EPA's Air Quality Regulations for Stationary Reciprocating Internal Combustion Engines (RICE)

Melanie King
U.S. Environmental Protection Agency

January 18, 2012

Agenda

- Overview of EPA's stationary engine air quality regulations:
  - NESHAP for Stationary Reciprocating Internal Combustion Engines (RICE)
  - NSPS for Stationary Compression Ignition (CI) Internal Combustion Engines (ICE)
  - NSPS for Stationary Spark Ignition (SI) ICE

What are the Differences?

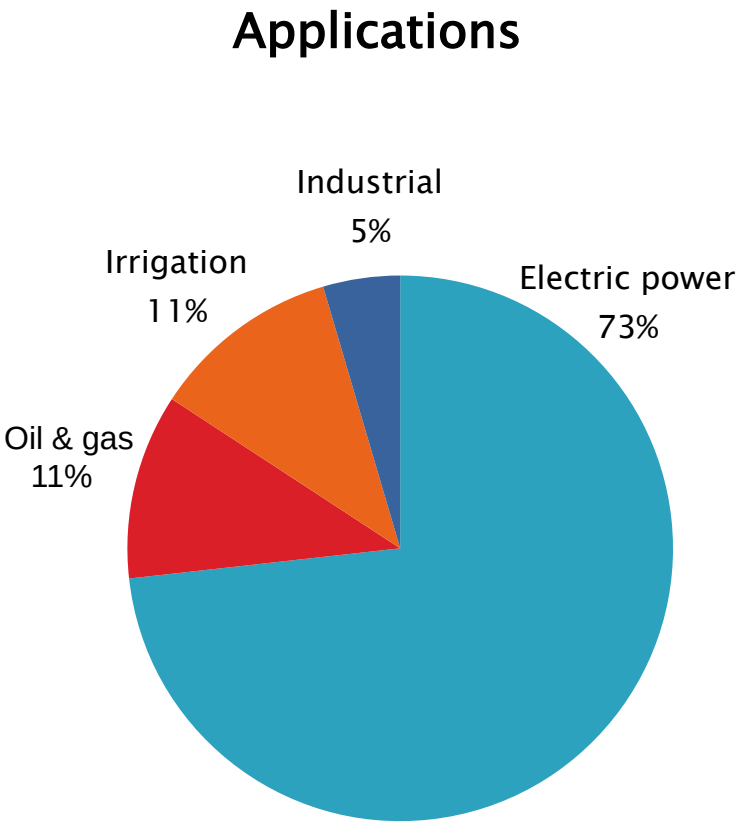
- RICE NESHAP
  - Applies to existing, new, and reconstructed stationary engines (both CI and SI)
  - Focus is air toxics (HAP)
  - Established under CAA section 112

- CI/SI ICE NSPS
  - Applies to new, modified, and reconstructed stationary CI/SI engines
  - Focus is criteria pollutants
  - Established under CAA section 111

Acronyms

- CAA: Clean Air Act
- CFR: Code of Federal Regulations
- CH_2O: Formaldehyde
- CI: Compression ignition
- CO: Carbon monoxide
- FR: Federal Register
- HAP: Hazardous air pollutants
- HP: Horsepower
- NESHAP: National Emission Standards for Hazardous Air Pollutants
- NMHC: Non-methane hydrocarbons
- NOx: Nitrogen oxides
- NSPS: New Source Performance Standards
- PM: particulate matter
- RICE: Reciprocating internal combustion engine
- SI: Spark ignition
  - 2SLB: 2-stroke lean burn
  - 4SLB: 4-stroke lean burn
  - 4SRB: 4-stroke rich burn
  - LFG/DG: landfill gas/digester gas
- SOx: Sulfur oxides
- VOC: Volatile organic compounds

Stationary RICE at a Glance



- ~1.5 million stationary engines in U.S.
  - 78% CI, 22% SI
  - ~ 900,000 used for emergency power
- Sizes range from <1 HP – 10 MW
- Main HAP emitted: formaldehyde, acetaldehyde, acrolein, methanol, and PAH
- Main criteria pollutants emitted: NOx, CO, VOC, PM

Why are Stationary Engine Emissions a Health Concern?

- Pollutants emitted from stationary engines are known or suspected of causing cancer and other serious health effects
  - Aggravation of respiratory and cardiovascular disease
  - Changes in lung function and increased respiratory symptoms
  - Premature deaths in people with heart or lung disease
  - Benzene and 1,3-butadiene are known human carcinogens
  - Noncancer health effects from air toxics may include neurological, cardiovascular, liver, kidney effects, also effects on immune and reproductive systems

Stationary vs. Mobile

- Stationary means not used in a motor vehicle and not a nonroad engine
  - Nonroad engines are:
    - Self-propelled (tractors, bulldozers)
    - Propelled while performing their function (lawnmowers)
    - Portable or transportable (has wheels, skids, carrying handles, dolly, trailer, or platform)
      - Portable nonroad becomes stationary if it stays in one location for more than 12 months (note different time criteria for seasonal source)

VS.

RICE NESHAP – Overview

- 40 CFR part 63 subpart ZZZZ
  - Electronic CFR: http://www.gpoaccess.gov/ecfr

- Regulates HAP emissions from stationary RICE at both major and area sources of HAP
  - All sizes of engines are covered

- **ONLY EXEMPTION**: existing emergency engines located at residential, institutional, or commercial area sources

RICE NESHAP – It's Complicated!

"40 CFR Part 63 Subpart ZZZZ . . . is the most complicated and confusing regulation in the entire suite of EPA NSPS and NESHAPS regulations, bar none. We seriously believe that a viable defense could be mounted against an EPA enforcement action with the simple but true statement, 'Your honor, we honestly could not discern our obligation under the rule in a timely manner.'"

Public comment submitted in response to EPA's request for public input on improving regulations per Executive Order 13563

RICE NESHAP Timeline

	MAJOR SOURCES		AREA SOURCES	
	EXISTING	**NEW**	**EXISTING**	**NEW**
≤ 500 HP	2010 rules	2008 rule	2010 rules	2008 rule
	EXISTING	**NEW**	**EXISTING**	**NEW**
> 500 HP	2004 rule 2010 rule (non-emergency CI)	2004 rule	2010 rules	2008 rule

Existing vs. New

- Engines >500 HP at major source
  - Existing if construction commenced before December 19, 2002
  - New if construction commenced on or after December 19, 2002
  - Reconstructed if reconstruction commenced after December 19, 2002

- Engines ≤500 HP located at major source of HAP, and engines of all HP located at an area source of HAP
  - Existing if construction commenced before June 12, 2006
  - New if construction commenced on or after June 12, 2006
  - Reconstructed if reconstruction commenced after June 12, 2006

Determining Construction Date

- *Commenced* and *Construction* defined in 40 CFR 63.2
  - Essentially, it means owner/operator has entered into a contractual obligation to undertake and complete, within a reasonable amount of time, a continuous program for the on-site installation of the engine
  - "Construction does not include removal of all equipment . . . from an existing location and the reinstallation of such equipment at a new location"

Emission Standards – Existing RICE Located at Major Sources

HP	Engine Subcategory					
	Non-emergency					Emergency
	CI	SI 2SLB	SI 4SLB	SI 4SRB	SI LFG/DG	
<100	Work practice standards					Work practice standards
100-300	230 ppm CO	225 ppm CO	47 ppm CO	10.3 ppm CH_2O	177 ppm CO	
300-500	49 ppm CO or 70% CO reduction					
>500	23 ppm CO or 70% CO reduction	No standards (2004 rule)	No standards (2004 rule)	350 ppb CH_2O or 76% CH_2O reduction (2004 rule)	No standards (2004 rule)	No standards (2004 rule)

Limits in yellow are expected to require emissions control retrofit

Note: Existing limited use engines >500 HP at major sources do not have to meet any emission standards. Existing black start engines ≤500 HP at major sources must meet work practice standards.

Emission Standards – Existing RICE Located at Area Sources

HP	Engine Subcategory					
	Non-emergency					Emergency or Black start
	CI	SI 2SLB	SI 4SLB	SI 4SRB	SI LFG/DG	
≤300	Mgmt practice standards	Mgmt practice standards	Mgmt practice standards	Mgmt practice standards	Mgmt practice standards	Mgmt practice standards
300–500	49 ppm CO or 70% CO reduction*					
>500	23 ppm CO or 70% CO reduction*		47 ppm CO or 93% CO reduction**	2.7 ppm CH_2O or 76% CH_2O reduction**		

Limits in yellow are expected to require emissions control retrofit

*Except engines in rural Alaska
**If engine used >24 hrs/yr

Emission Standards – New RICE Located at Major Sources

HP	Engine Subcategory					
	Non-emergency					Emergency
	CI	SI 2SLB	SI 4SLB	SI 4SRB	SI LFG/DG	
≤250	Comply with CI NSPS	Comply with SI NSPS	Comply with SI NSPS	Comply with SI NSPS	Comply with SI NSPS	Comply with CI/SI NSPS
250–500			14 ppm CH_2O or 93% CO reduction (also comply with SI NSPS)			
>500	580 ppb CH_2O or 70% CO reduction (also comply with CI NSPS)	12 ppm CH_2O or 58% CO reduction (also comply with SI NSPS)		350 ppb CH_2O or 76% CH_2O reduction (also comply with SI NSPS)	No standards (also comply with SI NSPS)	No standards (also comply with CI/SI NSPS)

Limits in yellow are expected to require emissions control retrofit

Notes: New limited use engines >500 HP at major sources do not have to meet any emission standards under the NESHAP. New engines may also be subject to the NSPS.

Emission Standards – New RICE Located at Area Sources

- Meet Stationary Engine NSPS
  - CI: part 60 subpart IIII
  - SI: part 60 subpart JJJJ

HAP Emission Controls

- CI and SI lean burn engines
  - Oxidation catalyst
    - Estimated capital cost:
      - CI: $27.4*HP – $939
      - SI 4SLB: $12.8*HP + $3,069
    - Estimated annual cost:
      - CI: $4.99*HP + $480
      - SI 4SLB: $1.81*HP + $3,442
- SI 4SRB engines
  - Non-selective catalytic reduction (3-way catalyst)
    - Estimated capital cost: $24.9*HP + $13,118
    - Estimated annual cost: $4.77*HP + $5,679

Emergency Engine Requirements

- No limits on hours of operation for emergency service
- Maintenance checks & readiness testing limited to 100 hrs/yr
  - If engine is >500 HP, located at a major source, and installed prior to June 12, 2006, there is no limit on maintenance/testing hours
- 50 hrs/yr allowed for non-emergencies
  - Counts as part of the 100 hr/yr maintenance & testing limit
- Engine cannot be used for peak shaving or as part of financial arrangement with another entity, except 15 of the 50 non-emergency hrs/yr can be used for demand response in emergency situations (e.g., imminent blackout)
  - Engines that are >500 HP, located at a major source, and installed prior to June 12, 2006 do not have the allowance for 15 hours of demand response

Compliance Requirements

Engine Subcategory	Compliance Requirements
•Existing non-emergency CI ≥100 HP at major source •Existing non-emergency SI 100-500 HP at major source •Existing non-emergency CI >300 HP at area source •Existing non-emergency SI >500 HP at area source that are 4SLB or 4SRB and are used >24 hours/year	•Initial emission performance test •Subsequent performance testing every 8,760 hours of operation or 3 years for engines >500 HP (5 years if limited use) •Operating limitations – catalyst pressure drop and inlet temperature for engines >500 HP •Notifications •Semiannual compliance reports (annual if limited use) Existing non-emergency CI >300 HP: •Ultra low sulfur diesel (except rural Alaska) •Crankcase emission control requirements

Compliance Requirements

Engine Subcategory	Compliance Requirements
Existing engines: •<100 HP at major source •Emergency/black start ≤500 HP at major source •Emergency/black start at area source •Non-emergency CI ≤300 HP at area source •Non-emergency SI ≤500 HP at area source •Non-emergency SI 2SLB >500 HP at area source •Non-emergency SI LFG/DG >500 HP at area source •Non-emergency SI >500 HP at area source that are 4SLB or 4SRB and are used ≤24 hours/year	•Change oil/filter, inspect air cleaner or spark plugs, hoses/belts on prescribed schedule •Operate/maintain engine & control device per manufacturer's instructions or owner-developed maintenance plan •May use oil analysis program instead of prescribed oil change frequency •Emergency engines must have hour meter and record hours of operation •Keep records of maintenance •Notifications not required

Compliance Requirements

Engine Subcategory	Compliance Requirements
•Existing/new non-emergency 4SRB >500 HP at major source •New non-emergency SI 2SLB >500 HP at major source •New non-emergency SI 4SLB >250 HP at major source •New non-emergency CI>500 HP at major source	•Initial emission performance test •Subsequent performance testing semiannually (can reduce frequency to annual)* •Operating limitations – catalyst pressure drop and inlet temperature •Notifications •Semiannual compliance reports

*Subsequent testing required for 4SRB engine complying with CH2O % reduction only if engine is ≥5,000 HP

Compliance Requirements

Engine Subcategory	Compliance Requirements
•New emergency/limited use >500 HP at major source	•Initial notification only
•New non-emergency LFG/DG >500 HP at major source	•Initial notification •Monitor/record fuel usage daily •Annual report of fuel usage

Notifications and Reporting

- Notifications
  - applicability [120 days after effective date] or construction/reconstruction
  - actual startup [15 days after actual startup]
  - performance test [60 days prior to test]
  - initial notification of compliance [60 days after compliance demonstrated]
- Compliance reports are semiannual or annual depending on engine
- Notifications/reports generally required only for engines subject to numeric CO or formaldehyde limits)
  - Initial notification only for new engines >500 HP at major sources that are emergency, limited use, or LFG/DG

Key Dates

- Initial applicability notifications for engines subject to 2010 amendments were due by:
  - August 31, 2010 for existing CI RICE
  - February 16, 2011 for existing SI RICE
- Compliance dates:
  - June 15, 2007
    - Existing RICE >500 HP at major sources (except non-emergency CI >500 HP at major sources)
  - May 3, 2013
    - Existing CI RICE (except emergency CI >500 HP at major sources)
  - October 19, 2013
    - Existing SI RICE ≤500 HP at major sources and all HP at area sources
  - Upon startup for new engines

RICE NESHAP – Next Steps

- Proposal in 2012 to address petitions for reconsideration and/or review
  - Petitioners:
    - American Petroleum Institute
    - Interstate Natural Gas Association of America
    - Exterran
    - Gas Processors Association
    - National Rural Electric Cooperative Association
    - State of Delaware
    - CPower, EnergyConnect, EnerNOC, Innoventive Power
      - Proposed settlement agreement – see Jan. 4, 2012 FR notice (77 FR 282)
    - Dresser-Waukesha/Engine Manufacturers Association
      - Proposed settlement agreement – see Nov. 2, 2011 FR notice (76 FR 67728)

Stationary CI Engine NSPS

- 40 CFR part 60 subpart IIII
- Affects new, modified, and reconstructed stationary CI engines
- Originally promulgated July 11, 2006
- Amended June 28, 2011

Who is Subject to the CI NSPS?

- Manufacturers of 2007 model year or later stationary CI engines <30 liters/cylinder displacement
  - Model years differ for fire pump engines

- Owners/operators of stationary CI engines
  - constructed (ordered) after July 11, 2005 **and** manufactured after April 1, 2006 (July 1, 2006 for fire pump engines)
  - modified/reconstructed after July 11, 2005

Modification/Reconstruction

- Modification
  - Physical or operational change that results in an increase in emissions of a regulated pollutant

- Reconstruction
  - Replacement of components where fixed capital cost of new components exceeds 50% of fixed capital cost for comparable new engine

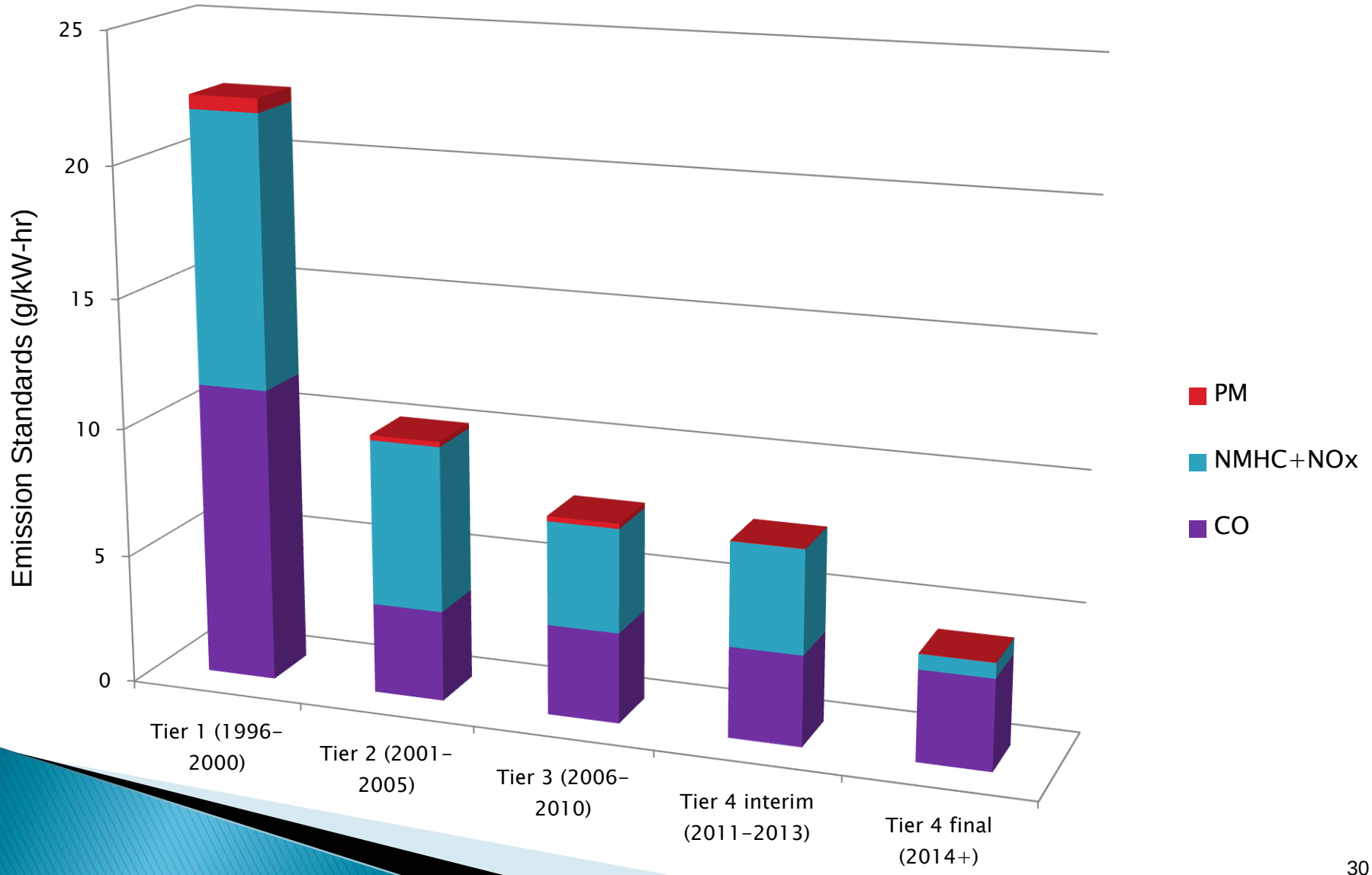
See 40 CFR 60.14 and 60.15 for more information

Emission Standards

Engines with displacement <30 liters/cylinder

- Modeled after EPA's standards for nonroad and marine engines
- Output-based, units of g/KW-hr (g/HP-hr)
- Pollutants: NOx, PM, CO, NMHC
- Smoke standards as a %
- SOx reduced through use of low sulfur fuel
- Phased in over several years and have Tiers with increasing levels of stringency

Example – 500 HP CI Engine



Emission Standards

Engines with displacement ≥30 liters/cylinder

- NOx and PM limits
  - NOx limits (g/kW-hr): equivalent to EPA standards for large marine engines
  - PM limit: 60% reduction or 0.15 g/kW-hr
- Limits based on use of selective catalytic reduction (SCR) and electrostatic precipitator (ESP)

Fuel Requirements

- October 1, 2007 – 500 ppm sulfur diesel (low sulfur diesel [LSD])
- October 1, 2010 – 15 ppm sulfur diesel (ultra low sulfur diesel [ULSD]) for engines <30 liters/cylinder displacement
- June 1, 2012 – 1,000 ppm sulfur diesel for engines ≥30 liters/cylinder displacement

Note: engines not subject to subpart IIII are <u>not</u> subject to these requirements

Requirements for Engine Manufacturers

- Certify 2007 model year and later engines with displacement <30 liters/cylinder
  - Fire pump engines certified beginning model year 2008–2011
  - Certification = EPA Certificate of Conformity
- Not required to certify engines with displacement ≥30 liters/cylinder

CI Engine NSPS – Compliance

- 2007 model year and later CI engine with displacement <30 liters/cylinder (except fire pump engines)
  - purchase certified engine
  - for CI fire pump engine, 2008-2011 model year depending on engine size
  - Install, configure, operate and maintain engine per manufacturer's instructions or manufacturer-approved procedures
    - Owner/operator performance testing not required
  - Per June 28, 2011 amendments (76 FR 37954), can operate differently than manufacturer's recommendations, but must do performance test to show compliance

CI Engine NSPS – Compliance

- Engines not required to be certified:
  - Choose 1 of 5 options for demonstrating compliance:
    - Purchase certified engine
    - Keep records of performance test conducted on similar engine
    - Keep records of engine manufacturer data indicating compliance
    - Keep records of control device vendor data indicating compliance
    - Conduct initial performance test
- Engines ≥30 liters/cylinder displacement
  - Initial performance test
  - Annual performance test for non-emergency engine
  - Continuously monitor operating parameters

Monitoring/Recordkeeping/Reporting

- Emergency engines
  - Non-resettable hour meter and records of operation if engine does not meet non-emergency engine standards
- Engine equipped with diesel particulate filter (DPF)
  - Backpressure monitor and records of corrective actions
- Non-emergency >3,000 HP or having a displacement >10 liters/cylinder, and non-emergency pre-2007 model year >175 HP that are not certified
  - Submit initial notification
  - Keep records of notifications and engine maintenance
  - If certified, keep records of documentation of engine certification
  - If not certified, keep records of compliance demonstrations

Stationary SI Engine NSPS

- 40 CFR part 60 subpart JJJJ
- Affects new, modified, and reconstructed stationary SI engines
- Initially promulgated on January 18, 2008
- Amended June 28, 2011

Who is Subject to the SI NSPS?

- Manufacturers of stationary SI engines:
  - ≤25 HP and manufactured on/after July 1, 2008
  - >25 HP, gasoline or rich burn LPG, manufactured on/after July 1, 2008 (on/after January 1, 2009 for emergency engines)
  - Voluntarily certified engines manufactured on/after
    - July 1, 2007 >500 HP (except lean burn 500≤HP<1,350)
    - January 1, 2008 lean burn 500≤HP<1,350
    - July 1, 2008 <500 HP
    - January 1, 2009 emergency engines

Who is Subject to the SI NSPS? (cont'd)

Owners/operators of engines:

- Constructed (ordered) after June 12, 2006 **and**
  - >500 HP manufactured on/after July 1, 2007 (except lean burn 500≤HP<1,350)
  - lean burn 500≤HP<1,350 manufactured on/after January 1, 2008
  - <500 HP manufactured on/after July 1, 2008
  - emergency >25 HP manufactured on/after January 1, 2008
- Modified/reconstructed after June 12, 2006

Emission Standards

- Phased in over time with increasing levels of stringency
- Output-based, units of g/KW-hr (g/HP-hr)
- ppmvd@15% O_2 standards for some engines
- Pollutants: NOx, CO, VOC
- Sulfur limit on gasoline
- Some standards modeled after EPA's standards for nonroad SI engines

Fuel Requirements

- Owners/operators of gasoline engines must use gasoline that meets the sulfur limit in 40 CFR 80.195 – cap of 80 ppm.

Note: engines not subject to subpart JJJJ are not subject to these requirements.

SI Engine NSPS – Compliance

- Engine manufacturers must certify engines ≤25 HP, gasoline engines, and rich burn LPG engines
  - Certification = EPA Certificate of Conformity
- Engine manufacturers can elect to certify other engines

Compliance Requirements Owners/Operators

- Certified engines
  - Install, configure, operate and maintain engine according to manufacturer's instructions
  - If you do not operate/maintain according to manufacturer's instructions:
    - keep maintenance plan and maintenance records, operate consistent with good air pollution control practices
    - $100 \leq HP \leq 500$ – initial performance test
    - >500 HP – initial performance test and subsequent every 8,760 hours or 3 years, whichever is first

Compliance Requirements Owners/Operators

- Non-certified engines:
  - Maintenance plan
  - Performance testing
    - $25 < HP \leq 500$ – initial test
    - > 500 HP – initial test and subsequent every 8,760 hours or 3 years, whichever is first

Monitoring Requirements Owners/Operators

- Install non-resettable hour meter:
  - emergency engine ≥500 HP built on/after July 1, 2010
  - emergency engine 130≤HP<500 built on/after January 1, 2011
  - emergency engine <130 HP built on/after July 1, 2008

This is required only if engine does not meet standards for non-emergency engines

Recordkeeping/Reporting

Requirements include:

- Documentation of certification
- Records of engine maintenance
- Records of hours of operation for emergency engines
- Initial notification for non-certified engines >500 HP
- Results of performance testing within 60 days of test

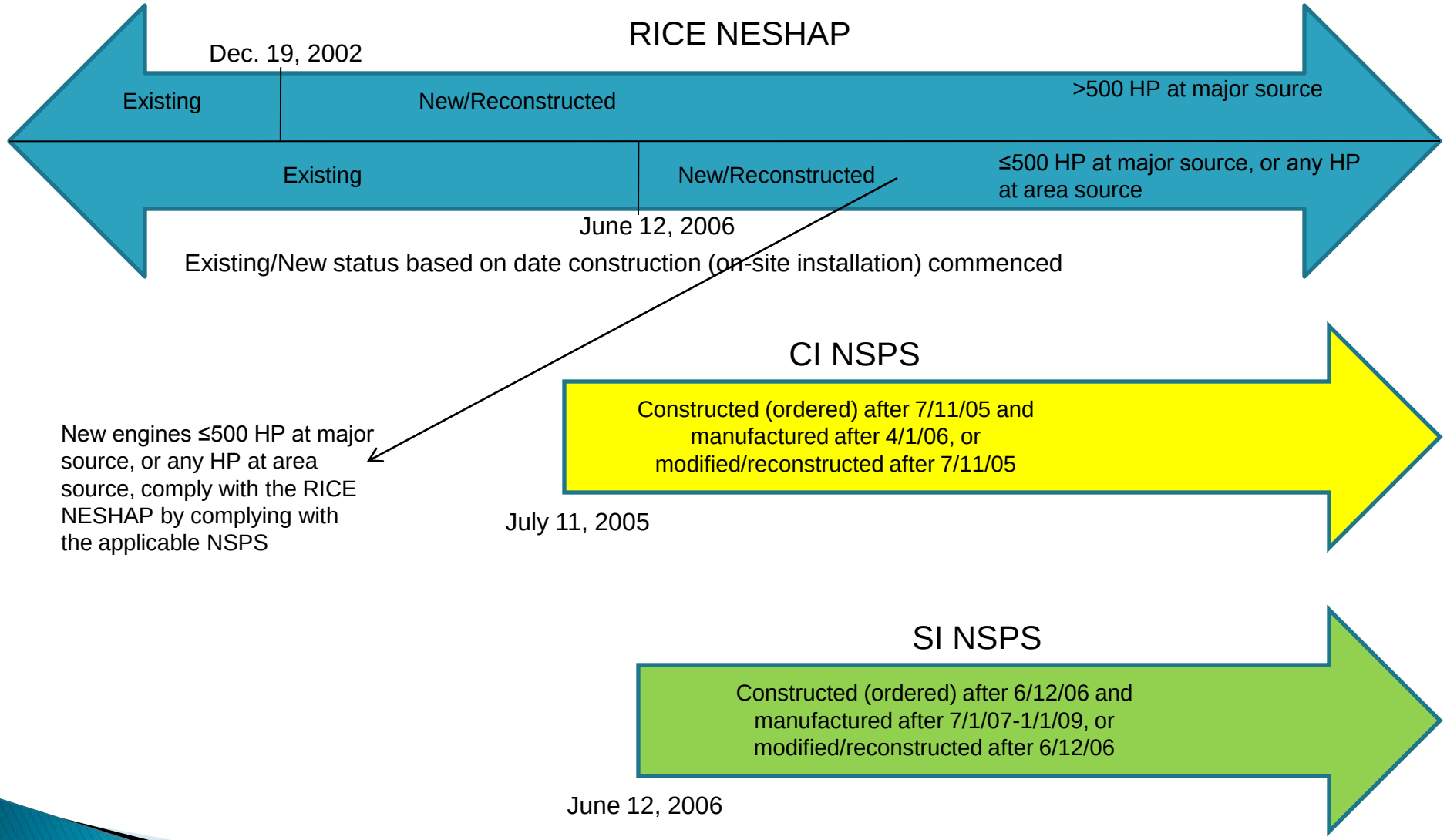
NSPS Emergency Engine Requirements

- No limits on hours of operation for emergency service
- Maintenance checks/readiness testing limited to 100 hrs/yr
  - Can be more if mandated by Federal, State, or local standards
  - Owner/operator can also petition for more hours
- 50 hrs/yr allowed for non-emergencies
  - Counts as part of the 100 hr/yr maintenance & testing limit
- Engine cannot be used for peak shaving, to supply power to the electric grid, or to supply power as part of financial arrangement with another entity

Stationary Engine NSPS – More Info

- CI Engine NSPS TTN website
  - http://www.epa.gov/ttn/atw/nsps/cinsps/cinspspg.html
- SI Engine NSPS TTN website
  - http://www.epa.gov/ttn/atw/nsps/sinsps/sinspspg.html
- Nonroad engine programs:
  - http://www.epa.gov/nonroad
  - See electronic CFR for 40 CFR part 89, part 1039 etc.

In Closing . . .


RICE NESHAP
Dec. 19, 2002
Existing
New/Reconstructed
>500 HP at major source
Existing
New/Reconstructed
≤500 HP at major source, or any HP at area source
June 12, 2006
Existing/New status based on date construction (on-site installation) commenced
CI NSPS
Constructed (ordered) after 7/11/05 and manufactured after 4/1/06, or modified/reconstructed after 7/11/05
July 11, 2005
New engines ≤500 HP at major source, or any HP at area source, comply with the RICE NESHAP by complying with the applicable NSPS
SI NSPS
Constructed (ordered) after 6/12/06 and manufactured after 7/1/07-1/1/09, or modified/reconstructed after 6/12/06
June 12, 2006

Contact Information

Melanie King
Energy Strategies Group
Sector Policies and Programs Division
Office of Air Quality Planning and Standards
Office of Air and Radiation

Phone: 919-541-2469

king.melanie@epa.gov