PROPOSED AMENDED RULES 1146, 1146.1, 1146.2 & PROPOSED RULE 1100 WORKING GROUP #5

AUGUST 2, 2018
SCAQMD
DIAMOND BAR, CA

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Agenda

- Rule Applicability
- Previous recommendations and public comments
- BARCT analysis
- Schedule
- Contacts

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Rule 1146 Series

Rule	Applicability	Size
Rule 1146	Boilers, steam generators, and process heaters	≥ 5 million Btu per hour (MMBtu/hr)
Rule 1146.1	Boilers, steam generators, and process heaters	>2 and <5 MMBtu/hr
Rule 1146.2	Natural gas-fired water heaters, boilers, and process heaters	≤ 2 MMBtu/hr

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Rule Applicability

- Remove exemption for RECLAIM facilities
- Rule 1146 and 1146.1 equipment at the following facilities will not be included:
  - Electricity Generating Facilities (EGFs);
    - Except for non-power producing boilers
  - Refineries
  - As discussed in previous Working Group Meetings other industry categories will be included in Rule 1146 and 1146.1
- Rule 1146.2 would apply to all RECLAIM facilities
  - Seeking input regarding refineries

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Previous Recommendations for PARs 1146 and 1146.1 (May Set Hearing)

- Maintain existing NOx concentration limits
- Defer compliance for units between 2 – 20 MMBtu/hr if
  - Unit can demonstrate that NOx concentration is 12 ppm or less
    - Existing provisions allow natural gas units between 2 – 20 MMBtu/hr permitted at 12 ppm or less may defer compliance until burner(s) replacement (Rule limit = 9 ppm)
- Implementation schedule
  - 75% of units by heat input for Rule 1146 and 1146.1 units (including BARCT-compliant equipment) by Jan. 1, 2021; 100% of units by heat input by Jan. 1, 2022
  - Facilities committed to replace existing boilers/heaters (whole units) will be allowed until Jan. 1, 2023 to replace unit
  - Submit a complete permit application by 12 months after rule adoption

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Previous Recommendations for PAR 1146.2 (May Set Hearing)

- Include commitment to conduct a technology assessment by January 1, 2022
  - If BARCT is the same as existing rule requirements (30 ppm), compliance by December 31, 2023
  - If BARCT is less than 30 ppm, a new compliance schedule will be developed
- Inventory data to be collected through:
  - Initial determination notifications and
  - Annual audit inspections

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Public Comments at May 2018 Set Hearing

- Summary of comments
  - Program level CEQA and Socioeconomic analysis should be conducted
  - NSR and permitting issues should be resolved before facilities transition out of RECLAIM
  - BARCT levels may not be cost-effective, need to look at various levels of control
  - BARCT should be defined for each class and category of equipment
- Since the May 2018 Set Hearing
  - BARCT has been re-assessed
  - Baseline Emissions
    - RECLAIM (various levels from 5 to 40+ ppm)
    - Non-RECLAIM (mostly 5 to 12 ppm, following Rule 1146 series)
  - Type of boilers (fire-tube vs. water-tube boilers)

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Overview of BARCT Analysis

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BARCT

- Is defined in the California Health and Safety Code Section 40406
  "…an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source."
- BARCT can be retrofit, replacement, fuel change, material substitution, etc.
- BARCT is reassessed periodically and is updated as technology advances
- BARCT is an emission limitation, and is not limited to a particular technology, whether add-on or replacement. This definition does not preclude replacement technologies

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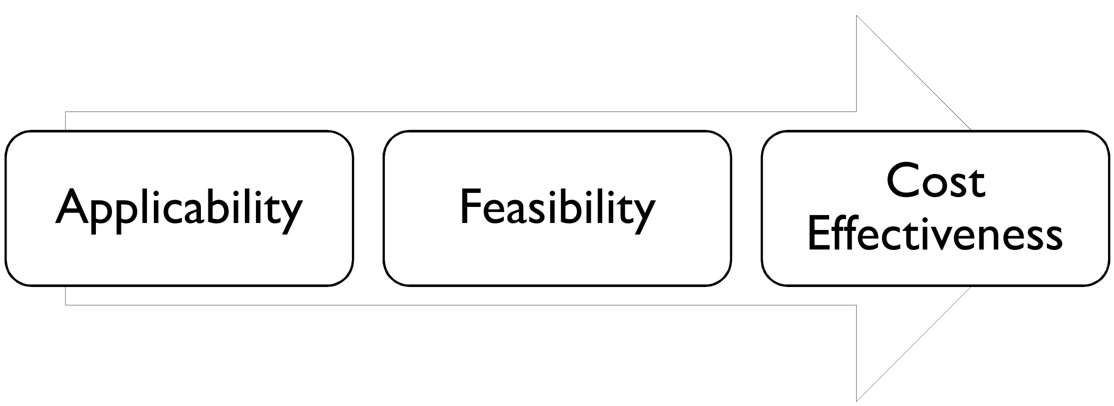
BARCT – Primary Considerations



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BARCT Analysis for PARs 1146 and 1146.1

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Objective of Technology Assessment

- ❑Overall objective of Technology Assessment is to assess applicable technologies to identify a possible BARCT emission standard
  - Cost-effectiveness analysis must be completed before BARCT recommendation can be made
- ❑Technology Assessment is specific to the equipment, plus fuel type, and takes into account size and application of the equipment
- ❑Each step of the Technology Assessment should identify possible emission limit
- ❑Four steps in the Technology Assessment

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Overview of Technology Assessment

Assessment of SCAQMD Regulatory Requirements

Purpose: Identify existing SCAQMD regulatory requirements for that particular source category

Assessment of Emission Limits for Existing Units

Purpose: Evaluate existing units to identify emission levels achieved based on permitted and actual levels

Other Regulatory Requirements

Purpose: Identify any other regulatory requirements with lower emission limits

Assessment of Pollution Control Technologies

Purpose: Identify pollution control technologies and potential emission reductions

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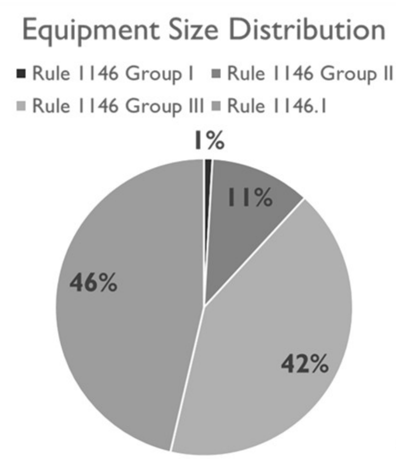
Rule 1146 and Rule 1146.1 Universe

- Approximate Size of Universe: 2,399 units
  - >97% of units utilize natural gas as primary fuel
  - <3% of units utilize landfill and digester gas as primary fuel
  - Liquid fuels mostly used as secondary
- NOx concentrations are adjusted to 3% O_2

Size Range (MMBtu/hr)	Category	Number of Units	
		Command-and-Control*	RECLAIM
2-5	Rule 1146.1	1,072	40
5-20	Rule 1146 Group III	869	134
20-75	Rule 1146 Group II	184	78
75+	Rule 1146 Group I	15	7
	Total	2,399	



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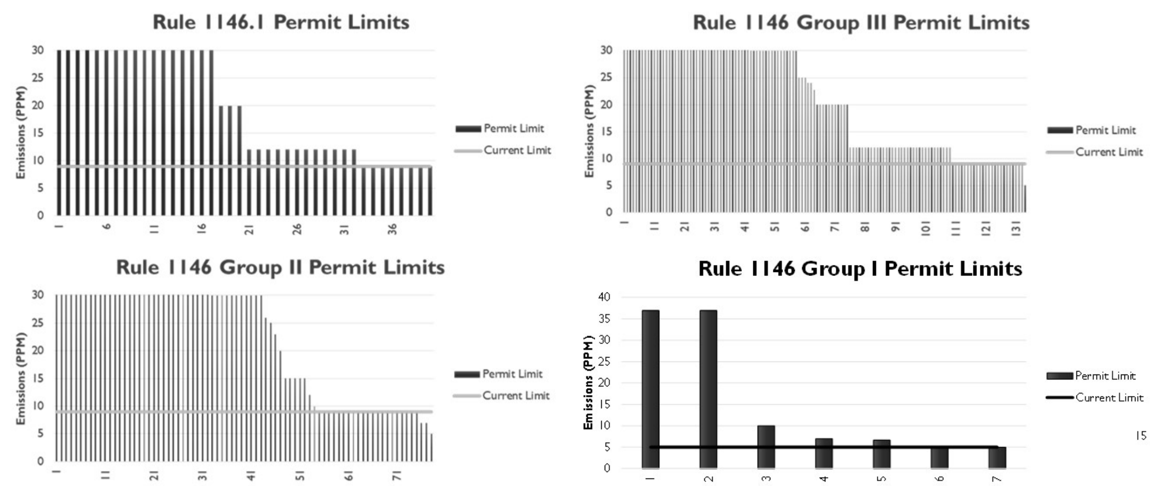
*Command and control equipment distribution figures obtained from 2008 rule revision staff report

RECLAIM Universe



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SCAQMD Regulatory Requirements

Assessment of SCAQMD Regulatory Requirements

Size (MMBtu/hr) / Type	Rules 1146 & 1146.1*	Compliance Date	Implementation Period (Sept 2008 Amendment)
≥75	5 ppm	January 1, 2013	4 years
≥20 to <75	9 ppm	January 1, 2012 thru January 1, 2014	3 – 5 years
≥5 to <20	9 ppm	January 1, 2013 thru January 1, 2015	4 – 6 years
>2 to <5	9 ppm	January 1, 2012 thru January 1, 2014	3 – 5 years
Atmospheric Units (≤10)	12 ppm	January 1, 2014	5 years
Thermal Fluid Heaters	30 ppm	September 5, 2008	Not Applicable

**Requirements are for natural gas fired units.*

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Assessment of SCAQMD Regulatory Requirements

SCAQMD Regulatory Requirements

- Current SCAQMD requirements are feasible and have been achieved since the 2008 amendment
  - Units have met the Rule 1146 and 1146.1 existing emission limits
  - Source test results have demonstrated compliance with existing emission limits

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Other Regulatory Requirements

Rules from Other Air Districts

- Reviewed other rules and regulations outside SCAQMD

San Joaquin Valley APCD	Bay Area AQMD	Other Air Districts / Agencies*
• Less stringent than SCAQMD (7 ppm vs. 5 ppm) for units ≥75 MMBtu/hr • More stringent than SCAQMD (7 ppm vs. 9 ppm) for units ≥20 to <75 MMBtu/hr • Same limits for units <20 MMBtu/hr • Mitigation fee option	• Same limits for units ≥20 MMBtu/hr • Less stringent than SCAQMD for units <20 MMBtu/hr	• Less stringent requirements for units of all sizes

**Mojave Desert, Antelope Valley, Ventura County, San Diego County, Arizona, Delaware, Illinois, Indiana, Maryland, Minnesota, New Jersey, Texas, Wisconsin, Wyoming*

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Other Regulatory Requirements

Rules from Other Air Districts (cont.)

- More stringent emission limits required by San Joaquin Valley APCD for units between 20 and 75 MMBtu/hr
- Lower limits potentially feasible

Size (MMBtu/hr) / Type	South Coast AQMD Rule 1146 & Rule 1146.1	San Joaquin Valley APCD Rule 4320 & Rule 4307
≥75	5 ppm	7 ppm (Standard) 5 ppm (Enhanced)
≥20 to <75	9 ppm	
≥5 to <20	9 ppm	9 ppm (Standard) 6 ppm (Enhanced)
2 to 5	9 ppm	9 ppm
Atmospheric Units (≤10)	12 ppm	12 ppm
Thermal Fluid Heaters	30 ppm	9 ppm

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**San Joaquin Valley APCD sources meeting the "enhanced" vs "standard" emission limit were given a longer implementation period*

Assessment of Pollution Control Technologies

Overview of Pollution Control Technologies

- Technologies that are commercially available and widely used
  - Combustion control
    - Reduce thermal NOx formation
    - Ultra-low NOx burners
    - Various burner configurations and designs (lean premix, flue gas recirculation, fuel/air staging)
    - Typically utilized for units less than 80 MMBtu/hr
  - Post-Combustion control
    - NOx after treatment of the boiler exhaust
    - Selective Catalytic Reduction (SCR) systems
    - Scalable and generally utilized for units > 10 MMBtu/hr
- Prospective transferable technologies being demonstrated in other combustion applications
  - ClearSign Duplex™ Technology
  - Cheng Low-NOx System
  - Flameless Combustion Technology

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Vendor Discussions

Assessment of Pollution Control Technologies

Feasibility of SCR Meeting 4 ppm or Less

- SCR retrofits for Rule 1146 applicable units at 3 ppm or less are potentially feasible but not guaranteed by vendors
- SCR retrofits can achieve 4 ppm or less with several limitations
  - Existing SCR systems might need larger catalyst bed for 5 ppm NH3 slip
  - NOx feedback analyzer might be needed for lower limits
  - Age and flow of catalyst can be limiting factors
- Might not have a sufficient safety margin between permitted limit and actual emissions to account for fluctuations in ambient temperature, gas BTU, etc.

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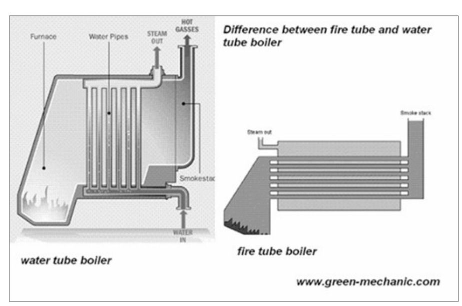
Vendor Discussions (cont.)

Assessment of Pollution Control Technologies

Feasibility of Ultra-Low NOx Burners Meeting 7 ppm or Less

- Feasible for new units (not retrofits) to meet 5 ppm or less
- Retrofits for 7 ppm or less are potentially feasible below a certain size (<50 MMBtu/hr)
- Feasible for existing units currently meeting 9 ppm to potentially meet 7 ppm with burner tuning or replacement
- Some limitations for 7 ppm or less retrofits:
  - Only applicable to fire-tube boilers
  - Additional controls needed, such as VFD and O_2 trim
  - Minimum furnace size required
  - Dependent on back pressure/steam pressure of existing unit



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Vendor Discussions (cont.)

Assessment of Pollution Control Technologies

Atmospheric Units

- Current requirement at 12 ppm
- 9 ppm with ultra-low NOx burners is achievable for new units, but not feasible for all retrofit applications
- Lower NOx emissions are not feasible for all applications since the fluctuations in ambient conditions affect atmospheric units more than sealed combustion boilers

Thermal Fluid Heaters

- Current requirement at 30 ppm
- Thermal fluid heaters operate at significantly higher temperatures, which results in greater NOx emissions
- Units with ultra-low NOx burners guaranteed to meet 20 ppm or less are available
  - Retrofit units could meet 12 to 15 ppm
    - Some efficiency loss with premix combustion due to higher O_2
  - New units for certain applications are capable of meeting 9 ppm

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Vendor Discussions (cont.)

Assessment of Pollution Control Technologies

- Possible recommendations based on vendor discussions for rule 1146.1 and 1146 applicable units:

5 ppm for SCR retrofits

7 ppm for Ultra-low NOx burner retrofits ≤ 50 MMBtu/hr (Fire-tube Only)

12 ppm for Atmospheric units ≤10 MMBtu/hr

12 ppm for Thermal fluid heaters

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Emission Limits for Existing Units

Assessment of Emission Limits for Existing Units

- Reviewed permit limits from:
  - US EPA
  - CARB
  - Various local agencies
- Analyzed and reviewed source test results
- Information gathered was used to establish staff recommendations

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Permitted Limits

Assessment of Emission Limits for Existing Units

- Reviewed lowest permitted limits from SCAQMD and SJVUAPCD permits
- Used available information from respective BACT clearing house

Size (MMBtu/hr)	Permitted Level Below Currently Adopted Rules	Control Technology	New or Retrofit	Type of Boiler
74	7 ppm	SCR	New	Water-Tube
69	5 ppm	SCR	Retrofit	Water-Tube
40 to 50	5 ppm	SCR	New	Water-Tube
29	5 ppm	ULNB	New	Fire-Tube
25	7 ppm	ULNB	New	Fire-Tube
21	5 ppm	SCR	Retrofit	Fire-Tube
19	5 ppm	SCR	Retrofit	Water-Tube
5 to 12	9 to 20 ppm	LNB	New and Retrofit	Thermal Fluid Heater 26
7	12 ppm	LNB	Retrofit	Thermal Fluid Heater

Installations at Other Air Districts or Other Regions Worldwide

Locating Applicable Equipment
(Clearing House[1] and Vendor Information)

National	State	Other Local Districts			
EPA	CARB	BAAQMD	SMAQMD	VCAPCD	SJVUAPCD
No records of equipment permitted at or below 7 ppm with ULNB only					**One unit permitted at 5 ppm NOx**

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1. Clearing house data obtained might not reflect most recent permitting information

Source Test Records

- ❑ Source tests are used to demonstrate compliance with SCAQMD emission limits
  - Testing must be conducted according to district approved methods such as Method 100.1
- ❑ Reviewed source test reports obtained from SCAQMD database
  - Reports submitted by facilities
- ❑ Source test reports are used to analyze actual emissions from permitted equipment
  - Staff reviewed a total of 183 source test reports from RECLAIM and non-RECLAIM equipment

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Source Test Records Analysis

- Total Rule 1146 and Rule 1146.1 Universe: 2,399
- Total Surveyed: 183
  - RECLAIM: 92
  - Non-RECLAIM: 91

Unit Size	Number of units tested and current rule limit	Emissions reported by source test: Retrofit	Emissions reported by source test: New	Possible Recommendations
SCR Boilers **19 to 127 MMBtu/hr**	• Current Limit: 5 PPM • Total Surveyed: 15	Between 2.5-3.5 PPM: 6 Units	2 Units	SCR Boilers >10 MMBtu/hr 4 PPM
Rule 1146 Group II **20-75 MMBtu/hr**	• Current Limit: 9 PPM • Total Surveyed: 44	Between 3.5-6.3 PPM: 4 Units	12 Units	R1146 Group I and II R1146.1 2 to 75 MMBtu/hr 7 PPM
Rule 1146 Group III **5-20 MMBtu/hr**	• Current Limit: 9 PPM • Total Surveyed: 75	Between 3.5-6.3 PPM: 4 Units	13 Units	
Rule 1146.1 **2-5 MMBtu/hr**	• Current Limit: 9 PPM • Total Surveyed: 35	Between 3.3-6.3 PPM: 2 Unit	10 Units	
Thermal Fluid Heaters **2+ MMBtu/hr**	• Current Limit: 20 PPM • Total Surveyed: 14	Between 6.5-10.8 PPM: 2 Unit	3 Units	Thermal Fluid Heaters 12 PPM

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Continuous Emissions Monitoring System (CEMS)

- CONTINUOUS EMISSION MONITORING SYSTEM (CEMS) - the total combined equipment and systems required to continuously determine air contaminants and diluent gas concentrations and/or mass emission rate of a source effluent (as applicable).
- Consists of three major subsystems:
  1. Sampling interface
  2. Analyzer
  3. Data acquisition system (DAS)
- Required by units that meet minimum size and annual input thresholds:
  - Rule 1146:
    - Rated to ≥**40 MMBtu/hr** with annual heat input of **>200x10^9 MMBtu/yr**
  - Rule 2012:
    - Rated between **40 to 500 MMBtu/hr** with annual heat input of **>90x10^9 MMBtu/yr**; or
    - Rated to **>500 MMBtu/hr**

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Technical Assessment

SCAQMD Requirements ⇨ **Current Permit Limits for Existing Units** ⇨ **Source Test Results** ⇨ **CEMS Data** ⇨ **Additional Considerations**

SCAQMD Requirements
- For units ≥ 75 MMBtu/hr, emission limit at 5 ppm
- For units between 2 – 75 MMBtu/hr, emission limit at 9 ppm
- Thermal fluid heaters at 30 ppm

Current Permit Limits for Existing Units
- Equipment with SCR permitted at 5 ppm
- Equipment with ULNB permitted between 7 to 9 ppm
- Thermal fluid heaters permitted at 12 ppm

Source Test Results
- Evaluated a total of 183 source test, and determined possible recommendations
- 4 ppm for Group I & SCR units
- 7 ppm for Group II & III and 1146.1 Units
- 12 ppm for Thermal Fluid Heaters

CEMS Data
- Evaluated CEMS data for 2 facilities with permit limits of 5 ppm for SCR retrofits
- Showed real time emissions fluctuating around 3-4 ppm

Additional Considerations
- Type of Boilers (Fire-tube vs. Water-tube)

Summary of Technical Assessment

- Assessment of SCAQMD Requirements
- Assessment of Emission Limits for Existing Units
- Analysis of Source Test Results
- Analysis of CEMS Data
- Additional Considerations

Recommendations

- SCR
  5 ppm (Current)
- ULNB
  7 ppm for fire-tube
  9 ppm for water-tube
- Thermal Fluid Heaters
  12 ppm
- Atmospheric Units:
  12 ppm (Current)

BARCT Analysis Process

Technology Assessment

Assessment of SCAQMD Regulatory Requirements

Assessment of Emission Limits for Existing Units

Other Regulatory Requirements

Assessment of Pollution Control Technologies

Possible BARCT Emission Standard

Cost-effectiveness analysis needed before BARCT emission standard established

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Technologically Achievable Emission Limit

Group	Size (MMbtu/hr)	Existing Limit	Preliminary Recommendation	Supporting Evidence
Rule 1146 Group I	≥75	5 ppm via SCR	Same as existing limit	n/a
Rule 1146 Group II	≥20 to <75	9 ppm via ULNB	5 ppm via SCR	• Permitted equipment • Vendor discussion • Source test records
Rule 1146 Group III	≥5 to <20	9 ppm via ULNB	Fire-tube boilers: 7 ppm via ULNB Water-tube boilers: 9 ppm via ULNB	• Permitted equipment • Vendor discussion • Source test records
Rule 1146.1	2 to 5	9 ppm via ULNB	Fire-tube boilers: 7 ppm via ULNB Water-tube boilers: 9 ppm via ULNB	• Permitted equipment • Vendor discussion • Source test records
Atmospheric Units	≤10	12 ppm	Same as existing limit	n/a
Thermal Fluid Heaters	NA	30 ppm	12 ppm	• Permitted equipment • Vendor discussion • Source test records

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COST EFFECTIVENESS

Cost Information

- Control technology cost consists of two main components:
  - Capital Cost
  - Annual Operating Cost
- Source of information:
  - Vendor discussion
  - U.S. EPA SCR Cost Manual*

Capital Cost

- Equipment
- Installation
- Permitting fees

Annual Operating Cost

- Additional electricity
- Additional O&M
- Additional monitoring
- Ammonia
- Catalyst

*Available at: https://www3.epa.gov/ttn/ecas/docs/SCRCostManualchapter7thEdition_2016.pdf

Capital Cost (Equipment + Installation)

- ❑ Obtained cost estimates from 5 vendors
- ❑ Capital cost based on:
  - Equipment size
  - NOx emission limit
  - Control technology (ultra-low NOx burner retrofits, SCR retrofits)
- ❑ Assumptions:
  - Retrofits only
  - No major changes to existing units (no structural or foundation changes)
  - An equipment lifespan of 15 years for ultra-low NOx burner and 25 years for SCR
- ❑ Significant deviation in cost from one vendor
  - Compared average cost
    - with outliers
    - without outliers

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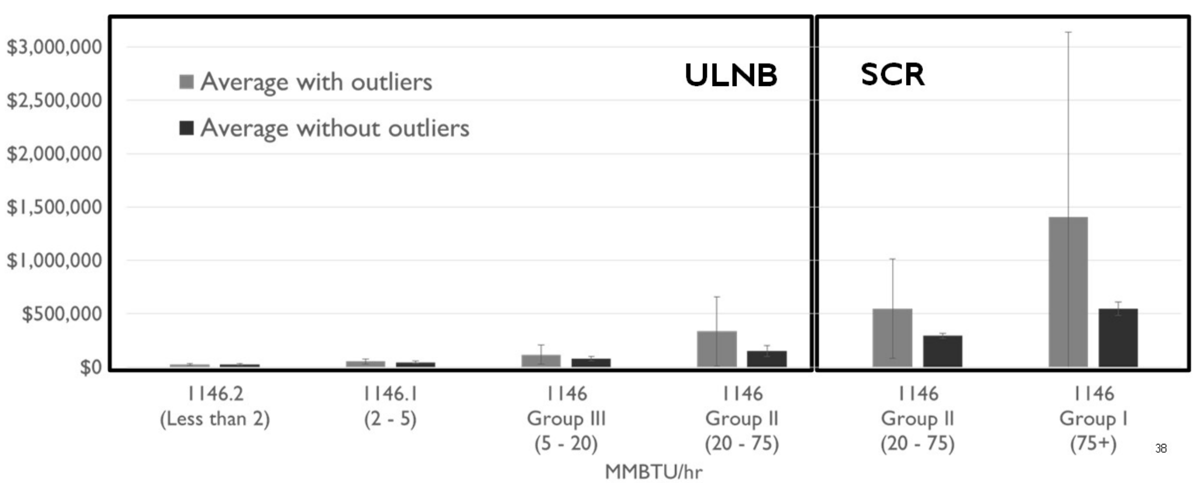
Average Capital Cost (Equipment + Installation)



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Additional Electricity Cost

❑ Recurring annual cost for the additional energy consumption above that already required for the existing operation

Potential cost increase → Potential savings → Staff Proposes

	Potential cost increase	Potential savings	Staff Proposes
Ultra-low NOx burner retrofit	Flue gas recirculation (FGR) uses higher dilution requiring additional energy	▪ Improved burner efficiency with higher turndowns ▪ Installation of O_2 sensors and variable frequency drive (VFD) can reduce electricity cost	No additional energy cost
SCR system retrofit	Additional energy needed for higher pressure, ammonia vaporization, and induction fan	For units that currently use FGR, potential savings from lower use/removal of FGR	To account for savings from FGR reduction based on percentage of existing non-compliant units with FGR

Additional Electricity Cost – SCR

- ❑ U.S. EPA SCR Cost Manual* used to estimate the additional energy cost
- ❑ Annual electricity cost based on:
  - SCR power consumption (kW)
  - Annual electricity cost ($0.10 per kW-hr)
  - Operating capacity (50%)

*Available at: https://www3.epa.gov/ttn/ecas/docs/SCRCostManualchapter7thEdition_2016.pdf

Ammonia and Catalyst Cost

- SCR uses catalyst and ammonia (NH_3) to selectively reduce NOx
  - Ammonia is injected into the flue gas stream where it reacts with NOx and oxygen within the catalyst to produce nitrogen and water vapor
  - U.S. EPA SCR Cost Manual* used to estimate ammonia and catalyst cost
- Recurring annual cost for ammonia and catalyst based on:

Ammonia	Catalyst
• Consumption rate (lb/hr) • Aqueous NH_3 price (\$/lb NH_3)	• Catalyst volume (ft^3) • Catalyst cost (\$/ft^3) • Replacement frequency (7 – 12 yrs)

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* Available at: https://www3.epa.gov/ttn/ecas/docs/SCRCostManualchapter7thEdition_2016.pdf

Additional Operation & Maintenance Cost

- Recurring annual cost for operation & maintenance (O&M) labor and materials not already part of existing operations
- Emissions monitoring considered separately

	Existing O&M	New O&M	Staff Proposes
Ultra-low NOx burner retrofit	Contracts already in place to maintain existing burner	Less maintenance and fewer repairs for retrofit burner	No additional O&M cost
SCR system retrofit	Existing boiler O&M with no SCR	Annual SCR maintenance checks	To account for additional SCR system O&M

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Additional Monitoring Cost

- ❑ Recurring annual cost for additional monitoring, reporting, and recordkeeping (MRR) not already required
- ❑ Existing RECLAIM MRR requirements comparable with landing rule requirements (except for reporting)

	Existing MRR	New MRR	Staff Proposes
Ultra-low NOx burner retrofit	Requirements for existing unit specified in Rule 2012	Requirements for retrofit unit specified in R1146 series	No additional MRR cost
SCR system retrofit	Not applicable for SCR retrofit	• Requirements for existing unit specified in R1146 series • SCR system annual ammonia slip test	To account for additional emissions testing

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Potential Monitoring/Reporting Savings

- ❑ Reporting requirements

Rule 1146	RECLAIM
• Every 6-months (Rule 218) for units >40 MMBtu/hr	• Daily, monthly, and quarterly electronic reporting • Paper submittal of quarterly certifications and annual permit emissions reports

- Savings based on estimated annual staffing cost needed to fulfill RECLAIM reporting requirements
  - Potential savings approximately $40,000 and $2,000 per piece of major and non-major sources, respectively

- ❑ Continuous emission monitoring system (CEMS) applicability threshold:

	Rule 1146	**RECLAIM**
Size	40 MMBtu/hr	40 MMBtu/hr
Fuel Usage	200 Billion Btu per year	90 Billion Btu per year

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Determination of Cost Effectiveness and Emission Reductions

- Cost effectiveness is measured in terms of the control equipment cost in dollars per ton of air pollutant reduced

$$Cost\ Effectiveness = \frac{Present\ worth\ value}{Emissions\ reductions\ over\ equipment\ life}$$

- Present worth value of the control equipment is the capital cost plus the annual operating cost over the life of the equipment

$$Present\ worth\ value = Capital\ cost + (Annual\ operating\ cost\ \times Present\ worth\ factor)$$

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Baseline Emissions

1. Determine fuel usage from AER reports
2. Retrieve permit limit for equipment
3. For RECLAIM major sources without permit limits, emission limit was calculated using annual AER usage and CEMS throughout data
4. Emissions for equipment missing AER data were calculated assuming 50% capacity

1 Usage from Annual Emission Reports (AER)

2 Equipment specific permit limits

3 CEMS data and RATA results

Baseline Calculation:

$$\mathrm{B_u} = \sum (A\ x\ P)$$

B_U = Total Baseline Emissions for Universe [in Pounds]
A = AER fuel usage [in mmSCF]
P = Permit Limit [in Pounds per mmSCF]

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Emission Reductions

__Emission Reduction Calculation:__

$$P_e = \sum(Be \times \frac{\mathrm{Pr}}{P_l})$$

$$\mathrm{T_r} = B_u - P_\mathrm{e}$$

$\mathrm{P_e}$ = Total Emissions from Proposed Limits [in tpd]
$\mathrm{B_e}$ = Baseline Emission per Equipment [in tpd]
$\mathrm{P_r}$ = Proposed Emissions Limit [in ppm]
$\mathrm{P_l}$ = Current Permit Limit [in ppm]
$\mathrm{T_r}$ = Total Reductions
$\mathrm{B_u}$ = Total Baseline Emissions for Universe

Calculate Baseline	
AER Data	Permit Limits

Determine Future Baseline Emissions	
Baseline	Ratio of proposed limits and permit limits

Calculate Reduction	
Current Baseline Emissions	Future Baseline Emissions

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Cost Effectiveness Methodology

- Cost effectiveness calculated using the discount cash flow methodology assuming:
  - 4% interest rate
  - A useful life of 25 years for SCR systems
  - A useful life of 15 years for ultra-low NOx burners
  - Considered potential savings, if applicable
  - Average equipment and installation cost with outliers

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Cost Effectiveness

Group	Size (MMBtu/hr)	Preliminary Recommended Emission Limit	Cost Effectiveness ($/ton)	
Rule 1146 Group I	≥75	5 ppm via SCR (existing limit)	$16,000*	
Rule 1146 Group II	≥20 to <75	5 ppm via SCR	For units > 12 ppm*	For units ≤ 12 ppm*
			$29,000	>$50,000
Rule 1146 Group II	≥20 to <75	7 ppm via ULNB for fire-tube boilers	For units ≤ 12 ppm	
			$13,000 when compliance deferred until burner replacement	
Rule 1146 Group III	≥5 to <20	7 ppm via ULNB for fire-tube boilers	For units > 12 ppm*	For units ≤ 12 ppm*
			$29,000	$14,000 when compliance deferred until burner replacement
Rule 1146.1	2 to 5	Same as above	For units > 12 ppm*	For units ≤ 12 ppm*
			$48,000	$13,000 when compliance deferred until burner replacement
Atmospheric Units	≤10	12 ppm via ULNB (existing limit)	$34,000^	
Thermal Fluid Heaters	NA	12 ppm via ULNB	$39,000^	

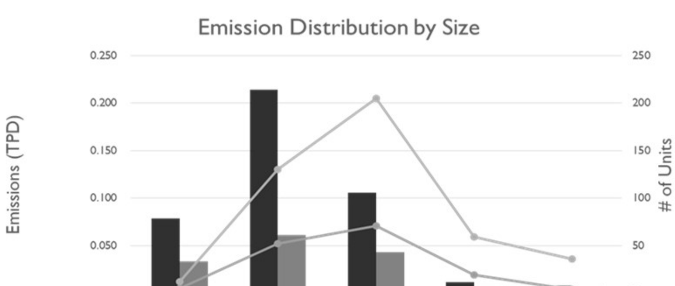
** Estimated using emissions from RECLAIM units*
^ Estimated assuming 20% operating capacity and a baseline of 30 ppm

PRELIMINARY STAFF RECOMMENDATION

Staff Recommendation

Group	Size (MMbtu/hr)	Preliminary Recommended Emission Limit	Requirements for Existing Units and for Group II, Group III and Rule 1146.1 Units ≤ 12 ppm
Rule 1146 Group I	≥75	5 ppm via SCR (same as existing limit)	n/a
Rule 1146 Group II	≥20 to <75	For units > 12 ppm: 5 ppm via SCR	To apply Group III limits to Group II units upon burner replacement
Rule 1146 Group III	≥5 to <20	For units > 12 ppm: Fire-tube boilers: 7 ppm via ULNB Water-tube boilers: 9 ppm via ULNB	Compliance deferred until burner replacement
Rule 1146.1	2 to 5	For units > 12 ppm: Fire-tube boilers: 7 ppm via ULNB Water-tube boilers: 9 ppm via ULNB	Compliance deferred until burner replacement
Atmospheric Units	≤10	12 ppm via ULNB (same as existing limit)	n/a
Thermal Fluid Heaters	NA	12 ppm	To apply 12 ppm limit to entire universe including non-RECLAIM units; Compliance deferred until burner replacement for units permitted at ≤ 20 ppm

Emission Reductions



	Rule 1146 Group I	Rule 1146 Group II	Rule 1146 Group III	Rule 1146.1	Rule 1146.2
Baseline	0.079	0.214	0.105	0.011	0.008
Proposed	0.034	0.061	0.043	0.005	0.005
# of Total Units	7	78	134	40	32
# of Retrofits	5	52	71	19	4

- Emission reduction estimates are calculated with RECLAIM universe
- Units already covered by command and control limits will not need to meet proposed limits until burner replacement
- Based on preliminary staff recommendations, total emission reduction is 0.25 tpd by the compliance timeframe (Jan. 1, 2023 in Proposed Rule 1100)

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Updated Schedule

▪ Aug – Oct 2018	Working Group Meetings
▪ Aug 29, 2018	Public Workshop
▪ Oct 19, 2018	Stationary Source Committee
▪ Nov 2, 2018	Set Hearing
▪ Dec 7, 2018	Public Hearing

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Contacts

General RECLAIM Questions	Proposed Amended Rules 1146, 1146.1, 1146.2 and Proposed Rule 1100
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