



Current EPA Air Regulatory Issues for the Gas Compressor Industry

Gas/Electric Partnership Conference

February 10, 2011



Current Regulatory Environment

- NGOs Continue to Press for EPA Regulations Through Court Actions and Public Comments
- EPA Responding to Court Cases Upholding Stringent Interpretations of CAA Mandates
- EPA Administrator Sympathetic to NGO's Requests
- Better Balance in Congress Makes:
 - New Stringent Environmental Legislation Unlikely
 - Congressional Oversight May Buffer EPA's Actions
- Environmental Agenda Will Be Driven Via Regulation

Expected High Impact EPA Air Quality Rulemakings in 2010



(Does not include Climate Change Rules)

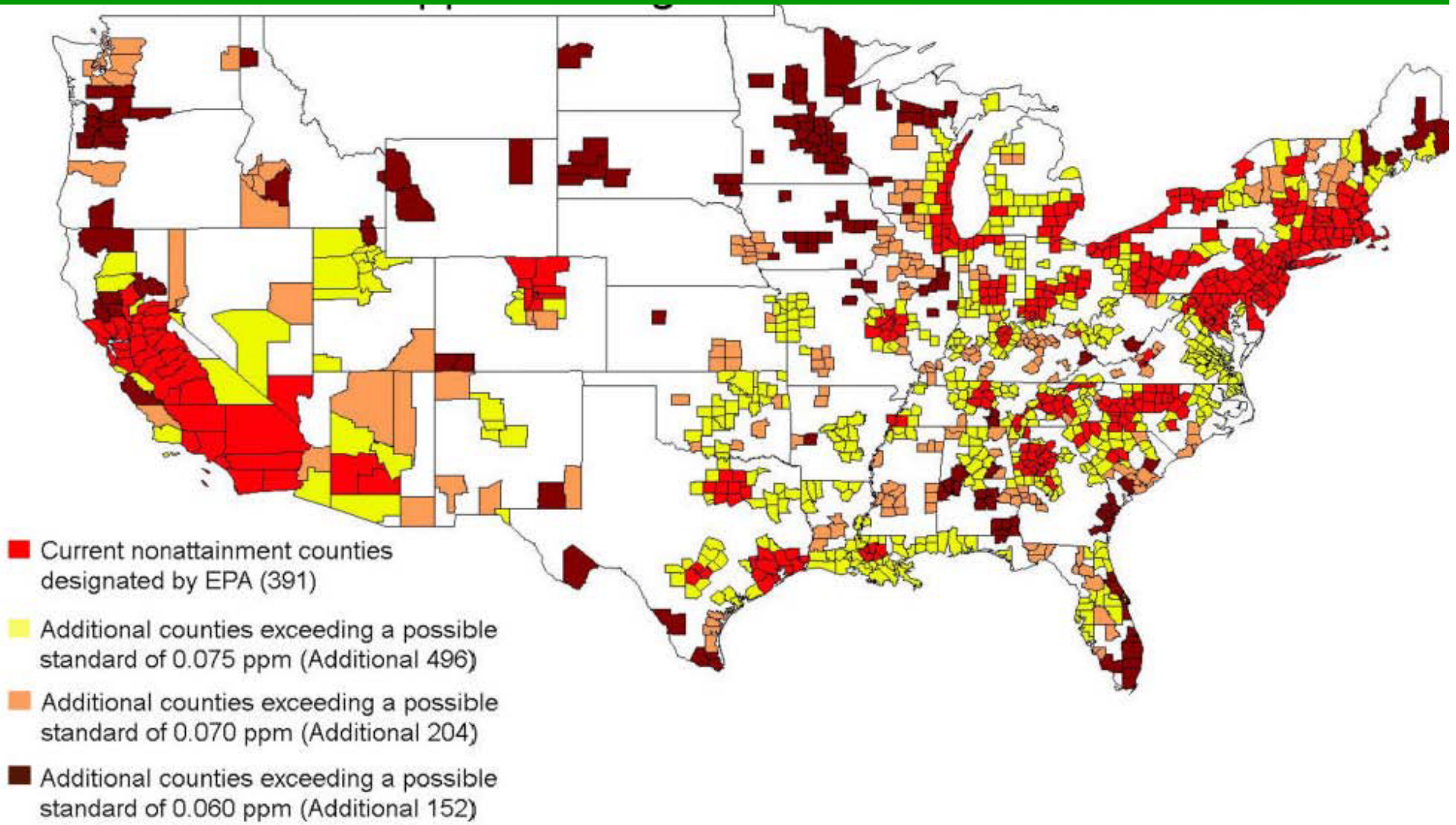
- Ozone NAAQS Reconsideration
- Short Term (1-hr) NO₂ NAAQS
- Source Aggregation
- Existing Engine NESHAP
- Review of O&G NSPS (KKK & LLL) and NESHAP (HH & HHH)
- NA & Minor Source NSR for Tribal Lands
- Revised NO₂ NAAQS – PSD Modeling Concerns
- Revised Boiler/Heater NESHAP

Ozone NAAQS Reconsideration



- 8 Hr Standard Lowered to 75 PPB March 2008
- Obama Administration Criticized Bush for Going Outside of Range Suggested by CASAC
- Proposed Primary from 60 to 70 PPB
- Proposed Secondary Standard – W126 Accumulative Growing Season
- Many More Monitors Are Being Installed
 - Urban Areas > 50,000
 - Rural Areas (avg 2/state)

2003 – 5 Ozone Monitoring Data Non-Attainment Counties



Source: Based upon U.S. EPA data interpreted by A.S.L. & Associates, Helena, MT

7/2007



Non-Attainment Impacts

- States must develop SIPs
- RACT (Reasonably Available Control Technology) for existing equipment
- Restrictive permitting for new equipment
 - Offsets for emission increase
 - LAER (Lowest Achievable Emission Reductions) Controls



Concerns With Proposed Levels

- Levels So Close to “Background” that they May Be Unattainable in Many Areas
- “Policy Relevant Background” is Too Low
- Few Offsets Available in Rural Areas
- High Altitude Disadvantage
 - Form of Standard and Higher Background
- Winter Time Ozone – Unknown Mechanism
- Atmospheric Models Available Are Insufficient



Short Term (1-hr) NO₂ NAAQS

- Final Rule Published February 9, 2010
- Few New Non-Attainment Areas Expected
- PSD Permitting Requires Modeling to Assure NAAQS Is Not Exceeded.
- EPA Pushing States to Model for Minor Source Permits
- Current Models Not Accurate for Short Term NAAQS
- EPA Does Not Agree
- API is Litigating

O & G Source Aggregation



- Combining Multiple Surface Sites for Major Source Determination
- Major Sources Require PSD Permitting
 - 1 – 2 Year Permitting Delay (at best)
 - Complex Process with Inadequate Guidance
 - Federal Regulation/Oversight
 - Public Participation Requirements
- Also Requires Title V Operating Permit

O & G Source Aggregation



- Controversy Centers Around “Contiguous/Adjacent”
 - Industry believes that proximity limits adjacent sites (based on 1980 PSD “facility” definition)
 - NGO’s argues that functional dependence increases distance between sites considered to be adjacent.
- Three Recent Permit Decisions Use Functional Dep.
 - Two permits do not aggregate based on flexibility of system
 - One permit aggregates wells, compressors and gas plant based on single flow path for gas.
- Permit Decisions Being Litigated By Both NGOs and Industry

Layman's Summary of Engine Rules



Overview of US EPA Stationary Engine Rules

Engines (a.k.a. Reciprocating Internal Combustion Engines, RICE) have historically been one of the biggest sources of emissions that cause smog, particularly mobile sources (i.e. cars & trucks). Since the 1970's, EPA has been requiring manufacturers to lower the emissions from mobile engines, first from gasoline engines, then from diesel (i.e. truck, trains and construction equipment) and very small engines (i.e. lawn mowers and weed eaters). EPA now regulates emissions from almost all mobile source engines. At the same time, EPA was reducing emissions from stationary sources by requiring permits for the large facilities (in terms of emissions, not physical size) and emission performance standards for stationary equipment. EPA started writing emission performance standards in 2002 for engines and completed a rule that affects 90% of all stationary engines in September 2010. All stationary source engines are now regulated via one of these rules.

The Clean Air Act (CAA) has two types of rules that specify environmental performance standards for categories of equipment. The first is New Source Performance Standards (NSPS) that set the emission standard for criteria pollutants (basic components of smog) for new equipment. National Emission Standards for Hazardous Air Pollutants (NESHAPs) set emission standards for toxic pollutants (a.k.a. Hazardous Air Pollutant [HAP], causes health effects at low concentrations in the atmosphere) for both new and existing equipment. EPA has developed five different sets of NSPS and NESHAP rules covering engine air emissions in the past six years. These rules and how they interrelated are difficult to understand. This paper attempts to give an overview of these rules in layman's language. This overview will not detail all the compliance requirements, but will help the reader to understand the scope of the rules and the overall requirements. This paper will also not discuss the state specific engine requirements or permitting requirements. The chart below helps explain how the rules break up the universe of engines into categories that are impacted by the rules. Each color on the chart denotes a different rule and the engine categories that are within the rule's scope. First step is to understand some of the terms used in the below chart.

Major Source – a large facility based on the amount of toxic emissions, not its physical size.

Area Source – a small facility that emits less toxic emissions than a major source.

Existing or New – each rule defines a date (called threshold date below) where an engine manufactured before that date is "Existing" or is "New" if manufactured on or after that date.

Reconstruction – Existing engines that are rebuilt with the cost of the project exceeding 50% of the cost of installing an entirely new engine are considered "reconstructed". A reconstructed engine is treated similarly to a new engine with more stringent emission standards than an existing engine.

hp	Major Sources								Area Sources							
	Existing Engines				New Engine				Existing Engines				New Engines			
	CI	RB	4SLB	2SLB	CI	RB	LB		CI	RB	4SLB	2SLB	CI	RB	LB	
>1350	Cat	Cat	None	None	Cat	Cat	Cat		Cat	Cat	Cat	MP	MC	EL	EL	
500-1350	Cat	Cat	None	None	Cat	Cat	Cat		Cat	Cat	Cat	MP	MC	EL	EL	
300-500	Cat	Cat	Cat	Cat	MC	EL	EL		MP	MP	MP	MP	Cat	EL	EL	
250-300	EL	Cat	Cat	Cat	MC	EL	EL		MP	MP	MP	MP	Cat	EL	EL	
100-250	EL	Cat	Cat	Cat	MC	EL	EL		MP	MP	MP	MP	Cat	EL	EL	
50-100	MP	MP	MP	MP	MC	EL	EL		MP	MP	MP	MP	Cat	EL	EL	
25-50	MP	MP	MP	MP	MC	EL	EL		MP	MP	MP	MP	Cat	EL	EL	
<25	MP	MP	MP	MP	MC	MC	MC		MP	MP	MP	MP	Cat	MC	MC	

In the table above, the universe of engines into those at major and area sources, then subdivided into those at existing or new categories (designated by blue lines). Down the left side of the table the engines are further divided by engine size (by horsepower or hp). Abbreviations used in the table include:

Cat – catalyst; EL – emission limit; MP – maintenance practices; and MC – manufacturer-certified.

Finally, the engines are subdivided by engine design types, which include:

CI – compression ignition are fueled by diesel.

SI – spark ignition are fueled by natural gas (NG), gasoline or LPG and are further subdivided by:

RB – rich burn – only enough air is added to burn the fuel injected.

LB – lean burn – extra air is added to increase fuel efficiency and reduces pollutants.

4SLB – four stroke lean burn

2SLB – two stroke lean burn

Rules covering a type of equipment are placed in a "Subpart" and designated by letters. For example, the rules governing toxic emissions for engines are contained in NESHAP, Subpart ZZZZ, while the rules governing criteria pollutants for SI engines are found in NSPS, Subpart JJJJ. Each of the five sets of rules discussed below cover a different part of the CAA requirements with Court Decisions or Consent Decrees often driving the scope and/or the regulatory outcome. Many of the apparent inconsistencies in these rules are the outcome of Court proceedings.

Engine Rules in Effect Before 2010:

RICE MACT – NESHAP, Subpart ZZZZ – In February 2004, EPA finalized this rule covering new and existing (threshold date of December 19, 2002) engines, greater than 500 hp (>500 hp, a.k.a. large engines) that are located at major sources. The rule was restricted to large engines at major sources due to a lack of data for other engines. This rule requires catalytic controls on all new large engines as well as existing RB engines to control toxic emissions (predominately formaldehyde for engines). Existing LB engines did not require additional controls under this rule. NESHAP rules have detailed and requirements for notifications, reporting, recordkeeping, monitoring, and performance tests.

CI – NSPS, Subpart IIII – In July 2006, EPA finalized this rule covering all new (threshold date of July 11, 2005) CI engines. This rule and the Consolidated Engine Rule satisfied a Court Consent Decree due to missing CAA statutory deadlines. This regulation used the non-road engine precedent of requiring manufacturer-certified (MC, similar to that required for car engines) engines for compliance. For most new CI engines, the operators compliance are limited to purchasing an engine with the correct certification, maintaining the engine as recommended by the manufacturer, and documenting that this maintenance was completed. This rule also has requirements for maintenance recordkeeping and provisions where the engine operator is directly responsible for compliance for large engines and has an option for MC engines (to get flexibility in maintenance requirements).

Consolidated Engine Rule – SI – NSPS, Subpart JJJJ and Revisions to NESHAP, Subpart ZZZZ – In January 2008, EPA finalized a rule that contained both NSPS and NESHAP requirements for new (threshold date is June 12, 2006) SI engines. All new gasoline and LPG fueled engines and natural gas (NG) fueled engines <25 hp must be covered by manufacturer certifications similar to those in NSPS, Subpart IIII. All other NG engines have the option of MC (however few NG engines >25 hp have MC) or operator compliance with emission limitations (with associated recordkeeping, maintenance and performance testing requirements). 4SLB engines >250 hp and <500 hp at major sources also have additional requirements that were added to the NESHAP, Subpart ZZZZ rule for the control of toxic emissions (i.e. addition of catalyst, performance testing, semi-annual reporting, recordkeeping, etc). Finally, new SI engines that already had requirements under the RICE MACT rule have to comply with the provisions of both rules.

Engine Rules with Compliance Dates After 2010:

CI – Existing Engine NESHAP, Amendments to Subpart ZZZZ – In March 2010, EPA finalized the existing CI engine rules with a new/existing threshold date for this rule of June 12, 2006 to partially satisfy yet another Court Consent Decree for missing a CAA deadline. These rules require catalyst to be installed on existing CI engines >300 hp. Emission limits are included for CI engines >100 hp and <300 hp at major sources. Maintenance practices (MP) are required for CI engines <100 hp at major sources and <300 hp at area sources. This rule began the stringent application of "MACT floor" (a minimum emission level required by the CAA) calculation as interpreted by a DC Court opinion. Existing Engines covered by this rule must be in compliance by May 3, 2013.

SI – Existing Engine NESHAP, Amendments to Subpart ZZZZ – In August 2010, EPA finalized the existing SI engine rules with a new/existing threshold date for this rule of June 12, 2006. This rule covers existing SI engines at major sources <500 hp and all existing SI engines at area sources. Catalyst are required for engines >500 hp at area sources and engines >100 hp and <500 hp at major sources. MPs are required for engines covered by this rule and not requiring catalyst (including emergency engines and other engines operating <24hrs/yr at an area source). Existing engines covered by this rule must be in compliance by October 19, 2013. This rule requires CPMS (continuous parameter monitoring system, strict measurement, recordkeeping and data retention requirements) for area source engines >500 hp. CPMS standards were finalized for the first time and are required for RICE MACT engines by October 19, 2010.

Engine Rules



2004 RICE (Recip. Internal Combustion Engine) MACT

- Applies only to engines >500 hp at major sites
- Few engines are covered by this rule.

2006 CI, ICE (a.k.a. Diesel Engine) NSPS, Subpart IIII

- New threshold date – July 11, 2005
- Manufacture Certification Philosophy, Similar to Vehicle

2008 SI (Spark Ignited), ICE NSPS, Subpart JJJJ

- Applies to All New/Rec. Engines – June 12, 2006
- Most engines comply w/ NESHAP via NSPS compliance
- **API Litigation** to Clarify and Reduce Compliance Risk
Existing CI Engine NESHAP, Subpart ZZZZ Amend.
Existing SI Engine NESHAP, Subpart ZZZZ Amend.
- Applies to Existing Engines at Area Sources and <500 hp Engines at Major Sources
- **API Litigation** to change certain requirements.

Overview of Engine Rules



Draft - Final Existing Engine NESHAP^a Overview^b - Draft

HP	Engine Rule Applicability															Original RICE MACT Final Rule NESHAP, Subpart ZZZZ	Compression Ignition NSPS Final Rule NSPS, Subpart IIII
	Major Sources								Area Sources								
	Existing				New/Reconstructed				Existing				New/Reconstructed				
	CI	RB	4SLB	2SLB	CI	RB	LB		CI	RB	4SLB	2SLB	CI	RB	LB		
>1350	OC	NSCR	None	None	Oxy Cat	NSCR	EL/EL	Oxy Cat	OC	NSCR	OC	MMP2	MC	EL	EL	<ul style="list-style-type: none"> Major sources only Proposed December 19, 2002 Finalized February 26, 2004 Existing if pre 12/19/02 Applies to engines > 500 hp Controls HAPs – formaldehyde Complex administrative burdens for notifications, testing, monitoring and SSM Plans (start-up, shutdown, and malfunctions) Few engines are controlled by this rule, Many companies choose to over control emission to become area source to avoid administrative burden. Engines <500 hp delayed due to lack of sufficient data. 	<ul style="list-style-type: none"> Proposed July 11, 2005 Finalized July 11, 2006 Applies to all new/reconstructed (after July 11, 2005) compression ignition (CI, diesel fueled engines) Controls criteria pollutants (NOx, CO, PM and HC) Uses manufacture emission certification for most engines Some non-certified engines have emission limits Operator responsible for maintenance and operation to manufacturer recommendations, as well as maintaining emission limits for life of engine. Restricts definition of emergency and adds requirements for these engines.
500-1350	OC	NSCR	None	None	Oxy Cat	NSCR	EL/EL	Oxy Cat	OC	NSCR	OC	MMP2	MC	EL	EL		
300-500	OC	NSCR	OC	OC	MC	EL	EL	EL	OC	MMP1	MMP1	MMP2	MC	EL	EL		
250-300	EL	NSCR	OC	OC	MC	EL	EL	EL	MMP3	MMP1	MMP1	MMP2	MC	EL	EL		
100-250	EL	NSCR	OC	OC	MC	EL	EL	EL	MMP3	MMP1	MMP1	MMP2	MC	EL	EL		
50-100	MMP3	MMP1	MMP1	MMP2	MC	EL	EL	EL	MMP3	MMP1	MMP1	MMP2	MC	EL	EL		
25-50	MMP3	MMP1	MMP1	MMP2	MC	EL	EL	EL	MMP3	MMP1	MMP1	MMP2	MC	EL	EL		
<25	MMP3	MMP1	MMP1	MMP2	MC	MC	MC	MC	MMP3	MMP1	MMP1	MMP2	MC	MC	MC		

EL – Emission Limit for existing CI engines 100≤HP≤300 located at major sources = 230 PPMvd CO @15% O₂, however catalyst may not be required; For SI engines see rule for NSPS-JJJ emission limits if new/reconstructed after June 11, 2006.
 MC – Manufacturer Certification is required for almost all diesel, gasoline or LPG fueled engines. MC required for natural gas (NG) fueled engines <25 hp, but voluntary for all other sizes of NG fueled engines.
 MMP – Maintenance Management Practice
 MMP1 – 4SRB and 4SLB non-emergency engines not requiring catalyst must change oil, spark plugs and inspect hoses/belts every 1440 hours.
 MMP2 – 2SLB non-emergency engines not requiring catalyst must change oil, spark plugs and inspect hoses/belts every 4320 hours.
 MMP3 – CI non-emergency engines not requiring catalyst must change oil and inspect air filter (AF) every 1000 hours and inspect hoses/belts every 500 hr
 MMP(Emer) – emergency engines must change oil and inspect hoses/belts every 500 hours and change spark plugs (AF for CI) ever 1000 hrs.
 NSCR – Non-Selective Catalytic Reduction; CI – Compression Ignition; RB – Rich Burn; LB – Lean Burn; MACT – Max Achievable Control Tech.

Existing RICE MACT SI Engine NESHAP 2010 Amended Rule		Final Diesel Existing Engine NESHAP	
General Rule Information <ul style="list-style-type: none"> Proposal published - March 4, 2009 Final SI Rule Signed - August 10, 2010 Existing if constructed before 6/12/2006 Two new engine groups covered <ul style="list-style-type: none"> All existing engines at area sources Existing engines <500 hp at major sites Revised rules for <ul style="list-style-type: none"> Adds emission standard for startup and malfunction periods for all engines. Compliance Timeline ~ November 2013 Maintenance Management Practices <ul style="list-style-type: none"> Area source non-emergency engines >500 hp run less than 24 hr/year can substitute MMP3 in lieu of catalyst. Recordkeeping of maintenance Oil analysis program may extend oil life if following parameters are not exceeded (Change oil within 2 days if exceeded): <ul style="list-style-type: none"> TAN >3.0 mg KOH/g from new ±20% change of oil's viscosity when new >0.5% water content by volume 	Rule Requirements <ul style="list-style-type: none"> Engines must start up ASAP, but <30 minutes; Emission Limits (EL) apply at all other times Major Source Catalyst EL – 100hp≤HP≤500hp <ul style="list-style-type: none"> 4SRB – 10.3 PPMvd formaldehyde @15% O₂ 4SLB – 47 PPMvd @15% O₂ 2SLB – 225 PPMvd @15% O₂ Catalyst maintained and operated per manufacture recommendations Area Source Catalyst EL – ≥500 HP <ul style="list-style-type: none"> 4SRB – 2.7 PPMvd formaldehyde @15% O₂ or 76% formaldehyde reduction 4SLB – 47 PPMvd @15% O₂ or 93% CO reduction Must install CPMS and keep records Catalyst Operated <ul style="list-style-type: none"> Within 2"WC of performance test ΔP Oxy Cat inlet temp 450 ≤° F ≤ 1350 NSCR inlet temp 750 ≤° F ≤ 1250 Performance test every 8760 op. hours or 3yr Require initial, performance and compliance notifications Other Provisions <ul style="list-style-type: none"> Method 323 for Formaldehyde has been approved. 	Final Diesel Existing Engine NESHAP <ul style="list-style-type: none"> Final Rule Published March 3, 2010 SSM Provision Effective Date – May 3, 2010 Existing Engine Compliance Date – May 3, 2013 Improved Requirements <ul style="list-style-type: none"> 200 hr oil change frequency for small engines (<300 hp) increased to 500 hr for emergency and 1000 hr for non-emergency engines. Emission limits for emergency and <100 hp at major sources replaced by maintenance management practice (MMP) Increased emission limit/decrease control efficiency <ul style="list-style-type: none"> 300-500 hp – 49 PPMvd CO or 70% Reduction >500 hp – 23 PPMvd CO or 70% Reduction Added an oil condition analysis (OCA) option to changing the oil. Start-up work practice allowance of max. 30 min. for warm-up w/o EL. SSM Plans requirements appear to be removed, but text still vague. New or More Stringent Requirements <ul style="list-style-type: none"> Malfunction emission limit raised from MACT Floor to same as in normal operation Added MMP requirement to inspect air filter every 1000 hr Added requirement for crankcase ventilation control of oil mist, particulate and metallic HAPs for engines >300 hp. 	Consolidated Engine Final Rule NSPS, Subpart JJJJ & Amendments to NESHAP, Subpart ZZZZ <ul style="list-style-type: none"> Proposed: June 12, 2006; Final: January 18, 2008 Three separate rules in one <ul style="list-style-type: none"> New Source Performance Standard (NSPS, 40 CFR, Part 60) Subpart JJJJ NESHAP, MACT Small Engine Standard at a Major Source National Emission Standards for Hazardous Air Pollutants (NESHAP) Areas Source Standard Applies to new/reconstructed (after July 12, 2006) spark ignition (SI, natural gas, gasoline or LPG fueled) engines NSPS, Subpart JJJJ Rule Summary <ul style="list-style-type: none"> Controls criteria pollutants (NOx, CO, PM and HC) Some engines have Manufacture Certification requirement (see MC note in table) All engines have maintenance requirements Most engines require performance testing (initial test for engines <500 hp, initial and every 8760 hours for engines >500 hp). NESHAP, Subpart ZZZZ Rule Summary <ul style="list-style-type: none"> Most engine categories demonstrate NESHAP compliance by NSPS compliance <ul style="list-style-type: none"> CO and VOCs are used as a surrogate for HAPs (predominately formaldehyde) No NESHAP requirements, notifications or General Provisions apply Lean burn engines between 250 hp and 500 hp at major sources have requirements that are identical to the 2004 RICE MACT (except that new/reconstructed/existing threshold date is June 12, 2006) Restricts definition of emergency and adds requirements for these engines.

^aNESHAP – National Emission Standards for Hazardous Air Pollutants, found in 40 CFR, Part 63.

^bThis is a **Overview Only** and is **NOT intended to be used as a compliance tool** because regulatory requirements have been left out for simplification and brevity. Its purpose is to promote a general understanding of the multiple regulations that cover Internal Combustion Engines (ICE).

^cNSPS – New Source Performance Standard, found in 40 CFR, Part 60.



Several Big Wins

- Maintenance practices in lieu of catalyst for 4SRB - 50 to 500 hp and 4SLB & 2SLB - 250 to 500 hp at area sources, i.e. **Less Catalyst**
- **Maintenance practice frequency** for non-emergency engines increased from 200/500 (for <50 hp) or 500/1000 (for >50 hp) operating hours to 1440 operating hours for 4SRB and 4SLB and 4320 operating hours for 2SLB,
- Maintenance practices only in lieu of emission limits for emergency engines at major sources,
- Provisions added for "Oil Analysis Program" (OAP) to extend the period between oil changes,
- **Approval of Method 323** – wet test method for formaldehyde
- And Raising the "MACT Floor Emission Limit" for in almost every way"
- **Lowered BP Est. Capital Budget** – decreased from **\$47 M for the proposed rule to \$20 M for final rule.**



Rule Provisions – Major Sites

- Compliance by Oct. 19, 2013 for existing engines
- Major Sources – Emission Limits for engines $100 < \text{hp} < 500$
 - Catalyst based for 4SRB and 4SLB
 - 4SLB – 47 PPMvd CO @15% O₂
 - Not catalyst based for
 - 4SRB – 10.3 PPMvd Formaldehyde @15% O₂ (?)
 - 2SLB – 225 PPMvd CO @15% O₂
 - catalyst maybe required for compliance with emission limit.
 - Require notifications (initial, start-up perf. test, etc.),
 - Require initial performance test.
- > 500 hp still regulated per 2004 RICE MACT
- Other engines require maintenance practices
 - Engines <100 hp
 - Emergency Engines

Rule Provisions – Area Sites



- Area Sources – Catalyst based emission limits for 4SRB & 4SLB engines > 500 HP
 - 4SRB – 2.7 PPMvd Formaldehyde or 76% Reduction
 - 4SLB – 47 PPMvd CO @15% O₂ or 93% Reduction
 - Requires notifications
 - Requires continuous temp. measurement (CPMS), ΔP measurement,
 - Requires initial and annual performance test, etc.
- Other engines have maintenance Practices
 - 2SLB
 - Emergency engines
 - Low use non-emergency engines - <24 hr/yr (not useful?)

Quick Deadlines



- February 15, 2010 – Initial Notifications for Engines w/ Emission Limitations.
- October 19, 2010 – CPMS Requirements for Engines Currently Covered By RICE MACT

Continuous Parameter Monitoring System Requirements



- Data handling, validation, and averaging requirements;
- A site-specific CPMS Monitoring Plan is required;
- An annual performance evaluation and ongoing O&M consistent with the CPMS Monitoring Plan are required.
- Temperature device (i.e., thermocouple) calibration is required at least every three months.
- Currently Stayed until April 19, 2011 to Negotiate Calibration and Data Handling Requirements.

Maintenance Practices for Engines with No Emission Limit



- Oil changes, spark plug, belt & hose inspection
 - 4SRB and 4SLB – every 1440 operating hours (60 days)
 - 2SLB – every 4320 operating ours (180 days)
 - Emergency engines or low use – 500 operating hours
 - All engines must be serviced at least annually
- May use oil analysis program (OAP) to delay changing oil till next cycle.
 - Oil must be changed within 2 days if any of the following occur:
 - Total Acid Number – increases by more than 3.0 milligrams of potassium hydroxide (KOH) per gram from the TAN of the oil when new;
 - Viscosity of the oil changes by more than 20 percent from the viscosity of the oil when new; or
 - Water content (by volume) is greater than 0.5 percent.
- Maintenance plan and documentation

Q & A Session

