District Rule 4702
(Internal Combustion Engines)

June 28th, 2021

San Joaquin Valley Air Pollution Control District

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Valley's Air Quality Challenges

- Valley's challenges in meeting federal air quality standards unmatched due to unique geography, meteorology, and topography
- Valley designated as "Extreme" non-attainment of the 8-hour Ozone NAAQS; "Serious" non-attainment of federal standards for fine particulate matter (PM2.5)
- Combustion a significant source of NOx emissions, primary precursor to ozone and PM2.5 formation
  - Comprehensive strategy in *2018 PM2.5 Plan* includes commitment to reduce emissions from mobile sources and a number of stationary source categories, including internal combustion engines

Rule 4702 Overview

- District Rule 4702 applies to internal combustion (IC) engines rated at 25 bhp or greater
  - Spark-ignited (SI) engines
  - Compression-ignited engines
- Engines in Valley used to power pumps, compressors, or electrical generators at public and private facilities
- Many permitted compression-ignited engines used as emergency engines to provide backup power
- Rule limits emissions of NOx, CO, VOCs, and SOx

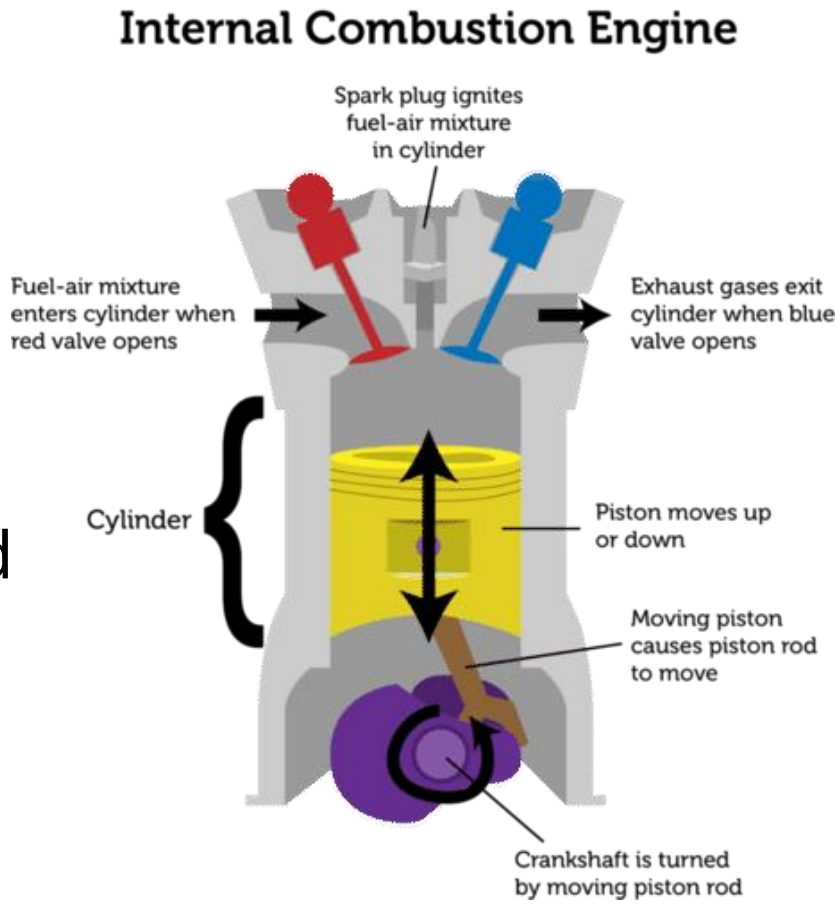


Image credit: C.Auyeung, 2019

Where do Internal Combustion Engines Operate?

- IC engines are used at the following facility types in the Valley:
  - Oil and gas production facilities
  - Petroleum refineries
  - Landfills and waste wastewater treatment plants
  - Water districts
  - Schools, universities
  - Electrical power generation facilities
  - Food processing operations
  - Agricultural operations

Image credit: EPA, 2013

Current Rule 4702 Requirements

- District Rule 4702 adopted August 2003, sixth generation rule
  - Rule limits emissions of NOx, CO, VOCs, and SOx
  - Past amendments established lower NOx limits for non-agricultural engines between 25-50 ppmv (rich-burn) and 65-75 ppmv (lean-burn)
  - 2011 amendment further strengthened rule by requiring NOx limits as low as 11 ppmv for non-agricultural spark-ignited engines
  - Rule achieved significant reductions in NOx and PM emissions from agricultural engines, with significant investment by agricultural operators – past amendments have established limits between 90 – 150 ppmv for ag engines
- Through Rule 4702, NOx emissions from IC engines already reduced significantly
  - Achieved 90-96% NOx emissions control for non-agricultural rich burn engines, 85-90% emissions control for non-agricultural lean burn engines
  - NOx emissions from agricultural engines reduced by 84%

Non-Ag Engines in the San Joaquin Valley

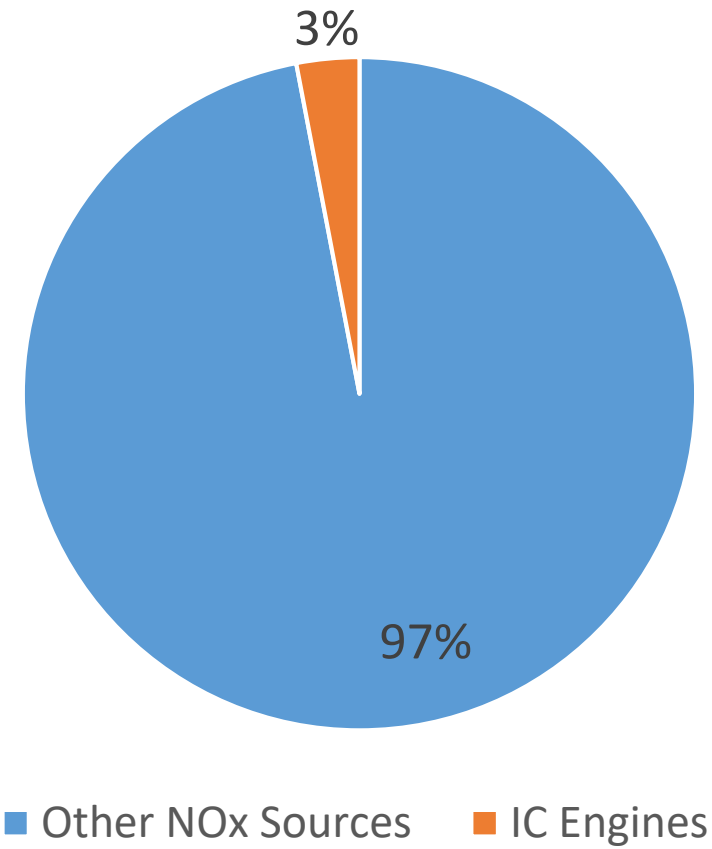
Engine Type	Total #
Rich Burn Spark Ignited Engines	
Waste Gas	0
Cyclic Loaded, Field Gas Fueled	7
Limited Use	18
Not Listed Above	198
Lean Burn Spark Ignited Engines	
Two-Stroke, Gaseous Fueled, >50 bhp and <100 bhp	0
Limited Use	0
Gas Compression	37
Waste Gas	13
Not Listed Above	19

Ag Spark-Ignited Engines in the San Joaquin Valley

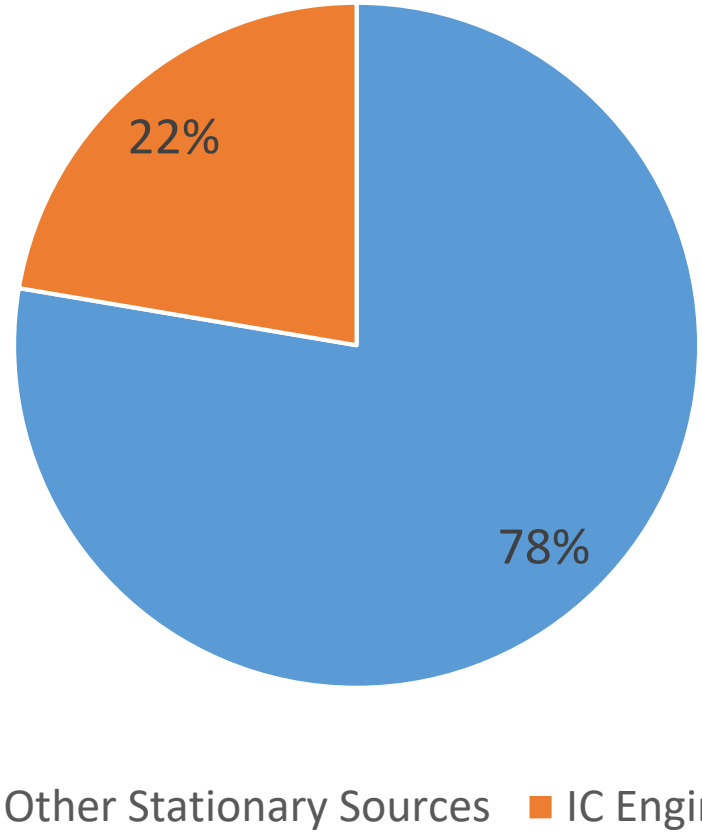
Engine Type	# of Permitted units	# of PEER units	Total # of Units
Rich Burn Spark Ignited	173	191	364
Lean Burn Spark Ignited	70	80	150
Total	243	271	514

NOx Emissions from Internal Combustion Engines in the Valley

All NOx Emissions in the Valley (Mobile, Stationary, & Area Sources)



NOx Emissions from Stationary Sources

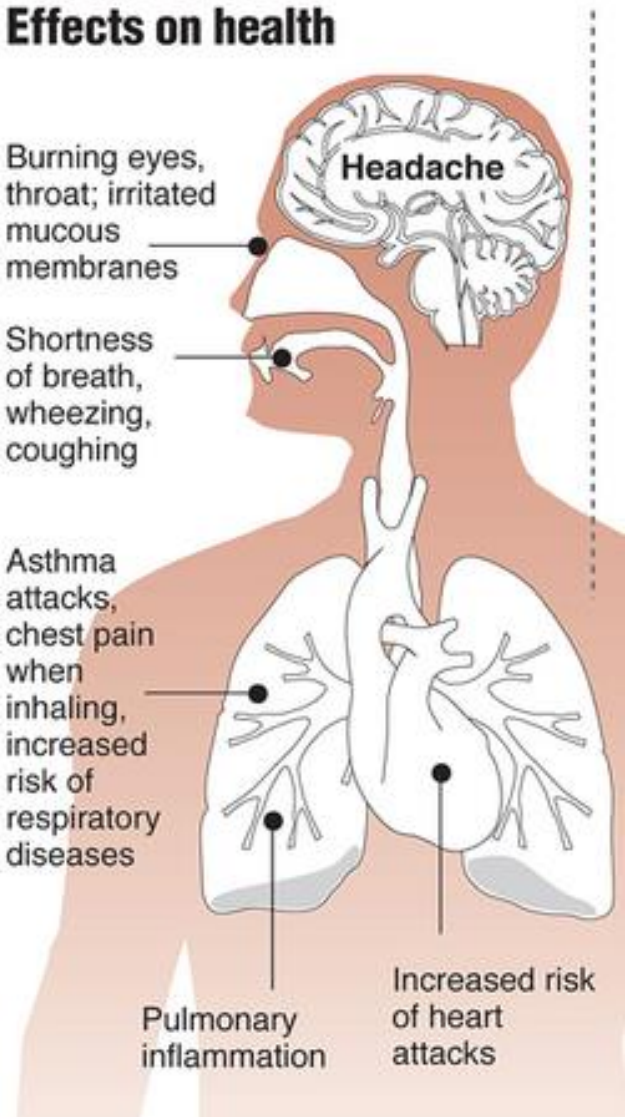


Emission Reductions Needed

- Valley's challenges in meeting federal air quality standards unmatched due to unique geography, meteorology, and topography
- Substantial reductions needed to achieve federal PM2.5 standards – need to go beyond already strict limits
- Commitment in *2018 PM2.5 Plan* to further evaluate emissions reduction opportunities from variety of source categories, including IC engines
- District staff have conducted comprehensive review of requirements in other air districts, lowest emission limits being achieved in installations statewide, and costs and feasibility of most effective emission control technologies available

Health Benefits of Implementing Rule Amendments

- Exposure to PM2.5 and Ozone linked to a variety of health issues, including (but not limited to):
  - asthma, chronic bronchitis, irregular heartbeat, and respiratory/cardiovascular hospitalizations
- District implements control measures to lower direct and precursor emissions throughout the Valley
  - NOx emissions are key precursor to formation of ammonium nitrate, which is large portion of total PM2.5 during peak winter season
  - NOx and VOC's are chemical precursors to formation of Ozone
- Proposed rule amendment will support goal of attaining health-based federal ambient air quality standards for both PM2.5 and Ozone, and help to protect public health



Public Process to Amend Rule 4702

- *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards*
  - Adopted: November 15, 2018
- Public scoping meeting held December 5, 2019
- Public Workshop held on September 24, 2020 and November 19, 2020
- Regular updates provided at Citizens Advisory Committee (CAC), Environmental Justice Advisory Group (EJAG), and District Governing Board meetings
- Ongoing opportunities for public input throughout rule development process

Available Ag Pump Replacement Incentive Program

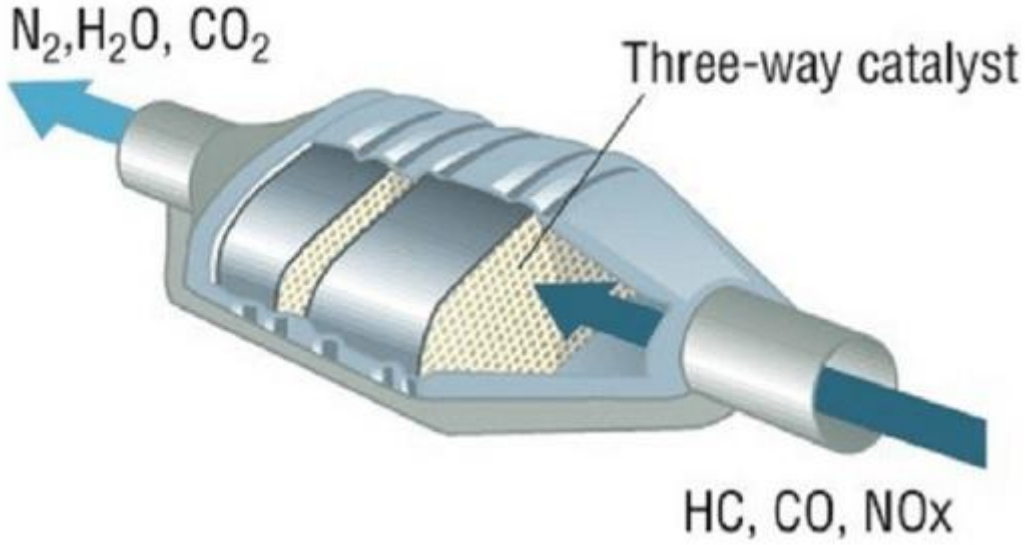
- District operates robust incentive program to provide funding for replacement of older ag engines with Tier 4 engines or electric motors
- Total program funding of over $120,000,000
- Funding amounts based on dollar per horsepower from $90/hp - $150/hp (additional funding for line extension)

- Incentives have replaced over 7,100 engines, with over 3,000 replaced with electric motors (more info: http://www.valleyair.org/grants/agpump.htm)
- District will continue to provide incentives to transition engines to latest TIER or electric motors

Engine Add-On Control Technologies

- **3-Way Catalyst (NSCR)**
  Applicable for Rich-Burn Engines: oxidizes hydrocarbons and carbon monoxide, and reduces nitrogen oxides into water, nitrogen and carbon dioxide

- **SCR System**
  Applicable for Lean-Burn Engines: injects reagent though a catalyst to convert NOx in exhaust to nitrogen & water



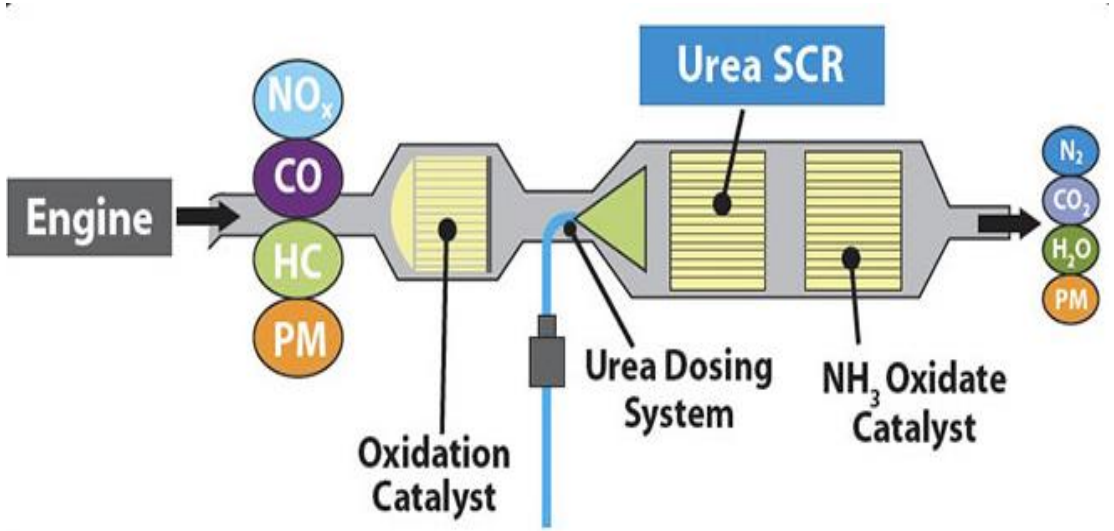


Figure Credits (from top): Laurenzi, 2018 ; Tomorrow's Technician, 2015

Available Control Options for IC Engines

- Lean-burn Spark-ignited engines
  - Replace with electric motor where electricity is available
  - Retrofit with SCR system
  - Replace with new rich burn engine with NSCR
- Rich-burn Spark-ignited engines
  - Replace with electric motor where electricity is available
  - Retrofit with 3-way catalyst
  - Replace with new well-controlled engine
- Cost-effectiveness varies greatly based on feasibility of retrofit vs. engine replacement

Cost Assessment of NOx Control Technology

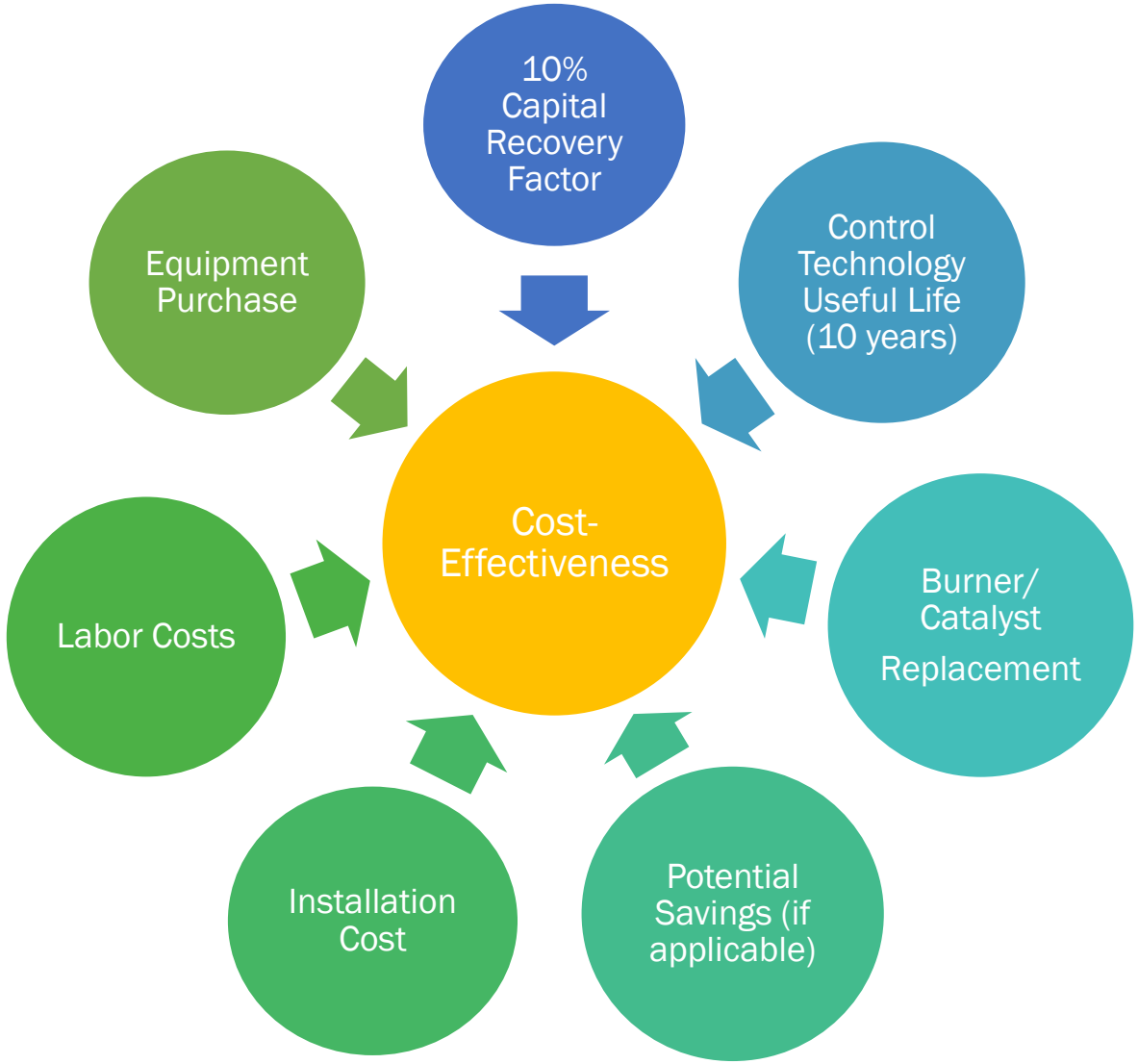
- Sources for costs
  - Actual costs provided by facilities, engineering estimates, and control technology vendors & manufacturers
  - Various sources for the cost of electricity, fuel, and replacement parts
  - Cost factors from EPA's Office of Air Quality Planning and Standards
- Staff held numerous in person and virtual meetings with facilities, vendors, manufacturers, and other stakeholders

Engine Add-On Control Technologies

- **Rich-Burn Engines**
  - Costs and emissions range based on size of engine, age of engine, current controls, type of use
    - Total Capital Cost $6,100 - $95,000
    - Additional operating and maintenance costs for controls: nominal
- **Lean-Burn Engines**
  - Costs and emissions range based on size of engine, age of engine, current controls, type of use
    - Total Capital Cost $22,000 - $191,000
    - Additional operating and maintenance costs for controls: $720 - $7,190/yr

Cost-Effectiveness (CE) Analysis

- Cost-Effectiveness is cost (capital and annual) over emission reductions for the life of the equipment ($/ton)
- Two major cost elements
  - Capital Costs (Equipment, Infrastructure, Engineering, Installation, Tax, Freight)
  - Annual Costs (Operation & Maintenance)
- Emission reductions based on current emission levels (baseline) to proposed emission limit



Proposed Rule 4702 Requirements

- Lower NOx limits for various categories based on technological feasibility and cost-effectiveness
- Lower VOC limits to 90 ppmv for all categories
- Rule compliance schedule
  - Non-ag Rich-Burn and Lean-Burn Engines: December 31, 2023
  - Ag Rich-Burn Engines: December 31, 2023
  - Ag Lean-Burn Engines: December 31, 2029, or 12 years after engine installation
- Removal of emissions fee compliance option for all categories
- Proposed limits and calculated CE shown in following slides for each affected engine category

Proposed NOx Limits and Cost Effectiveness (CE) for Non-AO Rich-Burn Spark-Ignited Engines

Non-AO Rich Burn Spark Ignited Engines	Affected Units	Permitted Above Proposed Limit	Current Rule 4702 NOx Limit ppmv	Proposed Rule 4702 NOx Limit ppmv	Current VOC Limit (ppmv)	Proposed VOC Limit (ppmv)	CE per ton NOx
Waste Gas	0	0	50	11	250	90	-
Cyclic Loaded, Field Gas Fueled	7	7	50	11	250	90	$1,100-$1,500
Limited Use	18	18	25	11	250	90	$1,800-$12,700
Not Listed Above	198	1	11	11	250	90	$2,000

Proposed NOx Limits and CE for Non-AO Lean-Burn Spark-Ignited Engines

Non-AO Lean Burn Spark Ignited Engines	Affected Units	Permitted Above Proposed Limit	Current NOx Limit (ppmv)	Proposed NOx Limit (ppmv)	Current VOC Limit (ppmv)	Proposed VOC Limit (ppmv)	CE per ton NOx
Two-Stroke, Gaseous Fueled, >50 bhp and <100 bhp	0	0	75	11	750	90	-
Limited Use	0	0	65	11	750	90	-
Gas Compression	37	33	65	40	750	90	$690-$2,400
Waste Gas	13	9	65	40	750	90	$2,656-$11,300
Not Listed Above	19	-	11	11	750	90	-

Proposed NOx Limits and CE for AO Spark-Ignited Engines

AO Engines	Total #	Current NOx Limit (ppmv)	Proposed NOx Limit (ppmv)	Current VOC Limit (ppmv)	Proposed VOC Limit (ppmv)	CE per ton NOx
Rich Burn Spark Ignited	364	90	11	250	90	$2,030 – $37,500
Lean Burn Spark Ignited	150	150	43	750	90	$2,150- $25,700

Updates from Initial Draft Rule

- Sulfur Oxides (SOx) Emission Control Requirements for Agricultural-Use IC Engines established to be consistent with requirements for non-AO engines (Section 5.7 of Rule 4702)
  - AO IC digester gas engines installed before 12/31/2021:
    - Limit fuel sulfur content to no more than 250 ppmv
  - AO IC digester gas engines installed on/after 12/31/2021:
    - Limit gaseous fuel sulfur content to no more than five (5) grains of total sulfur per one hundred (100) standard cubic feet; or install and properly operate an emission control system that reduces SO2 emissions by at least 95% by weight
- Particulate Matter (PM) Emission Control Requirements:
  - Spark-ignited engines to comply with SOx requirements to limit PM emissions
  - Compression-ignited engines to comply with applicable Tier certification standards at time of installation

Estimated NOx Emission Reductions

- NOx Emission Reductions from Rule 4702 in 2023
  - 0.62 tons per day
- NOx Emission Reductions from Rule 4702 in 2029
  - 0.08 tons per day
- Total Estimated NOx Emission Reductions
  - 0.70 tons per day

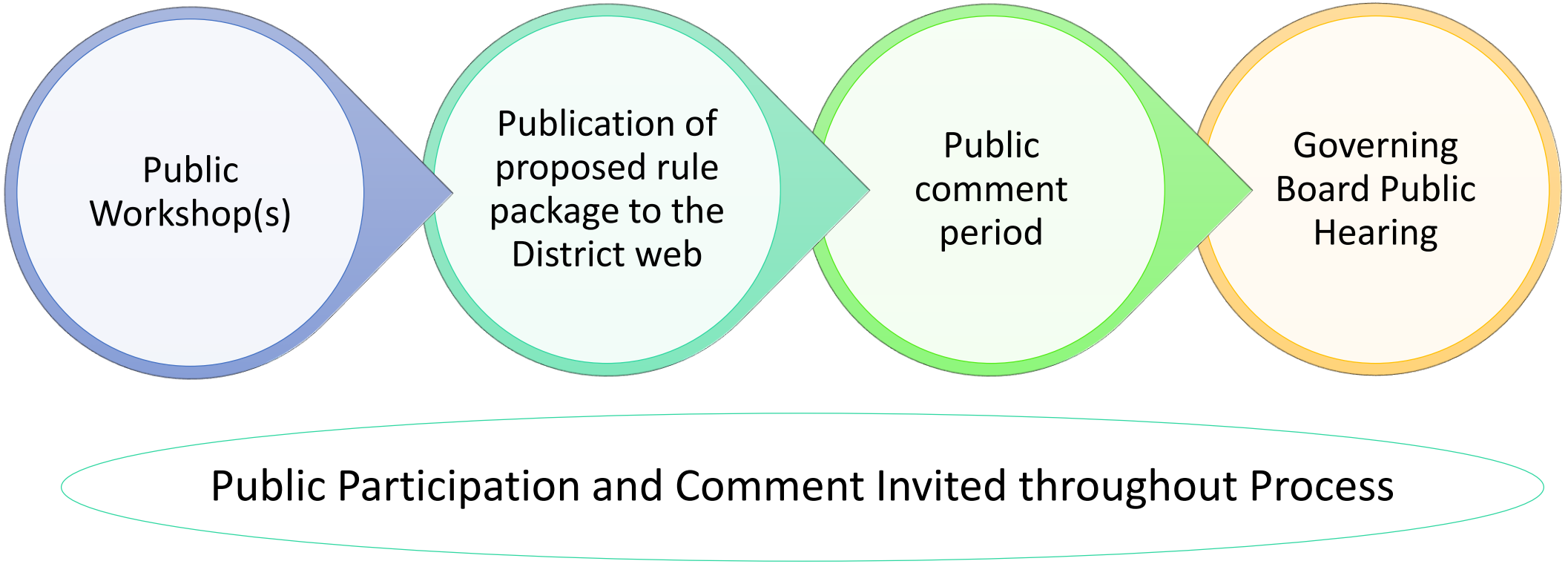
Estimated VOC Emission Reductions

- VOC Emission Reductions from Rule 4702 in 2023
  - 0.31 tons per day
- VOC Emission Reductions from Rule 4702 in 2029
  - 0.01 tons per day
- Total Estimated VOC Emission Reductions
  - 0.32 tons per day

Rule Process and Socioeconomic Impact Analysis

- Socioeconomic Impact Analysis conducted to support feasibility analysis
  - Characterization of the Valley's economic climate
  - Evaluation of economic impacts
  - Socioeconomic Impact Analysis report
  - Results of analysis will be included with proposed rule package
- Timeline for Rule Development:
  - Public comment on updated draft rule requested by July 14, 2021

Next Steps: Public Engagement Process for Rule 4702 Amendment



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