



# 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
  - *NO<sub>x</sub> 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)



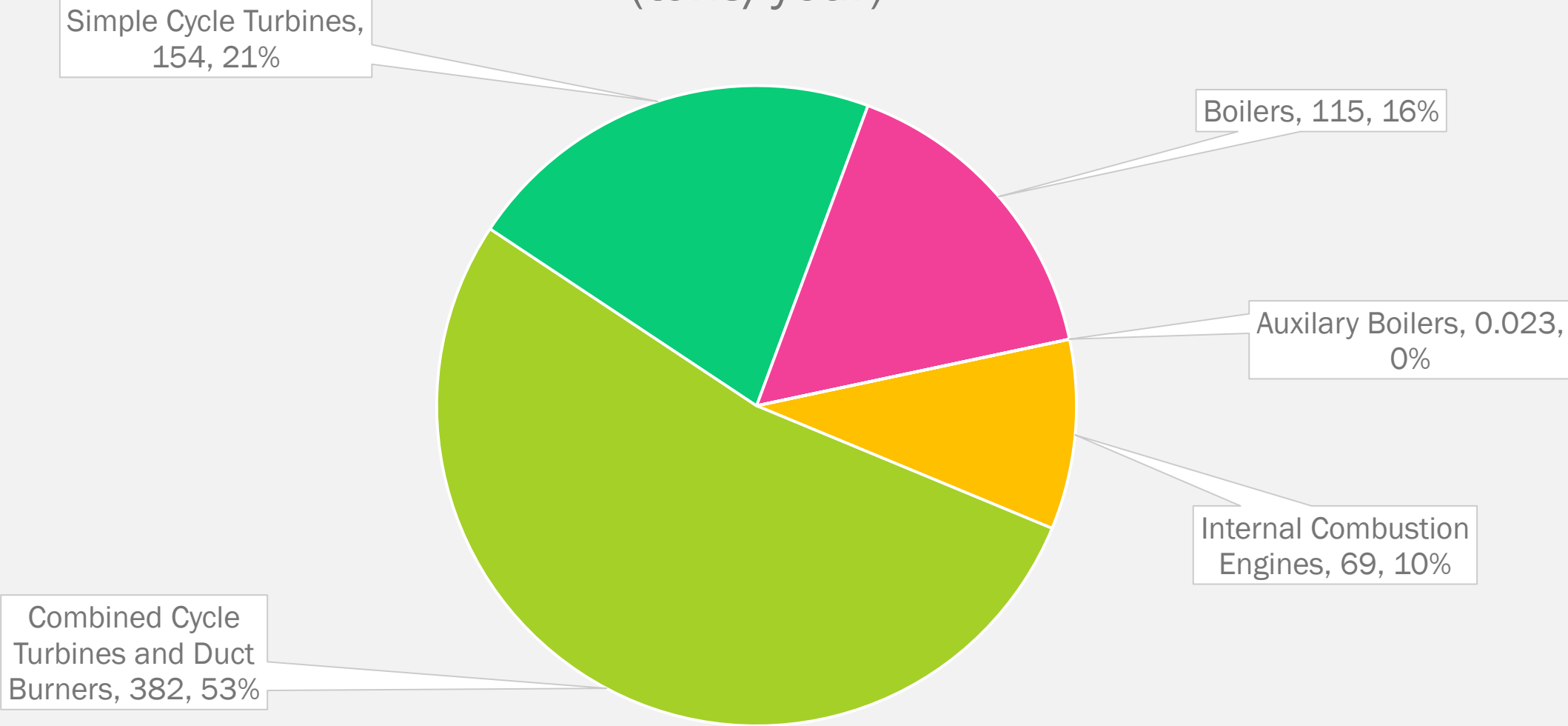
# Emissions Data

# 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

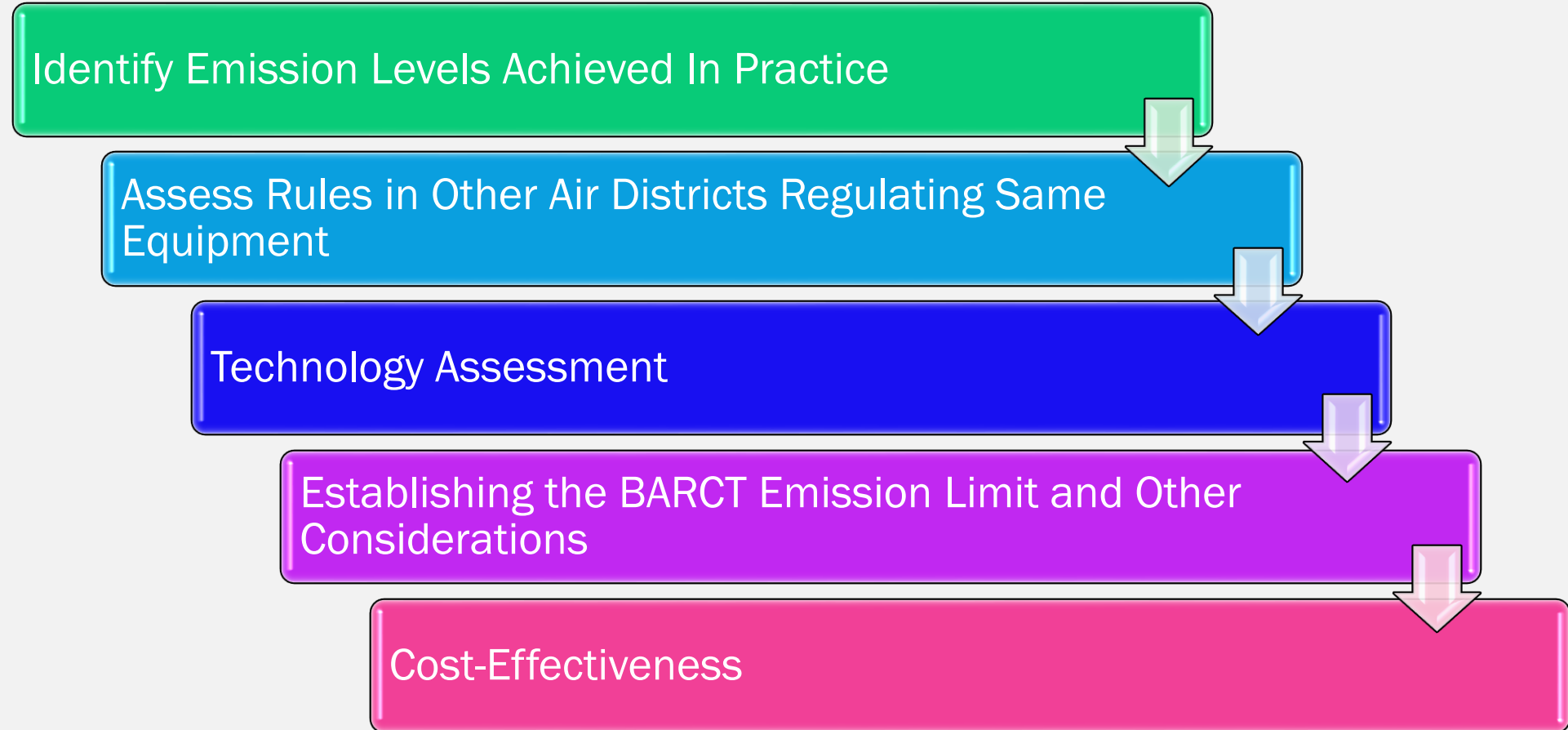
# Guiding Principles for Establishing BARCT Levels

- 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<sub>x</sub> 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<sub>x</sub> emissions (69 tons)
- NO<sub>x</sub> 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<sub>x</sub> emissions (154 tons)
  - *All units are original installations, none are retrofitted*
  - *37 units (55%) are at or below 2.5 PPM NO<sub>x</sub> and 5 PPM NH<sub>3</sub>*
    - All units installed in 2006 or later (3 - 12 years old)
    - (2) 490 MMBTU/HR units have a 2.3 PPM NO<sub>x</sub> and 5 PPM NH<sub>3</sub> emission limits (installed in 2009)
  - *30 units are greater than 2.5 PPM NO<sub>x</sub> and 5 PPM NH<sub>3</sub>*
    - NO<sub>x</sub> permit emission limits ranges from 3.5 - 24 PPM
      - *1 unit with 3.5 PPM NO<sub>x</sub> permit emission limit*
      - *25 units with 5 PPM NO<sub>x</sub> permit emission limit*
      - *2 units with 9 PPM NO<sub>x</sub> permit emission limit*
      - *2 units with 24 PPM NO<sub>x</sub> 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 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-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 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-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

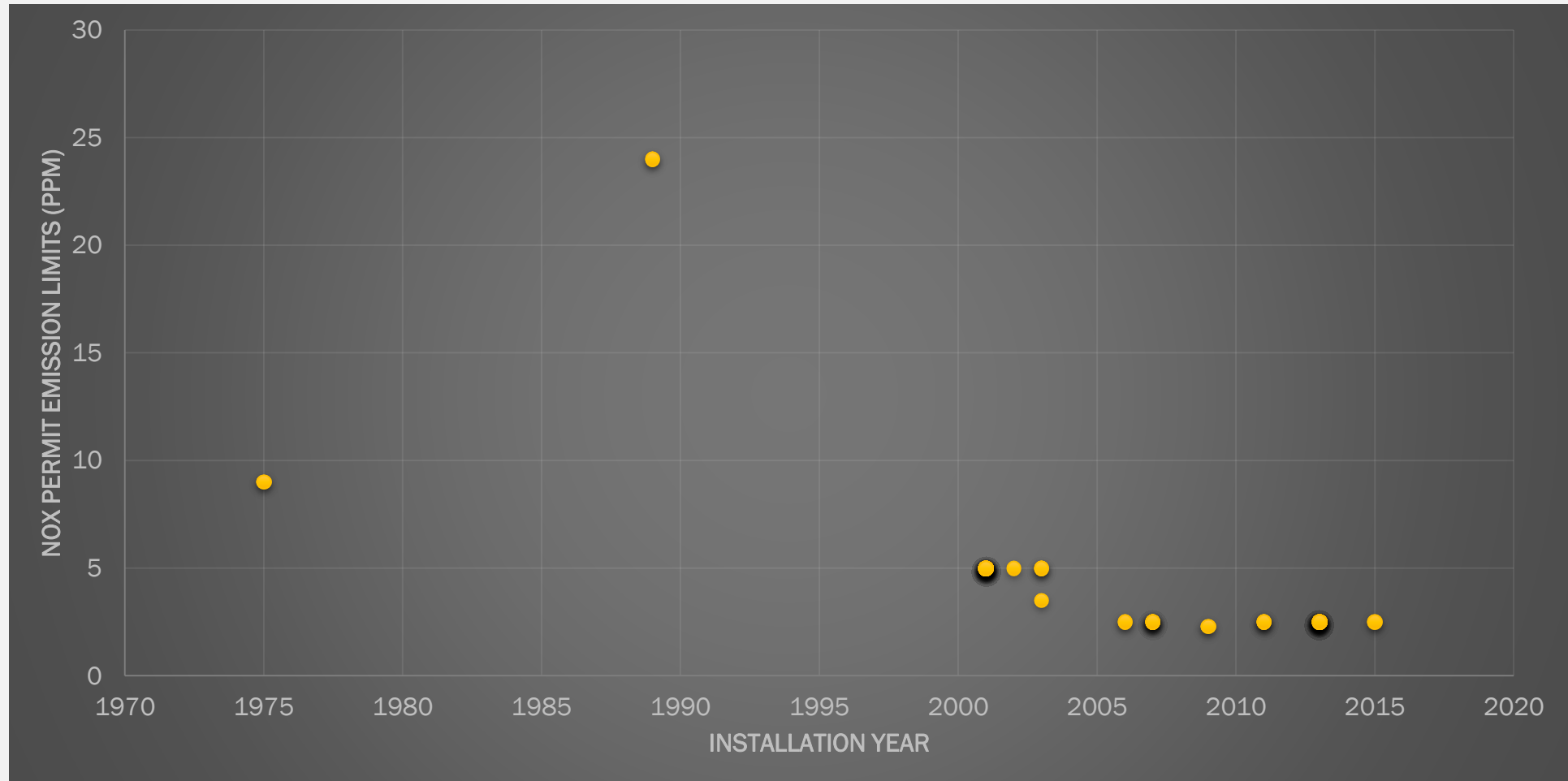
### Simple Cycle Turbines Less Than 2.5 PPM NOx & 5 PPM NH3 *(continued)*

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 NOx emissions (382 tons)
  - *All units are original installations, none are retrofitted*
  - *24 units (69%) are at or below 2.0 PPM NOx and 5 PPM NH3*
    - *All units installed in 2005 or later (3 - 13 years old)*
  - *11 units are greater than*
    - *NOx emission limits ranges from 2.5 - 9 PPM*
      - *5 units with 2.5 PPM NOx permit emission limit*
      - *2 units with 7 PPM NOx permit emission limit*
      - *1 unit with 7.6 PPM NOx permit emission limit*
      - *3 units with 9 PPM NOx 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

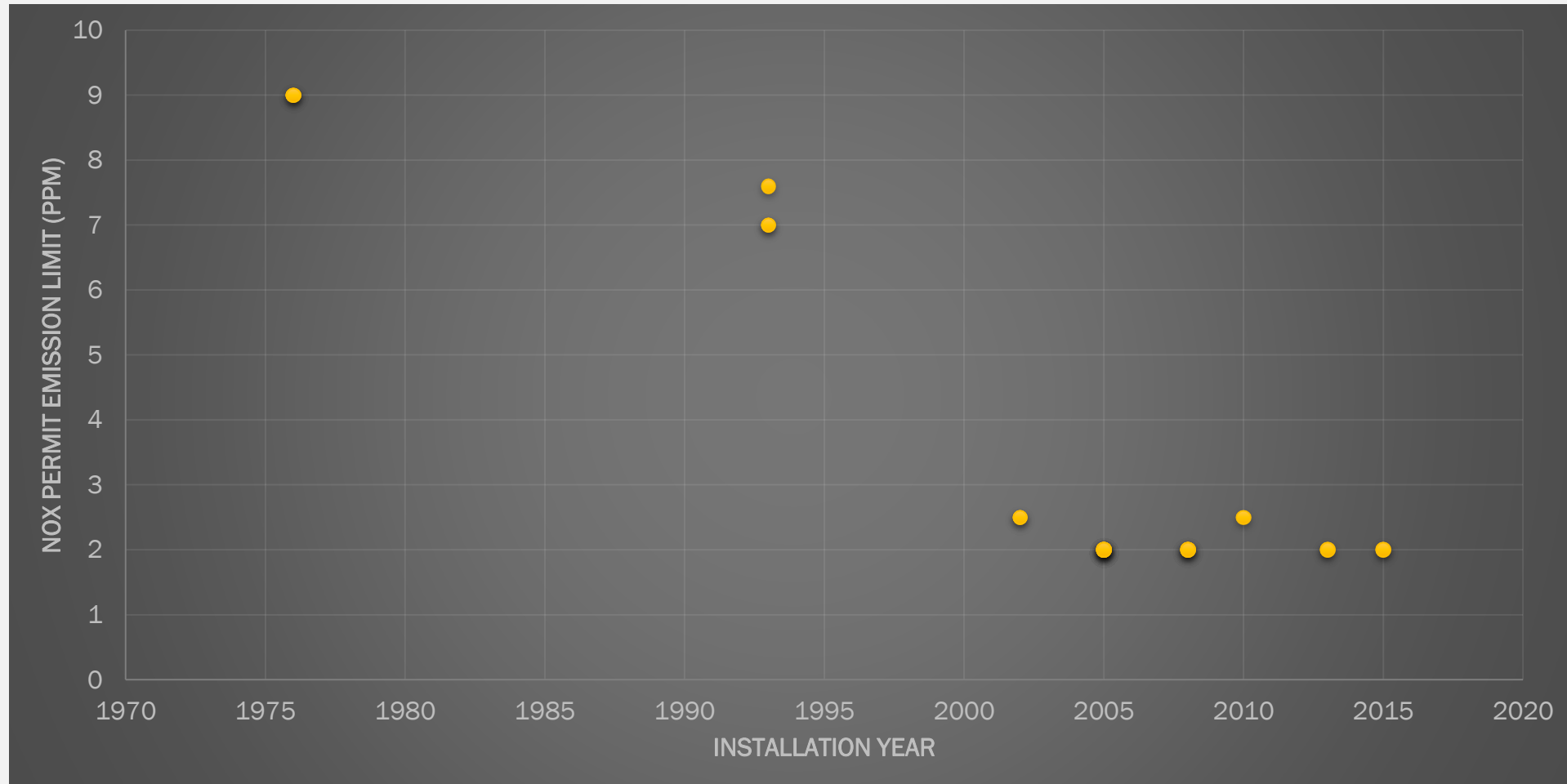
\*DLN – Dry Low NOx

### 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

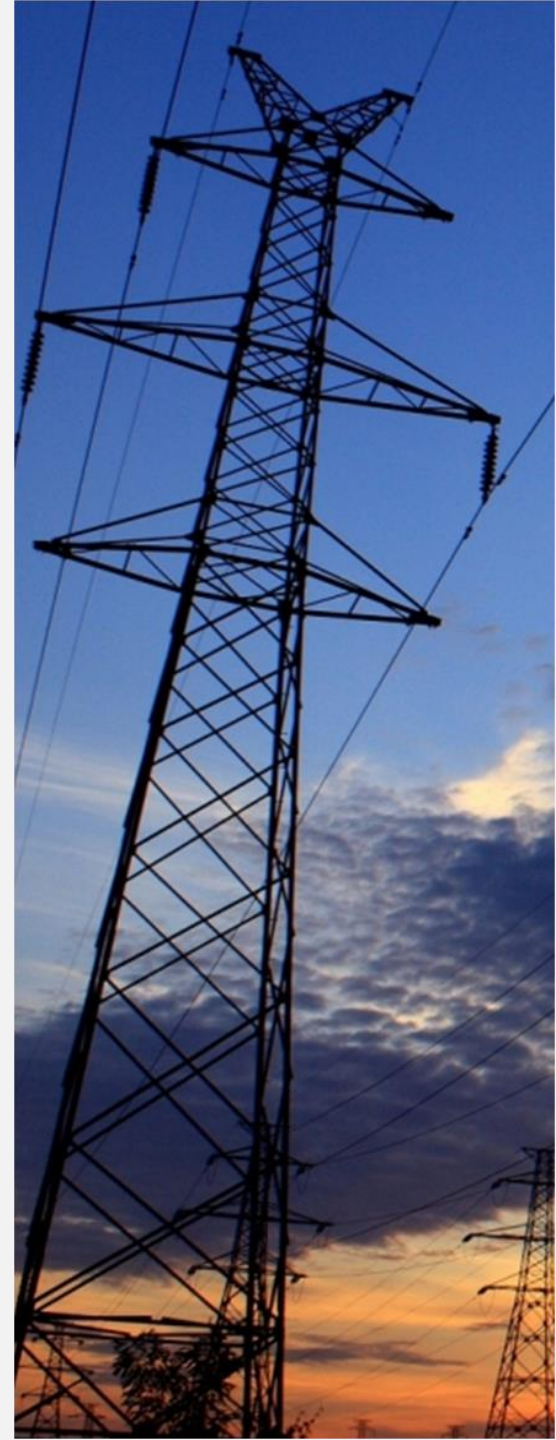
# Non-Emergency Internal Combustion Engines

## ■ SCAQMD Rule 1110.2 Limits

- *New Non-Emergency Electrical Generators (Natural Gas)*
  - 0.07 LBS/NET MWH, 15 minute average (~3 PPM at 15% O<sub>2</sub>)
- *Existing Non-Emergency Electrical Generators (Natural Gas)*
  - 11 PPM @ 15% O<sub>2</sub>, 15 minute average

# Utility Boilers

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



# Simple Cycle Gas Turbines

- 2004 SCAQMD LAER (major sources)
  - 3.5 PPM @ 15% O<sub>2</sub>, 3-hour rolling average
- 2016 BACT Guidelines Part D (minor source)
  - Gas Turbines, Natural Gas Fired,  $\geq 3$  MWe and  $< 50$  MWe
    - [2.5 PPM @ 15% O<sub>2</sub>] x [efficiency (%)/34%]
  - Gas Turbines, Natural Gas Fired,  $\geq 50$  MWe
    - 2.5 PPM @ 15% O<sub>2</sub>, 1-hour rolling avg; OR
    - [2.0 PPM @ 15 % O<sub>2</sub>, 3-hour rolling avg.] x [efficiency (%)/34%]



# Combined Cycle Gas Turbines and Duct Burners

- 2004 SCAQMD LAER (major sources)
  - *2.0 PPM @ 15% O<sub>2</sub>, 1-hour rolling average*
- 2016 BACT Guidelines Part D (minor source)
  - *Gas Turbines, Natural Gas Fired,  $\geq 3$  MWe and  $< 50$  MWe*
    - *[2.5 PPM @ 15% O<sub>2</sub>] x [efficiency (%)/34%]*
  - *Gas Turbines, Natural Gas Fired,  $\geq 50$  MWe*
    - *2.5 PPM @ 15% O<sub>2</sub>, 1-hour rolling avg; OR*
    - *[2.0 PPM @ 15 % O<sub>2</sub>, 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 NO<sub>x</sub> 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 <sup>rd</sup> Quarter 2018
Stationary Source Committee	September 21, 2018
Set Hearing	October 5, 2018
Public Hearing	November 2, 2018

# Contacts

## PAR 1135 Development

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## General Questions

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