



PROPOSED AMENDED RULE 1135

Emissions of Oxides of Nitrogen from Electric Power Generating Systems

Working Group Meeting #2

April 26, 2018

Agenda

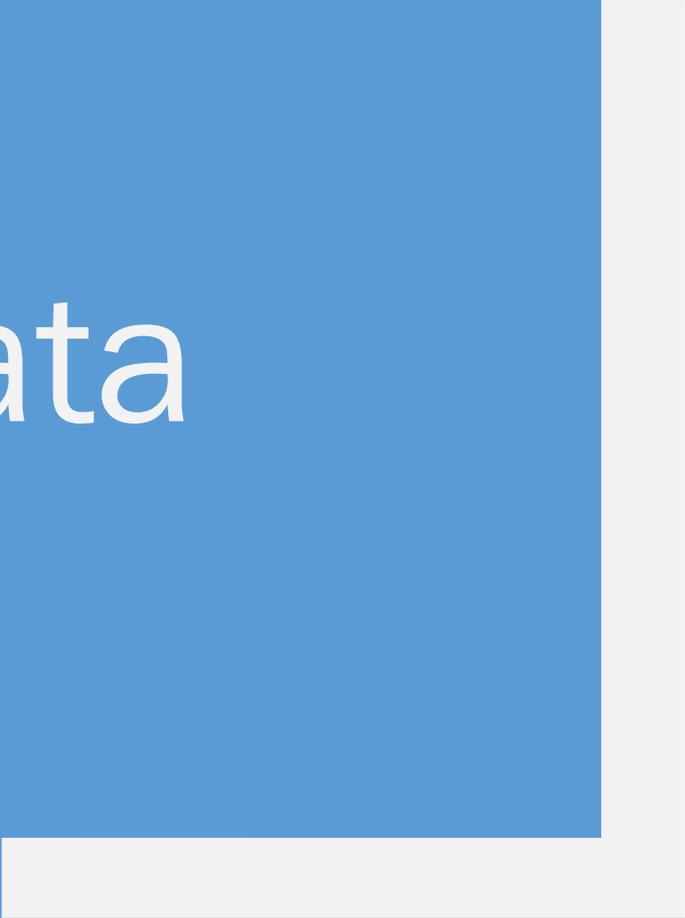
- Summary of Working Group #1
- Individual Stakeholder Meetings
- Emissions Data from PAR 1135 Equipment
- Initial BARCT Assessment
- Initial Rule Concepts

Summary of Working Group #1 (01/24/18)

- Background
 - *2016 AQMP and AB 617*
 - *Regulatory Background for Electricity Generating Facilities*
 - Rule 2009
- Proposed Amended Rule (PAR) 1135 Facilities
- Equipment at Electricity Generating Facilities
- Initial Concepts
 - *NOx Limit Recommendations*
 - *Implementation Timeline*
 - *Monitoring, Reporting, and Recordkeeping*
- Potential Issues

Individual Stakeholder Meetings

- Individual meetings with stakeholders
 - *12 stakeholders, covering 25 facilities*
 - *General Discussion Points*
 - Facility operations
 - Implementation timeline
 - Electricity generating facilities need flexibility to handle power demands, outages, etc.
 - Unique circumstances and challenges
 - Startup and shutdown limits
 - Monitoring, Reporting, and Recordkeeping
 - Low use exemptions
 - Incremental cost-effectiveness
 - Permitting
- Staff would like to meet with the remaining 8 stakeholders (covering 9 power plants)



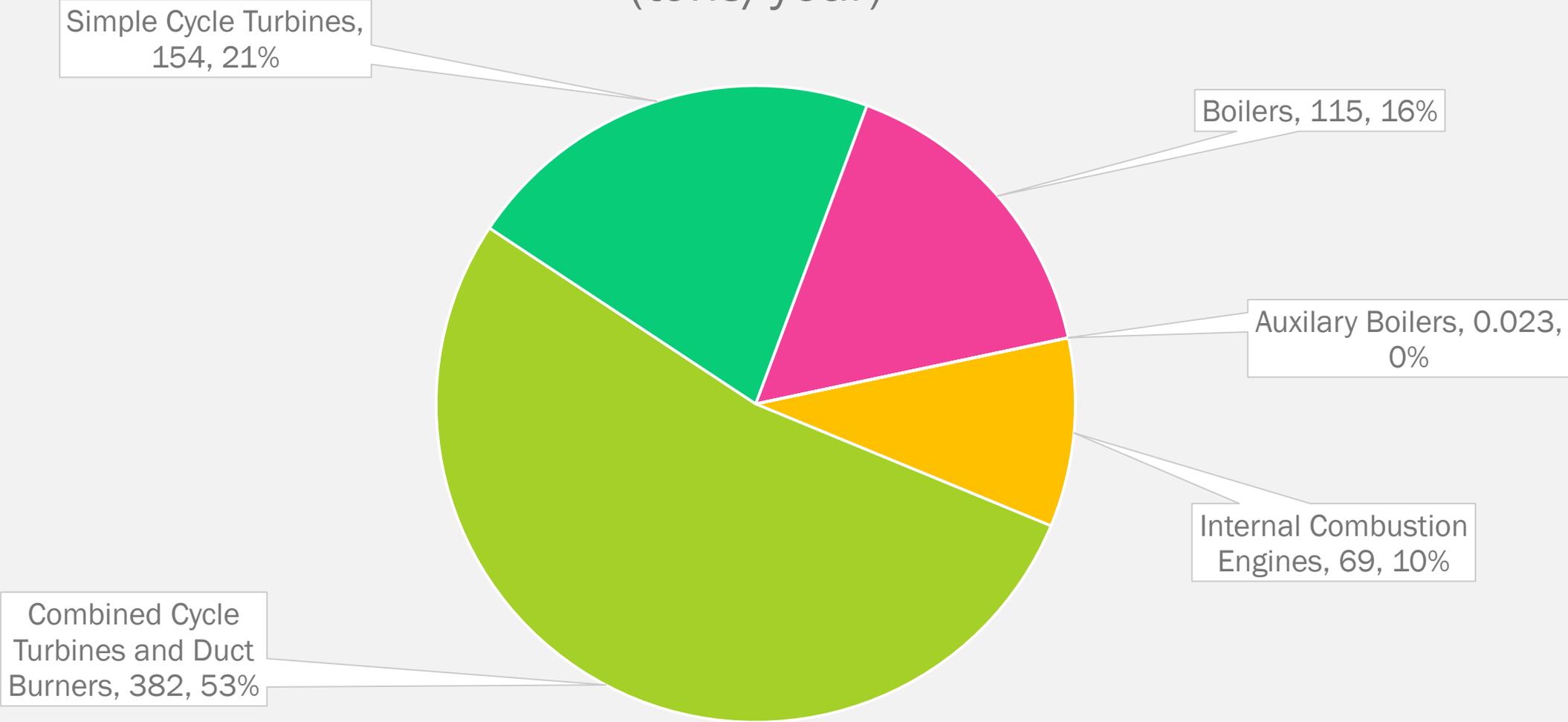
Emissions Data

Emissions Data – Overview

- Working Group #1
 - *Summarized equipment at electricity generating facilities*
 - Data broken down by equipment category (internal combustion engines, boilers, simple cycle turbines, and combined cycle turbines/duct burners)
 - For each equipment category, compared equipment size versus permit emission limit
- Staff has further refined data and compiled annual emissions data
 - *147 pieces of equipment*
 - 6 non-emergency internal combustion engines at 1 facility
 - 25 boilers
 - *24 utility boilers at 8 facilities*
 - *1 auxiliary boiler at 1 facility*
 - *1 permit pending for auxiliary boiler*
 - 67 simple cycle turbines at 21 facilities
 - *8 permits pending at 3 facilities*
 - 35 combined cycle turbines/duct burners at 13 facilities
 - *2 permits pending at 2 facilities*



2016 NOx Emissions from EGFs (tons/year)



Initial BARCT Assessment

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 is reassessed periodically and is updated as technology advances

Guiding Principles for Establishing BARCT Levels

- Consistent with state law, BARCT levels will take into account:
 - *Environmental impacts;*
 - *Energy impacts; and*
 - *Economic impacts*
- Must adhere to Health and Safety Code Section 40920.6, which establishes requirements prior to adopting rules or regulations regarding retrofit control technologies
- In addition to the overall cost-effectiveness, additional considerations for:
 - *Outliers*
 - *Stranded assets*
 - *Incremental cost-effectiveness*
 - *Accounting for recent installations – implementation of previous requirements (BARCT or BACT)*

Background on BARCT Assessment for EGFs

- 1991 – Rule 1135
 - *BARCT assessment for system wide emission rates, daily and annual emission caps, oil-burning, and cogeneration*
- 2001 – Adoption of Rule 2009
 - *Required installation of BARCT through compliance plans*
- 2014 – Norton Engineering Study
 - *Indicated 2 PPM NO_x level can be achieved by retrofit with catalyst modifications and additions*
- 2018 – Amend Rule 1135
 - *Conduct a new BARCT assessment*

BARCT Analysis Approach



Emission Levels Achieved In Practice

Identifying Emission Levels Achieved In Practice

- Grouped equipment by equipment type
- Identified:
 - *Permit emission limits*
 - *Types of control*
 - *If emission limit is based on retrofit or replacement*
 - *Installation and retrofit year*

Non-Emergency Internal Combustion Engines

- 6 diesel units result in 10% of EGF NO_x emissions (69 tons)
- NO_x permit emission limits ranges from 55 - 140 PPM
- All units installed at least 23 years ago
 - *5 of the units are older than 33 years old*
- All units controlled with SCR at 70%
 - *5 of the units were retrofitted in 2003*
 - *1 unit is an original installation*

Non-Emergency Internal Combustion Engines (Diesel)

Unit	Size (HP)	Output (MW)	Install Year	Retrofit Year	Control*	NOx Limit (PPM)	NH3 Limit (PPM)	2016 NOx Emissions (tons)
ICE1	1,575	1.125	1968	2003	SCR at 70% reduction	140	10	16
ICE3	2,200	1.4	1985	2003	SCR at 70% reduction	103	10	5.3
ICE5	1,500	1	1967	2003	SCR at 70% reduction	97	10	12
ICE6	2,150	1.5	1964	2003	SCR at 70% reduction	97	10	8.2
ICE2	3,900	1.5	1976	2003	SCR at 70% reduction	82	10	22
ICE4	1,950	2.8	1995	None	SCR at 70% reduction	55	10	5.9

*SCR – Selective Catalytic Reduction

Utility Boilers

- 24 units result in 16% of EGF NOx emissions (115 tons)
 - *17 natural gas units are to be repowered due to one-through-cooling (OTC) policy by 2029 at latest*
 - 81.4 tons NOx/year
 - *11% of EGF NOx emissions*
 - *71% of Utility Boiler NOx emissions*
 - NOx permit emission limits ranges from 5 - 90 PPM
 - *4 units with 5 PPM NOx permit emission limit*
 - *12 units with 7 PPM NOx permit emission limit*
 - *1 unit at 90 PPM NOx permit emission limit*
 - Units are between 49 - 70 years old
 - 16 units are controlled, all as retrofits

Once-Through-Cooling Utility Boilers Repowering

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Retrofit Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)	OTC Repower Date
B21	4752	480	1968	1994	SCR/FGR/Staged Comb	5	20	5.4	9/30/2019
B2	2021	215	1958	2001	SCR	7	10	8.2	11/1/2019
B5	514		1948		none	90	N/A	0.0	11/1/2019
B17	1785	175	1954	2001	SCR/Staged Comb	7	10	1.3	11/1/2019
B20	1785	175	1957	2001	SCR/Staged Comb	7	10	3.3	11/1/2019
B22	4752	480	1968	1994	SCR/FGR/Staged Comb	5	20	3.3	11/1/2019
B1	1785	175	1956	2001	SCR/FGR/Staged Comb	7	10	2.0	12/29/2019
B6	1785	175	1957	2001	SCR/FGR/Staged Comb	7	10	3.8	12/29/2019
B19	4752	480	1966	1994	SCR/FGR	5	20	2.3	12/29/2019

*FGR – Flue Gas Recirculation

*SCR – Selective Catalytic Reduction

*Staged Comb – Staged Combustion

Once-Through-Cooling Utility Boilers Repowering (continued)

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Retrofit Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)	OTC Repower Date
B16	4750	480	1969	1994	SCR/LNB/FGR	5	20	2.1	12/31/2020
B10	3350	320	1961	2001	SCR/FGR	7	10	14	12/31/2020
B13	3350	320	1962	2001	SCR/FGR	7	10	8.6	12/31/2020
B7	2021	215	1958	2001	SCR	7	10	7.6	12/31/2020
B4	1750	179	1958	2002	SCR	5	10	6.9	12/31/2024
B9	1750	179	1959	2002	SCR	5	10	1.8	12/31/2024
B3	2240	230	1962	1993	SCR	5	20	5.3	12/31/2029
B8	2240	230	1963	1993	SCR	5	20	5.5	12/31/2029

*FGR – Flue Gas Recirculation

*LNB – Low NOx Burner

*SCR – Selective Catalytic Reduction

Utility Boilers (*Continued*)

- 7 units remaining
 - *NOx permit emission limits ranges from 5 - 82 PPM*
 - 2 natural gas units with 5 PPM NOx permit emission limit
 - 2 natural gas units with 7 PPM NOx permit emission limit
 - 3 landfill gas units with 38 - 82 NOx permit emission limits
 - *Units are between 49 to 65 years old*
 - *All units controlled*
 - 5 of the units are retrofits
 - 2 of the landfill gas units are original installations

Utility Boilers

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Retrofit Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)
B23	552	44	1959	2002	SCR/LNB	5	10	0.0
B24	605	55	1964	2002	SCR	5	10	0.0
B11	2900	320	1963	2001	FGR/Staged Comb/SCR	7	10	3.6
B12**	260	20	1953		LNB/FGR	40	N/A	3.7
B14	2900	320	1963	2001	FGR/Staged Comb/SCR	7	10	4.1
B15**	492	44	1959		LNB/FGR	82	N/A	9.2
B18**	527	44	1969	2002	FGR/SNCR	38	10	13

** Landfill gas fired

*FGR – Flue Gas Recirculation

*LNB – Low NOx Burner

*SCR – Selective Catalytic Reduction

*SNCR – Selective Non-Catalytic Reduction

*Staged Comb – Staged Combustion

Simple Cycle Turbines

- 67 units result in 21% of EGF NO_x emissions (154 tons)
 - *All units are original installations, none are retrofitted*
 - *37 units (55%) are at or below 2.5 PPM NO_x and 5 PPM NH₃*
 - All units installed in 2006 or later (3 - 12 years old)
 - (2) 490 MMBTU/HR units have a 2.3 PPM NO_x and 5 PPM NH₃ emission limits (installed in 2009)
 - *30 units are greater than 2.5 PPM NO_x and 5 PPM NH₃*
 - NO_x permit emission limits ranges from 3.5 - 24 PPM
 - *1 unit with 3.5 PPM NO_x permit emission limit*
 - *25 units with 5 PPM NO_x permit emission limit*
 - *2 units with 9 PPM NO_x permit emission limit*
 - *2 units with 24 PPM NO_x permit emission limit*
 - Install dates range from 1975 – 2003 (15 – 43 years old)

Simple Cycle Turbines Less Than 2.5 PPM NOx & 5 PPM NH3

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)
T-SC-44	490	50	2009	SCR/water injection	2.3	5	0.72
T-SC-53	490	50	2009	SCR/water injection	2.3	5	0.87
T-SC-9	871.3	65	2007	SCR/water injection	2.5	5	0.91
T-SC-22	906.6	103	2013	SCR/water injection	2.5	5	0.94
T-SC-26	906.6	103	2013	SCR/water injection	2.5	5	1.1
T-SC-49	871.3	65	2007	SCR/water injection	2.5	5	1.2
T-SC-29	871.3	65	2007	SCR/water injection	2.5	5	1.2
T-SC-39	871.3	65	2007	SCR/water injection	2.5	5	1.2
T-SC-14	490	50	2006	SCR/water injection	2.5	5	1.3
T-SC-36	479	50	2011	SCR/water injection	2.5	5	1.3

*SCR – Selective Catalytic Reduction

Simple Cycle Turbines Less Than 2.5 PPM NO_x & 5 PPM NH₃ (continued)

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NO _x Limit (PPM)	NH ₃ (PPM)	2016 NO _x Emissions (tons)
T-SC-34	490	50	2006	SCR/water injection	2.5	5	1.3
T-SC-46	479	50	2011	SCR/water injection	2.5	5	1.4
T-SC-55	479	50	2011	SCR/water injection	2.5	5	1.5
T-SC-71	505	47	2007	SCR/water injection	2.5	5	1.5
T-SC-17	479	50	2011	SCR/water injection	2.5	5	1.5
T-SC-72	522	47	2007	SCR/water injection	2.5	5	1.7
T-SC-69	505.7	47	2007	SCR/water injection	2.5	5	1.9
T-SC-70	511.5	47	2007	SCR/water injection	2.5	5	2.0
T-SC-8	891.7	100	2013	SCR/water injection	2.5	5	2.0
T-SC-3	891.7	100	2013	SCR/water injection	2.5	5	2.5

*SCR – Selective Catalytic Reduction

Simple Cycle Turbines Less Than 2.5 PPM NO_x & 5 PPM NH₃ (continued)

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NO _x Limit (PPM)	NH ₃ (PPM)	2016 NO _x Emissions (tons)
T-SC-6	891.7	100	2013	SCR/water injection	2.5	5	2.6
T-SC-7	891.7	100	2013	SCR/water injection	2.5	5	2.6
T-SC-5	891.7	100	2013	SCR/water injection	2.5	5	2.6
T-SC-2	891.7	100	2013	SCR/water injection	2.5	5	2.7
T-SC-1	891.7	100	2013	SCR/water injection	2.5	5	2.7
T-SC-4	891.7	100	2013	SCR/water injection	2.5	5	2.7
T-SC-28	906.6	103	2013	SCR/water injection	2.5	5	3.8
T-SC-27	906.6	103	2013	SCR/water injection	2.5	5	4.4
T-SC-24	906.6	103	2013	SCR/water injection	2.5	5	4.6
T-SC-20	906.6	103	2013	SCR/water injection	2.5	5	4.9

*SCR – Selective Catalytic Reduction

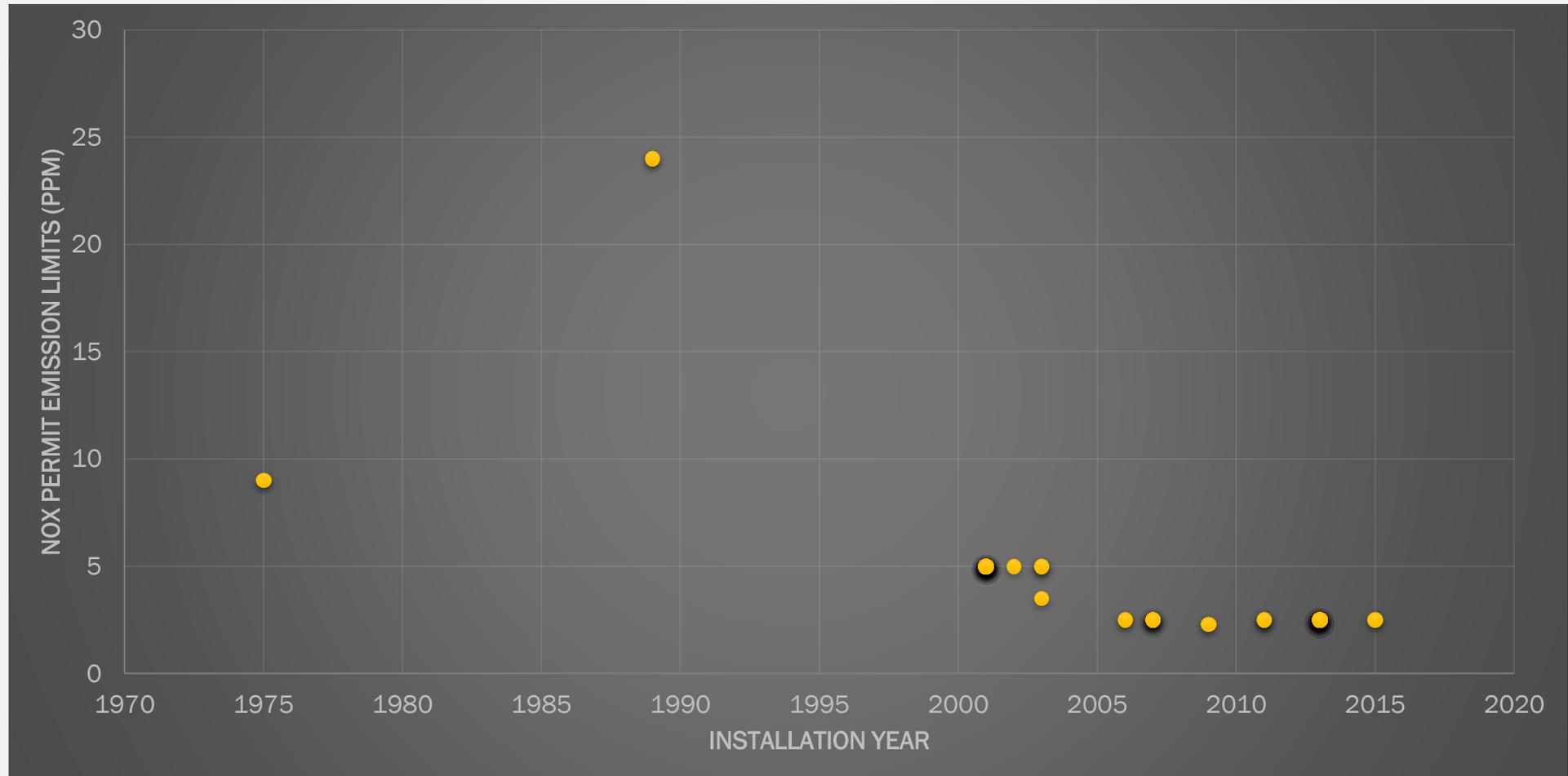
Simple Cycle Turbines Less Than 2.5 PPM NOx & 5 PPM NH3 *(continued)*

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)
T-SC-60	959	106	2015	SCR/water injection	2.5	5	7.0
T-SC-58	891.7	100	2013	SCR/water injection	2.5	5	7.7
T-SC-54	891.7	100	2013	SCR/water injection	2.5	5	8.0
T-SC-62	959	106	2015	SCR/water injection	2.5	5	8.2
T-SC-45	891.7	100	2013	SCR/water injection	2.5	5	9.7
T-SC-16	891.7	100	2013	SCR/water injection	2.5	5	9.7
T-SC-35	891.7	100	2013	SCR/water injection	2.5	5	10.2

*SCR – Selective Catalytic Reduction

Simple Cycle Turbines

NOx Emission Limits by Installation Date



Combined Cycle Gas Turbines and Duct Burners

- 35 units result in 53% of EGF NO_x emissions (382 tons)
 - *All units are original installations, none are retrofitted*
 - *24 units (69%) are at or below 2.0 PPM NO_x and 5 PPM NH₃*
 - *All units installed in 2005 or later (3 - 13 years old)*
 - *11 units are greater than*
 - *NO_x emission limits ranges from 2.5 - 9 PPM*
 - *5 units with 2.5 PPM NO_x permit emission limit*
 - *2 units with 7 PPM NO_x permit emission limit*
 - *1 unit with 7.6 PPM NO_x permit emission limit*
 - *3 units with 9 PPM NO_x permit emission limit*
 - *Install dates range from 1976 - 2010 (equipment age is 8 - 42 years)*

Combined Cycle Turbines and Duct Burners Less Than 2.0 PPM NOx & 5 PPM NH3

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)
T-CC-21	547.5	71	2015	SCR/water injection	2	5	0.43
T-CC-10	2597	405	2008	SCR/DLN	2	5	1.8
T-CC-9	2597	405	2008	SCR	2	5	6.2
T-CC-11	454.05	71.7	2005	SCR	2	5	9.8
DB-11	81.2		2005	SCR	2	5	10
T-CC-12	454.05	71.7	2005	SCR	2	5	9.9
DB-12	81.2		2005	SCR	2	5	10
T-CC-6	2096	286.5	2013	SCR/DLN	2	5	11
T-CC-7	2096	386.5	2013	SCR/DLN	2	5	11

*SCR – Selective Catalytic Reduction

*DLN – Dry Low NOx

Combined Cycle Turbines and Duct Burners Less Than 2.0 PPM NOx & 5 PPM NH3 (continued)

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)
T-CC-18	1757	295	2008	SCR/water injection	2	5	21
DB-18	286.6		2008	SCR/water injection	2	5	0.7
T-CC-15	1991	264	2005	SCR/DLN	2	5	23
DB-15	135		2005	SCR/DLN	2	5	0.2
T-CC-14	1991	264	2005	SCR/DLN	2	5	23
DB-14	135		2005	SCR/DLN	2	5	0.13
T-CC-13	1991	264	2005	SCR/DLN	2	5	24
DB-13	135		2005	SCR/DLN	2	5	0.13
T-CC-16	1991	264	2005	SCR/DLN	2	5	25
DB-16	135		2005	SCR/DLN	2	5	0.18

*SCR – Selective Catalytic Reduction

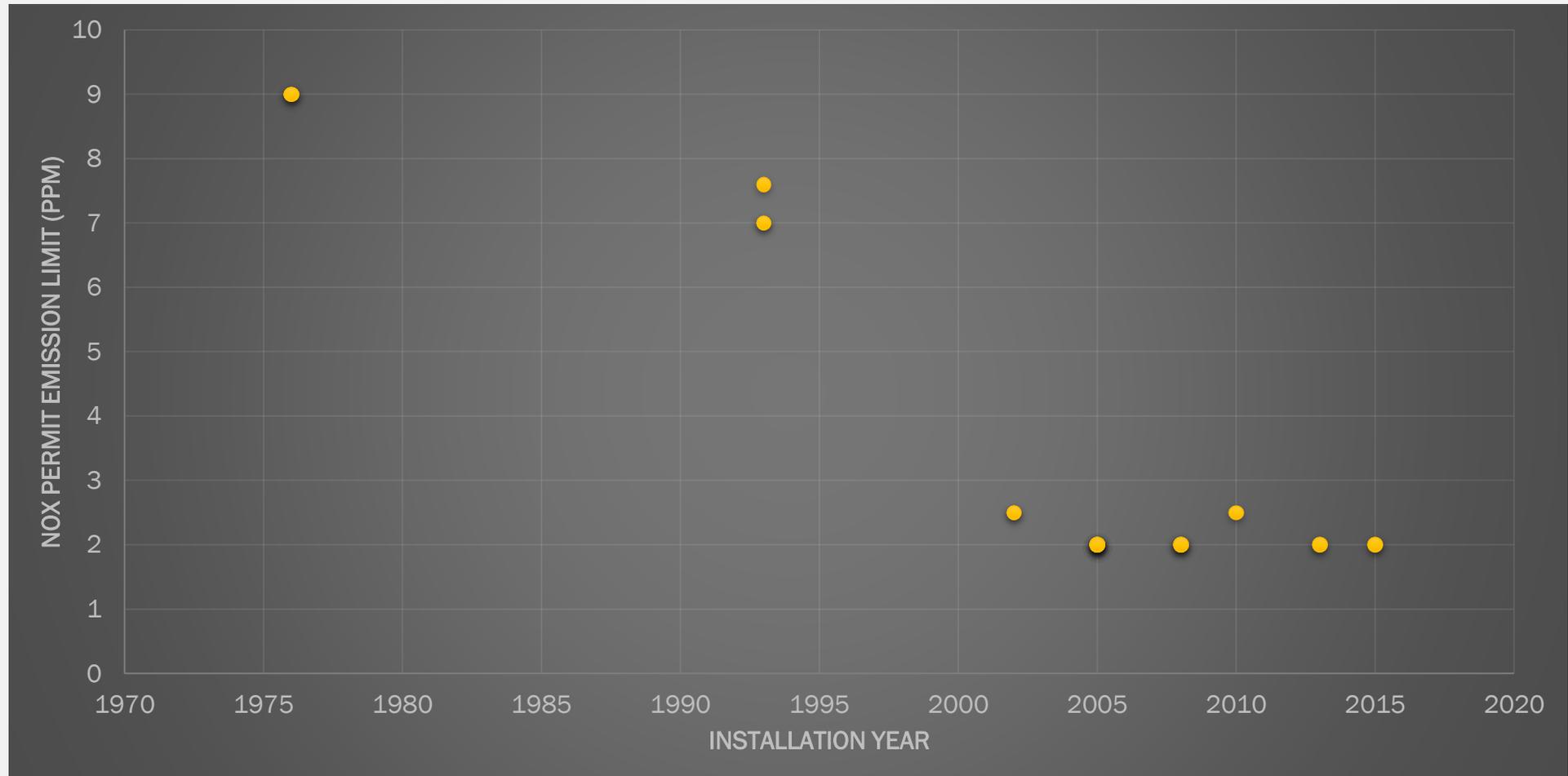
*DLN – Dry Low NOx

Combined Cycle Turbines and Duct Burners Less Than 2.0 PPM NOx & 5 PPM NH3 (continued)

Unit	Size (MMBTU/HR)	Output (MW)	Install Year	Control*	NOx Limit (PPM)	NH3 (PPM)	2016 NOx Emissions (tons)
T-CC-20	2205	321	2015	SCR/DLN	2	5	26
T-CC-8	1787	328	2005	SCR/DLN	2	5	33
DB-8	583		2005	SCR/DLN	2	5	0.0
T-CC-19	1757	295	2008	SCR/water injection	2	5	38
DB-19	286.6		2008	SCR/water injection	2	5	0.67

*SCR – Selective Catalytic Reduction

Combined Cycle Turbines NOx Emission Limits by Installation Date



Summary – Achieved in Practice

Equipment	Retrofit NOx Limit (ppm)	Equipment Meeting Limit	New Install NOx Limit (ppm)	Equipment Meeting Limit
Non-Emergency Internal Combustion Engine (Diesel)	82	17%, 1 unit	55	17%, 1 unit
Utility Boiler (Natural Gas)	5	25%, 6 units	40	4%, 1 unit
Simple Cycle Turbine (Natural Gas)	None	N/A	2.3	3%, 2 units
Combined Cycle Turbine/ Duct Burner (Natural Gas)	None	N/A	2.0	69%, 24 units

Other Air Districts

Rule Limits in Other Air Districts

Non-Emergency Internal Combustion Engines (Diesel)	
Agency	NOx Limit (PPM)
Bay Area AQMD	Rich Burn – 56 Lean Burn – 140
San Joaquin Valley APCD	80

Utility Boilers		
Agency	Boiler Capacity (MMBTU/HR)	NOx Limit (PPM)
Bay Area AQMD	> 1,175	10
	> 1,500 to < 1,175	25
	< 1,500	30
San Joaquin Valley APCD	> 20	6

Rule Limits in Other Air Districts

Turbines			
Agency	Capacity (MMBTU/HR)	Output (MW)	NOx Limit (PPM)
Bay Area AQMD*	5 - 50	N/A	42
	> 5 - 150		25 - 42
	> 150 - 250		15
	> 250 - 500		9
	> 500		5
San Joaquin Valley APCD	< 35**	< 3	25
	< 35 - 130**	< 3 - 10	25
	> 130**	> 10	25 - 42

*Currently under review

**Non-regulatory, converted for comparison purposes only

SCAQMD Limits

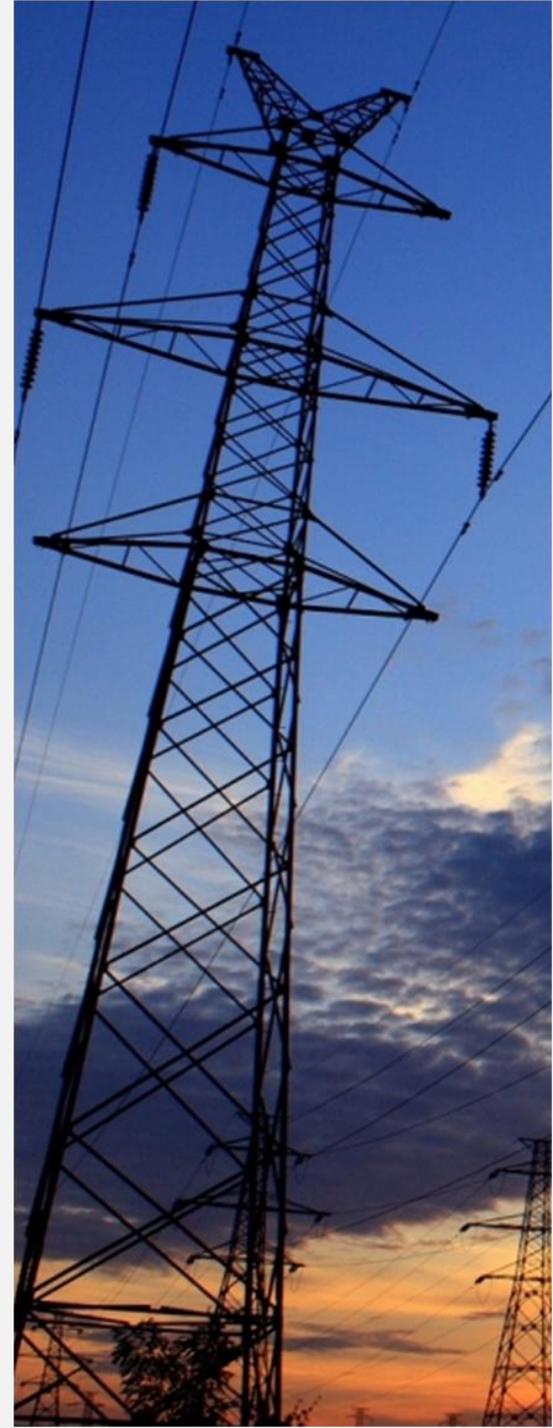
Non-Emergency Internal Combustion Engines

■ SCAQMD Rule 1110.2 Limits

- *New Non-Emergency Electrical Generators (Natural Gas)*
 - 0.07 LBS/NET MWH, 15 minute average (~3 PPM at 15% O₂)
- *Existing Non-Emergency Electrical Generators (Natural Gas)*
 - 11 PPM @ 15% O₂, 15 minute average

Utility Boilers

- 2005 BARCT Limit
 - *7 PPM at 3% O₂*
- 2005 Rule 2009 Compliance Plans
 - *10 units at 5 PPM at 3% O₂*
- 2014 Norton Engineering Study for Refineries
 - *2 PPM at 3% O₂*

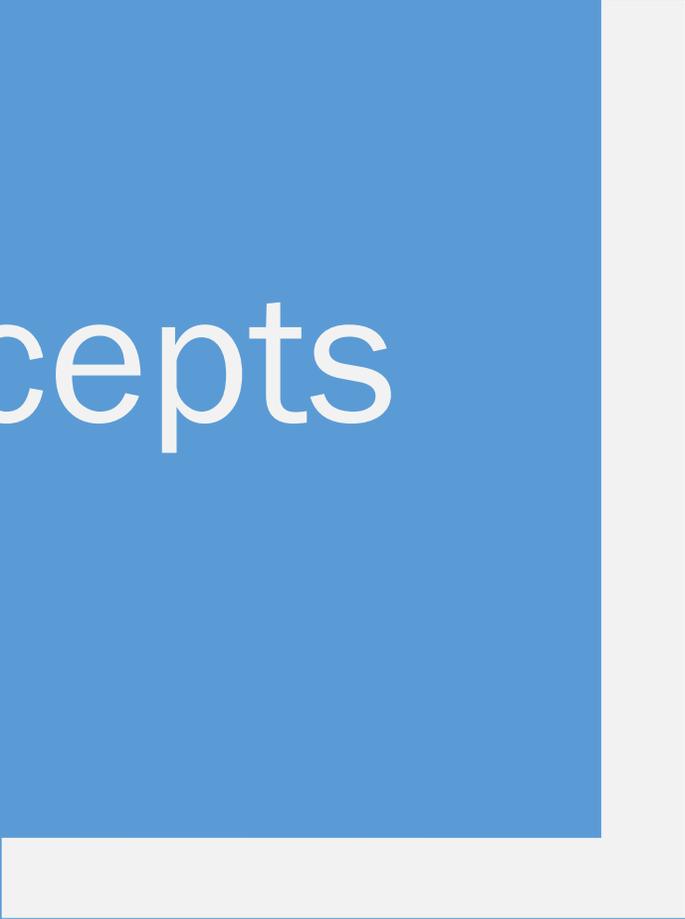
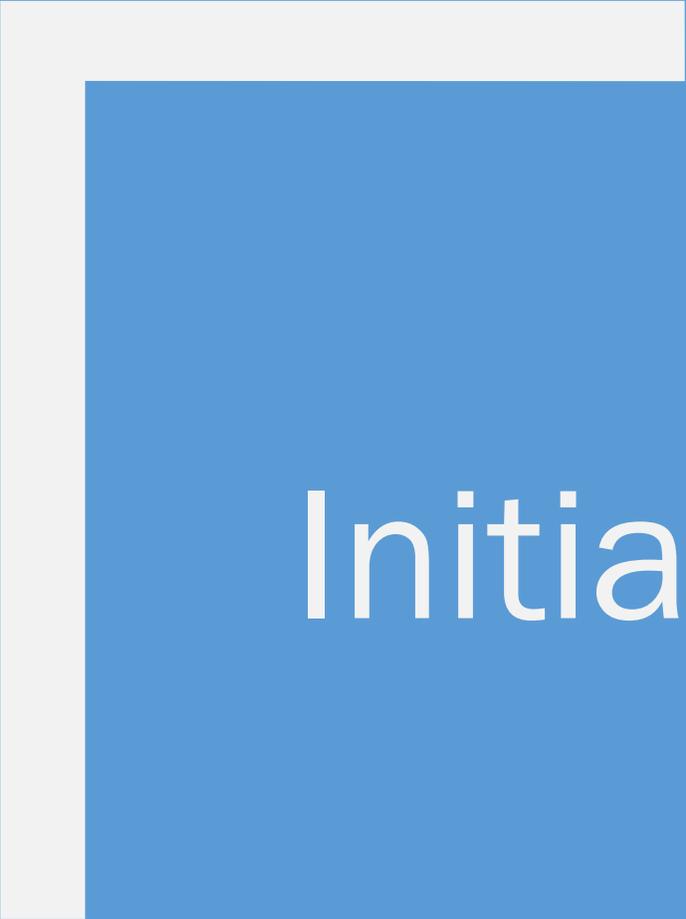


Simple Cycle Gas Turbines

- 2004 SCAQMD LAER (major sources)
 - 3.5 PPM @ 15% O₂, 3-hour rolling average
- 2016 BACT Guidelines Part D (minor source)
 - Gas Turbines, Natural Gas Fired, ≥ 3 MWe and < 50 MWe
 - [2.5 PPM @ 15% O₂] x [efficiency (%)/34%]
 - Gas Turbines, Natural Gas Fired, ≥ 50 MWe
 - 2.5 PPM @ 15% O₂, 1-hour rolling avg; OR
 - [2.0 PPM @ 15 % O₂, 3-hour rolling avg.] x [efficiency (%)/34%]

Combined Cycle Gas Turbines and Duct Burners

- 2004 SCAQMD LAER (major sources)
 - *2.0 PPM @ 15% O₂, 1-hour rolling average*
- 2016 BACT Guidelines Part D (minor source)
 - *Gas Turbines, Natural Gas Fired, ≥ 3 MWe and < 50 MWe*
 - *[2.5 PPM @ 15% O₂] x [efficiency (%)/34%]*
 - *Gas Turbines, Natural Gas Fired, ≥ 50 MWe*
 - *2.5 PPM @ 15% O₂, 1-hour rolling avg; OR*
 - *[2.0 PPM @ 15 % O₂, 3-hour rolling avg.] x [efficiency (%)/34%]*



Initial Rule Concepts

Development of Staff Proposal

- Initial rule concepts are presented at working group meetings to promote discussion
 - *Developing rule concepts and draft proposed rule language is an iterative process with stakeholder input*
- Stakeholder Input
 - *Key element throughout the rule development process*
 - *Staff encourages early input – opportunities for stakeholder input provided throughout the rulemaking process*
 - *Staff wants to hear from all stakeholders*
 - *Staff encourages facilities to meet with staff to discuss any concerns – unique situations, clarification of provisions, etc.*
- Emission limits, cost-effectiveness, and rule language likely to be provided at next working group



Proposed Applicability

- PAR 1135 will be applicable to electricity generating facilities that are:
 - *Municipal utilities; or*
 - *Under the balancing authority of California ISO*

Emission Limits

- Achieved in practice limits will be important factor in determining proposed limits
- Limits to allow for retrofit or replacement of equipment
- Cost-effectiveness and incremental cost-effectiveness information will be incorporated into proposal
- Include an ammonia emission limit
- Effective date still under consideration
 - *AQMP goal of 5 tons per day of NOx reductions by 2025*
 - *AB 617 requirement of BARCT implementation by 2023*

Further Considerations

- Low use exemption
- Consideration for once-through-cooling facilities' repowering schedules
- Potential Start-Up and Shutdown requirements for new units
- Unique circumstances
 - *Pebbly Beach, Glendale DWP, others*
- Others?

Schedule

Additional Working Groups	TBD
Public Workshop	3 rd Quarter 2018
Stationary Source Committee	September 21, 2018
Set Hearing	October 5, 2018
Public Hearing	November 2, 2018

Contacts

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