	M5	4	0		148.008	0.1481	SCBR	57	
No. 9 SDT	4/3/2009	M5	3	0		149.P005	0.1024	SCBR	58	
Smelt Tank West	8/29/2007	M5	3	0	Separate stacks: The smelt dissolving tank emission unit id CREC-2 has two identical stacks (CREC-2a and CREC-2b) and each stack has an identical scrubber (SCRBSTa and SCRBSTb).	150.CREC-2a		SCBR		

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
Smelt Tank East	8/29/2007	M5	3	0	Separate stacks: The smelt dissolving tank emission unit id CREC-2 has two identical stacks (CREC-2a and CREC-2b) and each stack has an identical scrubber (SCRBSTa and SCRBSTb).	150.CREC-2b	0.096	SCBR	59	
Smelt Dissolving Tank	03/07/2007	M5	3	0		152.04	0.2243	SCBR	60	
No. 1 Smelt Dissolving Tank	03/09/2004	M5	3	0	different dates within same year	154.P32 - Smelt Dissolving Tank 1	0.1000	SCBR	61	12
No. 1 Smelt Dissolving Tank	05/05/2004	M5	3	0	different dates within same year	154.P32 - Smelt Dissolving Tank 1	0.1500	SCBR	61	12
No. 2 Smelt Dissolving Tank	03/10/2004	M5	3	0	different dates within same year	154.P35 - Smelt Dissolving Tank 2	0.1200	SCBR	62	13
No. 2 Smelt Dissolving Tank	05/06/2004	M5	3	0	different dates within same year	154.P35 - Smelt Dissolving Tank 2	0.1800	SCBR	62	13
No. 1 SDT	10/25/2007	M5	3	0		162.381C	0.1435	SCBR	63	
No. 2 SDT	5/21/2009	M5	3	0		162.382B	0.1071	SCBR	64	
No. 1 SDT South	6/1/2011	M5	3	0		163.SD1902	unspecified	SCBR		
No. 1 SDT North	6/1/2011	M5	3	0		163.SD1903	unspecified	SCBR		
No. 2	6/2/2011	M5	3	0		163.SD2906	0.1486	SCBR	65	
No. 8 SDT	6/14/2004	M5	3	0		164.P08	unspecified	SCBR		
No. 10 SDT	6/16/2004	M5	3	0		164.P10	unspecified	SCBR		
No. 2 Smelt Tank Scrubber	7/21/2004	M5	3	0		165.000008	0.0945	SCBR	66	
No. 1 Smelt Tank Scrubber	7/27/2004	M5	3	0		165.000014	0.1086	SCBR	67	
No. 1 Smelt Dissolving Tank	7/14/2009	M5	3	0		166.ST01	0.1441	SCBR	68	
No. 2 Smelt Dissolving Tank	7/17/2009	M5	3	0		166.ST02	0.1568	SCBR	69	
Smelt Dissolving Tank	01/17/2011	M5	3	0		167.007SDT	0.1337	SCBR	70	
No. 3 Smelt Dissolving Tank	07/07/2009	M5	3	0		171.007	0.0900	SCBR	71	
No. 4 Smelt Dissolving Tank	07/06/2009	M5	3	0		171.008	0.1100	SCBR	72	
No. 1 SDT	10/27/2010	unspecified	3	0		172.ST01	unspecified	SCBR		

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
Smelt Dissolving Tank	12/19/2000	M5	3	0	different dates	173.SDT	0.2040	SCBR	75	14
Smelt Dissolving Tank	09/30/2004	M5	3	0	different dates	173.SDT	0.1800	SCBR	75	14
No. 4 SDT	10/27/2004	M5	3	0	different years	174.G-63B	0.2519	SCBR	76	15
No. 4 SDT	2/3/2005	M5	3	0	different years	174.G-63B	0.1953	SCBR	76	15
No. 5 SDT - East Stack	10/22/2004	M5	3	0	separate stacks	174.G-63C		SCBR		
No. 5 SDT - West Stack	10/22/2004	M5	3	0	separate stacks	174.G-63C	0.0663	SCBR	77	16
No. 5 SDT - East Stack	2/1/2005	M5	3	0	separate stacks	174.G-63C		SCBR		
No. 5 SDT - West Stack	2/1/2005	M5	3	0	separate stacks	174.G-63C	0.0717	SCBR	77	16
No. 2 SDT	4/13/2010	M5	4	0		175.ST2A	0.1951	SCBR	78	
No. 3 Smelt Dissolving Tank	03/24/2009	M5	3	0		175.ST3A	0.0686	SCBR	79	
SDT	3/29/2011	M5	3	0		177.EU0805	0.0343	SCBR	80	
No. 1 Smelt Dissolving Tank	09/07/2004	M5	3	0		178.08T014	0.0959	SCBR	81	17
Smelt Dissolving Tank No. 1	6/21/2011	M5	3	0		178.08T014	0.1600	SCBR	81	17
No. 2 Smelt Dissolving Tank	09/08/2004	M5	3	0		178.08T015	0.0508	SCBR	82	18
Smelt Dissolving Tank No. 2	6/22/2011	M5	3	0		178.08T015	0.1500	SCBR	82	18
No. 3 SDT Vent	5/27/2009	M5	3	0	different years	179.SDT	0.0756	SCBR	83	19
No. 3 SDT Vent	6/2/2010	M5	3	0	different years	179.SDT	0.0787	SCBR	83	19
No. 3 SDT Vent	3/17/2009	M5	3	0		180.D002, D907	0.0471	SCBR	84	
No. 4 RB SDT	1/25/2005	M5	3	0	different year	181.11	0.1080	SCBR	85	20
No. 4 RB SDT (condition 1: P-dop = 6.9 in H2O)	11/2/2006	M5	3	0	Separate conditions	181.11	0.1830	SCBR	85	20
No. 4 RB SDT (condition 3: P-drop = 7.7 in H2O)	11/3/2006	M5	3	0	Separate conditions	181.11	0.1220	SCBR	85	20
No. 5 RB SDT	1/25/2005	M5	3	0	different year	181.51	0.1090	SCBR	86	20

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
No. 5 RB SDT - (condition 1: P-drop = 5.9 in H2O)	10/31/2006	M5	3	0	Separate conditions	181.51	0.2288	SCBR	86	20
No. 5 RB SDT - (condition 2: P-drop = 7.0 in H2O)	11/1/2006	M5	3	0	Separate conditions	181.51	0.1600	SCBR	86	20
No. 5 RB SDT - (condition 3: P-drop = 7.1 in H2O)	11/1/2006	M5	3	0	Separate conditions	181.51	0.2140	SCBR	86	20
Smelt Dissolving Tank Vent	4/12/2005	M5	3	0		182.110	0.0700	SCBR	87	
Smelt Tank No. 1, West	08/27/2004	M5	3	0	different dates (test report did not indicate why each tank was tested twice)	184.SDT1	0.1647	SCBR	88	21
Smelt Tank No. 1, West	08/31/2004	M5	3	0	different dates (test report did not indicate why each tank was tested twice)	184.SDT1	0.1362	SCBR	88	21
Smelt Tank No. 2, East	08/25/2004	M5	3	0	different dates (test report did not indicate why each tank was tested twice)	184.SDT2a	0.2328	SCBR	89	22
Smelt Tank No. 2, East	08/26/2004	M5	3	0	different dates (test report did not indicate why each tank was tested twice)	184.SDT2a	0.2454	SCBR	89	22
Smelt Tank No. 2, East	10/26/2004	M5	3	0	different dates	184.SDT2a	0.1720	SCBR	89	22
Smelt Tank No. 2, West	08/25/2004	M5	3	0	different dates (test report did not indicate why each tank was tested twice)	184.SDT2b	0.5337	SCBR	90	23
Smelt Tank No. 2, West	08/26/2004	M5	3	0	different dates (test report did not indicate why each tank was tested twice)	184.SDT2b	0.4009	SCBR	90	23
Smelt Tank No. 2, West	10/21/2004	M5	3	0	different dates	184.SDT2b	0.1091	SCBR	90	23
No. 4 Smelt Tank	7/22/2008	M5	3	0	different years	186.RB17	0.0900	SCBR	91	24
No. 4 Smelt Tank	7/13/2009	M5	3	0	different years	186.RB17	0.0801	SCBR	91	24
No. 1 Smelt Dissolving Tank	06/06/2011	M5	3	0		188.015SD1	0.1010	SCBR	92	

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
No. 2 Smelt Dissolving Tank	06/06/2011	M5	3	0		188.017SD2	0.0950	SCBR	93	
SDT East	12/2/2010	M5	3	0		189.SN27	0.0500	SCBR	94	
SDT West	11/30/2010	M5	3	0		189.SN28	0.0990	SCBR	95	
SDTV NO. 1	9/24/2009	M5	3	0	different years	190.R404	0.0668	SCBR	96	25
No. 1 SDT	4/21/2010	M5	3	0	different years	190.R404	0.0527	SCBR	96	25
Smelt Dissolving Tank No. 2	10/15/2009	M5	3	0		190.R405	0.0724	SCBR	97	
No. 3 SDT	3/23/2010	M5	3	0		190.R406	0.1440	SCBR	98	
No. 2 North Smelt Tank Vent	4/20/2010	M5	3	0		196.SN-08North	0.0899	SCBR	99	
No. 2 South Smelt Tank Vents	4/20/2010	M5	3	0		196.SN-08South	0.0709	SCBR	100	
No. 3 Smelt Dissolving Tank	09/03/2004	M5	3	0		196.SN-15	0.1406	SCBR	101	
No. 3 SDT	7/27/2004	M5	3	0		198.020	0.0930	SCBR	102	
No. 3 Smelt Dissolving Tank	06/15/2011	M5	3	0		199.004	0.1613	SCBR	103	
Nos. 2 and 3 SDT Vent	7/29/2009	M5	3	0		200.007_8, 007_9	0.0548	SCBR	104	
Smelt Dissolving Tank	08/19/2004	M5	3	0		201.SR0034	0.1770	SCBR	105	
SDT EU322	7/19/2011	M5	3	0		202.Smelt Dissolving Tank EU322	0.0790	SCBR	106	
No. 2 DT Scrubber Vent Stack	10/12/2010	M5	1	0		203.2DTScr		SCBR		
No. 3 SDT	10/26/2010	M5	3	0		203.3DTScr	0.0700	SCBR	107	
Smelt Dissolving Tank	07/20/2010	M5	3	0		205.010	0.1110	SCBR	108	
No. 1 SDT	4/28/2010	M5	3	0	different years	208228535.002	0.0650	SCBR	109	26
No. 1 SDT	5/27/2011	M5	3	0	different years	208228535.002	0.101	SCBR	109	26
No. 2 SDT	8/19/2010	M5	3	0		208228535.008	0.0720	SCBR	110	
No. 2 SDT North	1/19/2004	M5	3	0		226.SDT1N	0.0611	SCBR	111	
No. 2 SDT South	1/20/2004	M5	3	0		226.SDT1S	0.0680	SCBR	112	
No. 3 SDT	1/17/2004	M5	3	0		226.SDT2	0.0855	SCBR	113	
No. 5 SDT	5/25/2010	M5	3	0		240.RF02	0.0942	SCBR	114	
No. 6 SDT East	3/17/2010	M5	3	0		240.RF05	0.0628	SCBR	115	

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
No. 6 SDT West	3/17/2010	M5	3	0		240.RF06	0.0592	SCBR	116	
SDT	9/15/2010	M5	3	0		242.AA-012	0.0846	SCBR	117	
No. 5 SDT	10/29/2009	M5	3	0		243.R403	0.1463	SCBR	118	
No. 6 SDT	10/28/2009	M5	3	0		243.R408	0.1563	SCBR	119	
Smelt Dissolving Tank	7/23/2004	M5	3	0	different years	340.007	0.1647	SCBR	120	27
Smelt Dissolving Tank	6/21/2005	M5	3	0	different years	340.007	0.1611	SCBR	120	27
No. 15 SDT	5/4/2011	M5	3	0		531.RF10	0.0434	SCBR	121	
No. 2 SDT	11/2/2010	M5	3	0		600.G0805*	0.0562	SCBR	122	
No. 3 SDT	6/8/2010	M5	3	0		600.G0807*	0.0460	SCBR	123	
No. 2 Smelt Dissolving Tank	03/19/2010	M5	3	0	different dates	606.SDT2	0.0892	SCBR	124	28
No. 2 Smelt Dissolving Tank	04/05/2011	M5	4	0	different dates	606.SDT2	0.1153	SCBR	124	28
No. 3 Smelt Dissolving Tank	10/25/2005	M5	3	0	different dates	606.SDT3	0.0880	SCBR	125	29
No. 3 Smelt Dissolving Tank	07/25/2010	M5	3	0	different dates	606.SDT3	0.0770	SCBR	125	29
No. 4 Smelt Dissolving Tank	07/20/2006	M5	3	0	different dates	606.SDT4	0.0985	SCBR	126	30
No. 4 Smelt Dissolving Tank	10/25/2010	M5	3	0	different dates	606.SDT4	0.1728	SCBR	126	30
No. 2 Smelt Dissolving Tank	07/09/2009	M5	3	0	Separate conditions: weak wash scrubber	610.10	0.0790	SCBR	127	31
No. 2 Smelt Dissolving Tank	07/09/2009	M5	3	0	Separate conditions: water scrubber	610.10	0.0540	SCBR	127	31
No. 1 Smelt Dissolving Tank	07/08/2009	M5	3	0	Separate conditions: weak wash scrubber	610.9	0.1210	SCBR	128	32
No. 1 Smelt Dissolving Tank	07/08/2009	M5	3	0	Separate conditions: water scrubber	610.9	0.1230	SCBR	128	32
No. 1 Smelt Dissolving Tank - Left Side	10/29/2009	M5	3	0		613.005	unspecified	SCBR		
No. 1 Smelt Dissolving Tank - Right Side	10/29/2009	M5	3	0		613.006	unspecified	SCBR		
No. 2 Smelt Dissolving Tank - Left Side	10/29/2009	M5	3	0		613.007	unspecified	SCBR		

Description	Test Date	Test Method	No. Runs	No. Runs BDL	Duplicate Emission Unit Notes	RTI+EUID	Outlet PM, lb/ton BLS[1,2]	Control[3]	Graph order (Fig C-1)	Graph order (Fig C-2)
No. 2 Smelt Dissolving Tank - Right Side	10/29/2009	M5	3	0		613.008	unspecified	SCBR		
SDT	10/20/2009	M5	3	0		615.25	0.1170	SCBR	133	

1. Mass emission rates for each stack from SDTs with multiple stacks were summed to arrive at total mass emissions from the SDT.
2. "Unspecified" lb/ton BLS results reflect emissions tests that did not include a BLS production rate needed to convert emissions to lb/ton BLS format. Unspecified results were not graphed.
3. OTH = mist eliminator, PBSCBR = packed bed scrubber, SCBR = scrubber

*Facility closed.