# FAC 7.1: Generators

EPA Impacts on Emergency Gensets for 2015 Installations

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DATA CENTER WORLD® ORLANDO
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ALIGNING THE DATA CENTER WITH BUSINESS STRATEGY

# FAC 7.1: Generators

In order to get the Air Emissions Permit for Data Centers that have diesel emergency standby generators, it is necessary to comply with EPA and local regulatory requirements. Ensuring that the Data Center design takes into account these regulatory requirements can have a significant impact on overall facility layout and cost.

This presentation provides an overview of the EPA regulatory framework that can impact Data Center design and layout.

# Items Covered

- Focus of this presentation
- What Emissions are of Concern?
- Overall EPA Regulatory Framework
- Air emissions modeling process
- Technology to Deal with Air Emissions from Diesel Engines
- Challenges Facing the Critical Power Engineer
- Possible Solutions

# Focus of this Presentation

- Focus is on the emission requirements for new, large stationary emergency Diesel (aka CI or "Compression Ignition") engines commonly found in new Data Centers
- This presentation does NOT focus on:
  - Existing or retrofit engines
  - Natural Gas (Spark Ignition) Engines or smaller ( < 500HP) Diesel Engines
  - Operational and reporting requirements once an engine is installed
  - Revenue production / non-emergency use for emergency engines (as of July 2013 the EPA is reviewing possible changes in this area)
  - Special exemptions for remote areas (i.e. Alaska)

# Emissions of Concern

Data Centers that have diesel driven emergency standby generators have the following emissions that are of concern…

NOx – yellow haze

Particulate Matter / Unburned HC & CO

# Example of a Data Center

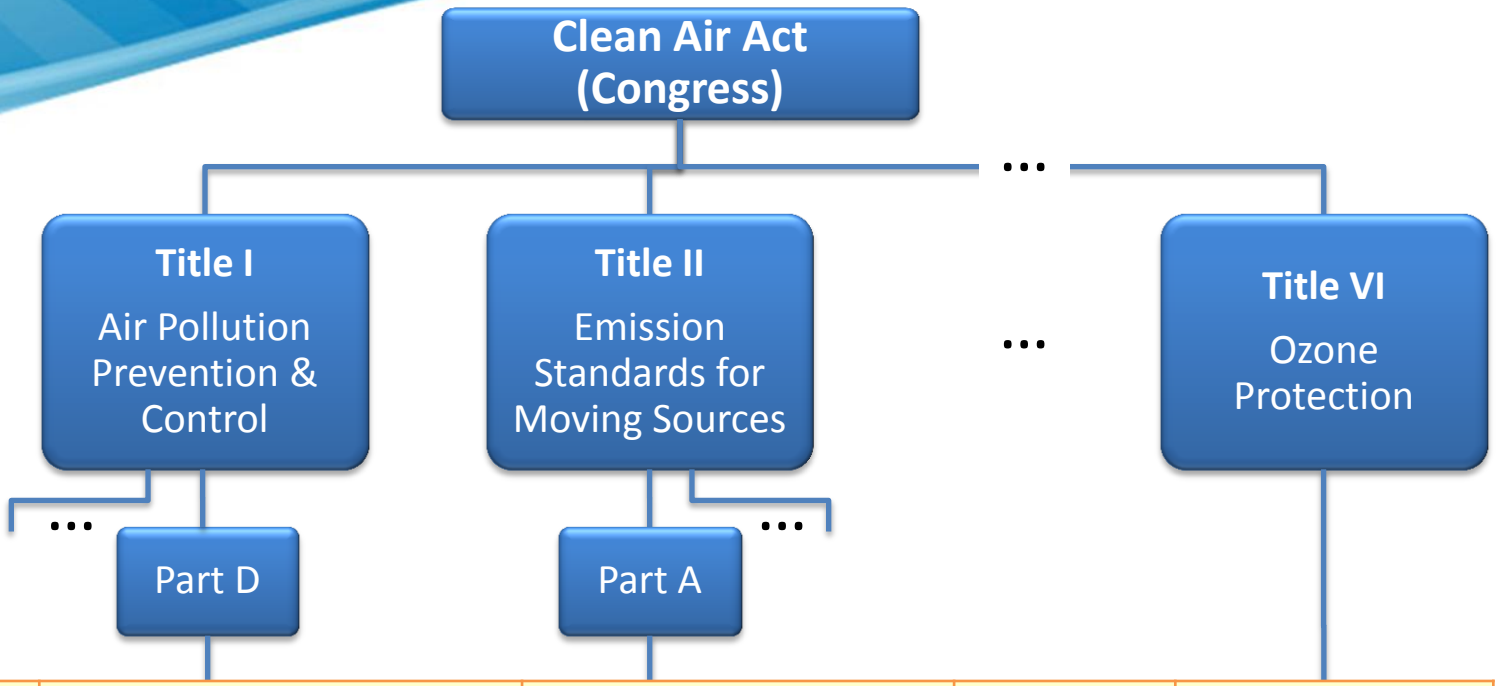
Example of a relatively new Data Center running on Diesel Engines during Testing.

Note the highly visible smokestacks which attract unwanted attention and the plume of emissions coming from them.

# Important EPA Nomenclature related to Gensets

- This presentation uses the following EPA terms and presents a framework that ties them together:
  - **NAAQS** = National Ambient Air Quality Standards – defines the specific pollutants and the acceptable level per geographic "area"
  - **NSPS** = New Source Performance Standards – regulates new sources put into operation after the rule
  - **RICE NESHAP** = Reciprocating Internal Combustion Engines National Emissions Standards for Hazardous Air Pollutants – regulates new and existing sources
  - **EPA Tier 2, 3 4i and 4f** = EPA standards used to certify engines from an air emissions standpoint
- There are many exceptions and special cases in the EPA regulatory framework. This presentation focuses only on new emergency diesel engines > 500HP – typically used in large Data Centers

# Overall EPA Regulatory Framework




| | | | | |
|---|---|---|---|---|
| | Plan Requirements For Non-Attainment Areas | Emissions Standards: Diesel Non Road Engines | … | |
| EPA Regulatory Program | NAAQS/RICE NESHAP/NSPS Office of Air & Radiation | EPA Tier 2,3,4 / Office of Transportation & Air Quality | … | |

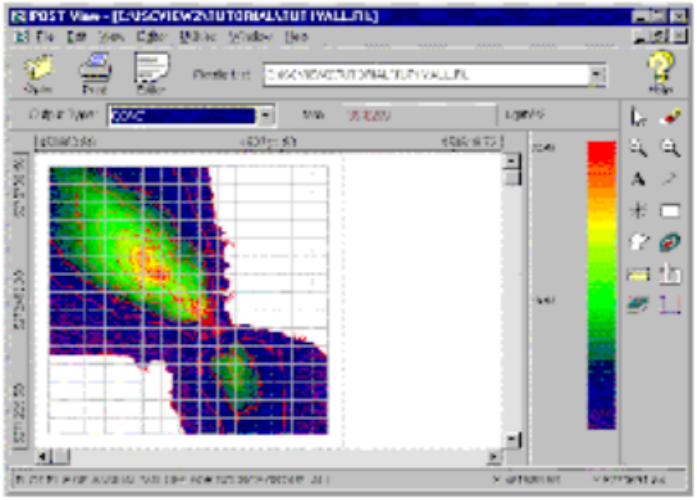
# EPA Definition of "Emergency"

- To address litigation filed by stakeholders (CSP's – Curtailment Service Providers), in January 2013 the EPA proposed the following amendments for Emergency engine operation:
  - Unlimited use for emergencies (e.g., power outage, fire, flood)
  - 100 hr/yr for maintenance/testing and emergency demand response
  - 50 hr/yr of the 100 hr/yr allocation can be used for:
    - local reliability (existing RICE at area sources of HAP only, subject to a NERC – North American Electric Corporation - Level 2 call, or when there is a voltage or frequency fluctuation of 5% or more)
    - peak shaving until May 3, 2014 (existing RICE at area sources of HAP only). Be aware that this usage is often over-ridden by local regulatory authorities – for example US northeastern states - NESCAUM region - do not generally allow this usage)

# EPA Regulatory Framework - NAAQS

- **NAAQS – National Ambient Air Quality Standard**
  - Applies to 6 "criteria" pollutants
  - Must be met by all states
  - Criteria pollutants include diesel emissions such as Nitrogen Dioxide ($NO_2$), Particulate Matter (PM) and Carbon Monoxide (CO)
  - Timetable for NAAQS implementation varies depending on pollutant
  - http://www.epa.gov/air/criteria.html
- **Non-attainment area**
  - "Areas" are often at the county or major urban center level
  - "Attainment" or "non-attainment" determined by EPA
  - Requires an EPA approved State Implementation Plan (SIP) to resolve
  - US Northeast (Maine to Northern Virginia) is called the Ozone Transport Region (OTR) – because of population density it has more stringent requirements

# EPA Regulatory Framework - NAAQS



- NAAQS for $NO_2$ (considered the harshest component of NOx) was changed in 2010 to include an hourly worst case of 188 µg/m3 ( 100 ppb) requirement (previously was an annual average). Timeline for implementation:
  - By June 2013 each state must submit a State Implementation Plan (SIP) to ensure attainment
  - By 2017 there must be full compliance with NAAQS for $NO_2$
- Similar NAAQS approach applies for CO and PM
- Modeling of the emissions sources at the site and its surroundings is used to determine if the site requires emission control devices
- Bottom Line: NAAQS requirements can result in the requirement for emission control devices on the diesel generators at a Data Center

# EPA Regulatory Framework - NSPS

- **NSPS** – New Source Performance Standards
- Applies only to new installations
- Typically specifies performance standards that are defined within the EPA "Tier" levels
- Most new diesel engines intended for emergency use would readily meet the requirements which are:
  - Tier 2 for engines > 752 HP
  - Tier 3 for smaller engines
- Bottom line: NSPS is likely not a constraint from the specifying engineer's perspective

# EPA Regulatory Framework – RICE NESHAP

- **RICE NESHAP** has had a big impact on existing non-emergency diesel generators
  - However this presentation looks at RICE NESHAP impact on new diesel generators > 500HP used for emergency applications
- **Important terminology**:
  - A facility is an **"Area Source"** if it has the potential to emit < 10 tons/year of any single hazardous air pollutant or < 25 tons/year of any combination of hazardous air pollutants annually
  - A facility is a **"Major Source"** if it can emit more than an "Area Source"
  - The emissions requirements and implementation timeline are typically more stringent for "Major Sources"
- EPA has classified over 70 area source categories – i.e. a stationary reciprocating internal combustion engine (RICE), or a boiler Each of these categories has special NESHAP (National Emissions Standards for Hazardous Air Pollutants) requirements

# EPA Regulatory Framework – RICE NESHAP

- **RICE NESHAP** typically references NSPS requirements for installations
- Request the end-user to use Ultra Low Sulfur Diesel **(ULSD)** – which has been a common standard since 2007
- Typically **RICE NESHAP** emissions compliance for new engines > 500HP is accomplished within the engine
- The facility operator must record emergency operation with reference to a non-resettable hour meter and make available to EPA on request
- **Bottom line**: RICE NESHAP is likely NOT a constraint from the specifying engineer's perspective

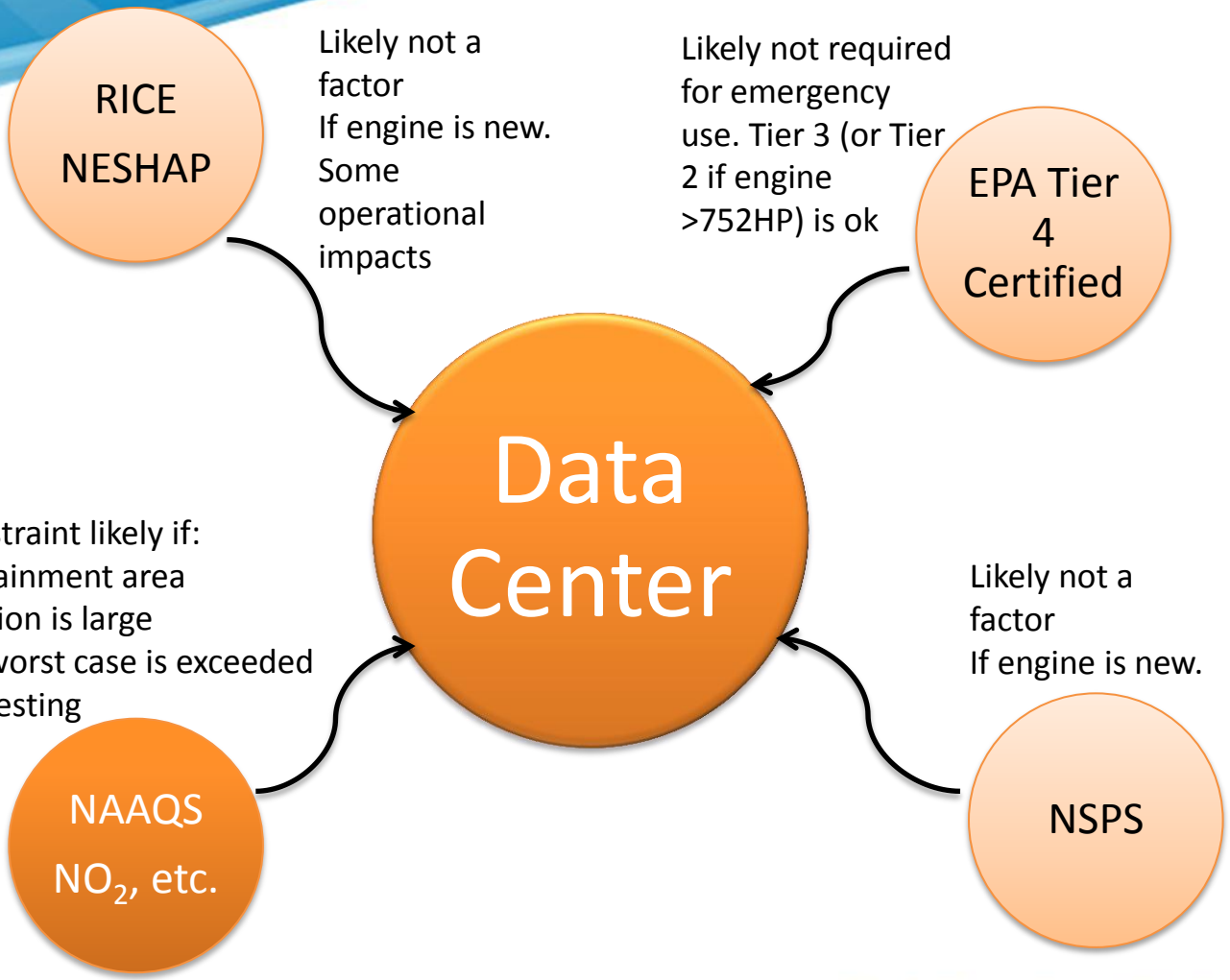
# EPA Regulatory Framework – Tier 4

- Tier 1 was adopted in 1991, the current level is Tier 4 interim (T4i) and by Jan2015 Tier 4 final (T4f) will be in place for non-emergency diesel engines
- If the engine is not T4 it must have a permanent label indicating for emergency use only
- There can be some significant disadvantages to using T4 certified engines for DC emergency applications
  - For example if the urea used for NOx reduction runs low the engine will trip
- **Bottom line**: EPA T4 is NOT required for emergency diesel engines, but some engine vendors are advocating use of T4 engines to ensure there are no operating restrictions

# EPA Impacts for New Diesel Emergency Engines > 500HP

| LAW - provides the authority for the EPA to write Regulations | Clean Air Act (Congress) | | | |
|---|---|---|---|---|
| REGULATIONS - explain the implementation details | NAAQS | NSPS | RICE NESHAP | TIER 2/3/4 |
| Explanation | National Ambient Air Quality Standards | New Source Performance Standards | Reciprocating Internal Combustion Engine National Emissions Standards for Hazardous Air Pollutants | Emissions Standards for Engines (including Stationary) |
| Regulatory Reference for Diesel Stationary Engines | 40 CFR Part 50 | 40 CFR Part 60 part IIII (for Diesel Engines) | 40 CFR Part 63 subpart ZZZZ | 40 CFR part 1039, 1065, 1068 for Tier 4 and 40 CFR part 89 for Tier 3 |
| Overview | Specifies the allowable limits for "criteria" pollutants in EPA defined geographic "areas" | applies to new stationary engines | applies to existing AND new stationary engines. | applies to new engines used in mobile and stationary applications |
| Latest Amendments | Depends on which criteria pollutant is being considered | Tier 3 has been in effect since 2008 and Tier 2 (applies to larger engines) since 2005 | March 2010 with amendments in Jan 2013 | Tier 3 has been in effect since 2008 and Tier 2 (applies to larger engines) since 2005 |
| Implication for Diesel Emergency Engines > 500 HP where there is no intent for revenue generation | If large multi-engine installation in a "non-attainment area" and 1 hr test to be conducted at full load may require SCR for NOx reduction to gain air permit | Tier 3 or Tier 2 for HP > 752 | No reqmts for major sources but best to comply with diesel engine NSPS. Operator may be reqd to follow certain requirements for fuel use, maintenance and reporting | Tier 3 or Tier 2 for HP > 752. Must be marked "For emergency use". |

# EPA Impacts for new Diesel Emergency Engines > 500HP



# Summary: EPA Impacts for Data Centers

- Assuming the key requirement is to get an air permit for the DC for <u>emergency</u> use of diesel gensets:
  - **RICE NESHAP** and **NSPS** requirements have likely been met by the engine manufacturer (since 2008)
  - You likely do NOT need **T4** certified engines
  - You may need emission control devices to meet **NAAQS** requirements:
    - If in a non-attainment area
    - If the Data Center is large (i.e. is an area source)
    - If the 1 hr worst case emissions are exceeded for any "criteria" pollutant during full load testing

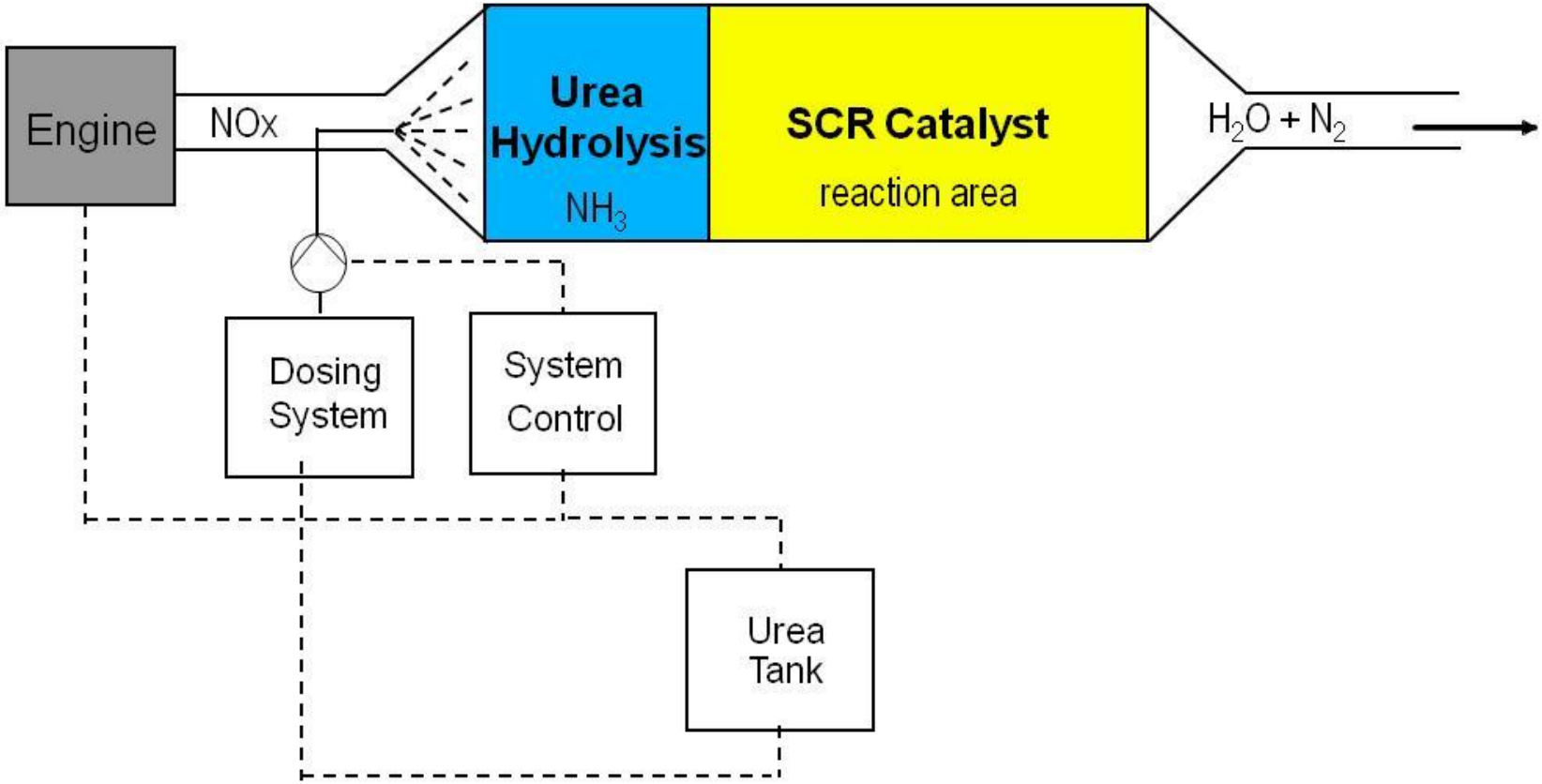
# Technology to Meet Air Emissions Requirements

- For diesel engines the available emission control technologies are:
  - **Diesel Oxidation Catalyst (DOC)** to deal with CO and unburned Hydrocarbons - odor
  - **Diesel Particulate Filter (DPF)** to meet Particulate Matter (PM) requirements - visual
  - **Selective Catalytic Reduction (SCR)** to meet NOx requirements
- Diesel engines used for emergency applications often need to meet NOx requirements based on local permitting requirements

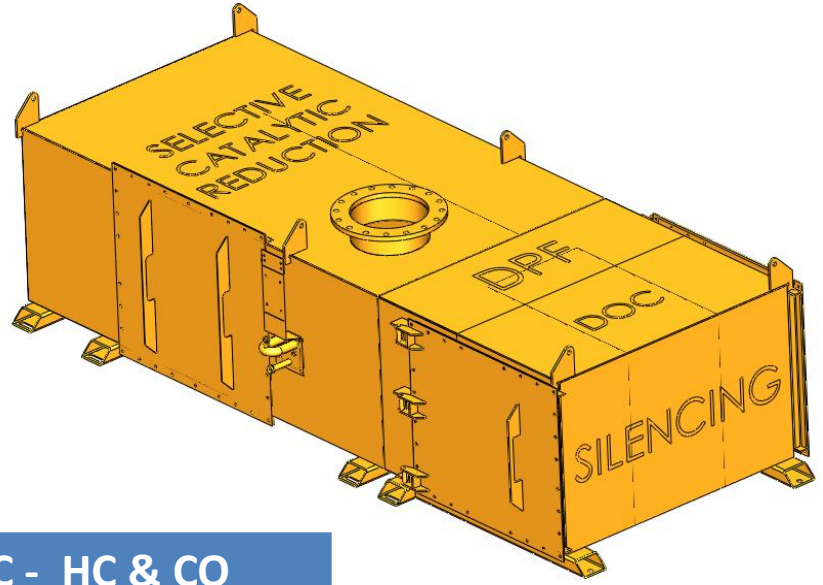
# Selective Catalytic Reduction

- **SCR** is a very well-established and well-known technology to reduce NOx emissions in various applications all over the world.
  - Coal-fired power plants
  - Gas turbines
  - Large marine vessels
  - Diesel cars and trucks
  - Stationary engines

# Basic SCR Technology Principle



# The Technologies and Capabilities

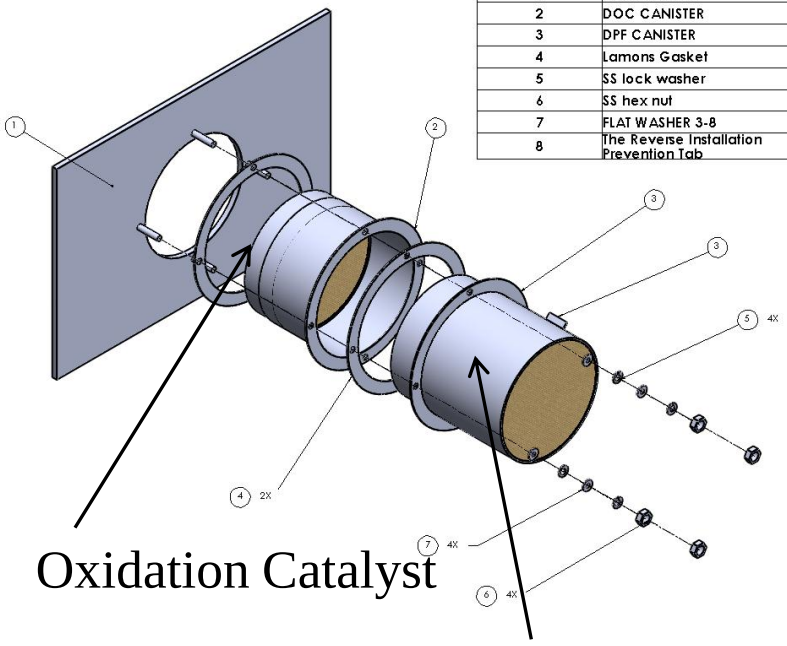



| SCR-NOx | DPF - PM | DOC - HC & CO |
|---|---|---|
| Typical is 80-95% removal | Typical is 70-85% removal | Typical is 70-80% removal |
| Can achieve~99% | Can achieve ~90% | Can achieve ~90% |

**SCR**-Selective Catalytic Reduction
**DPF** – Diesel Particulate Filter
**DOC** – Diesel Oxidation Catalyst
**NOx** – Nitrogen Oxides

# Example of Combination Diesel Oxidation Catalyst and Diesel Particulate Filter

| ITEM NO. | PART NUMBER | Default/QTY. |
|---|---|---|
| 1 | BULKHEAD_DPF | 1 |
| 2 | DOC CANISTER | 1 |
| 3 | DPF CANISTER | 1 |
| 4 | Lamons Gasket | 2 |
| 5 | SS lock washer | 4 |
| 6 | SS hex nut | 4 |
| 7 | FLAT WASHER 3-8 | 4 |
| 8 | The Reverse Installation Prevention Tab | 1 |




Oxidation Catalyst

Particulate Filter

Bulkhead for FOx modules for 3MW engine

**F**ilter **Ox**idation canister = Particulate Filter + Oxidation Catalyst

# Example of Combination SCR, Diesel Oxidation Catalyst, DPF, Silencing – enclosure mount

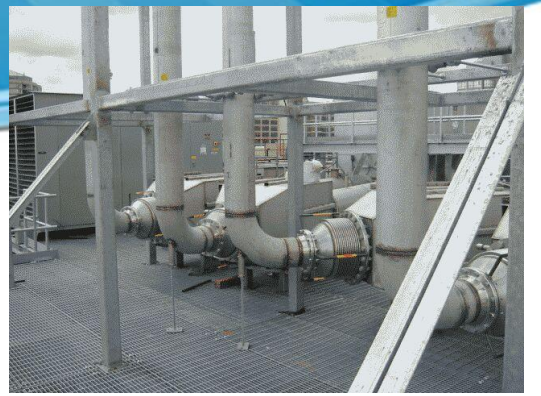
# Example of Combination SCR, Oxidation Catalyst, DPF – ceiling mount

ecoCUBE
Emission
Control System

Inlet exhaust
gas entry

Engine Pad

# Examples of Emission Control Systems on Diesel Gensets



CAT3512

MTU16V4000

C175

MTU 16V4000

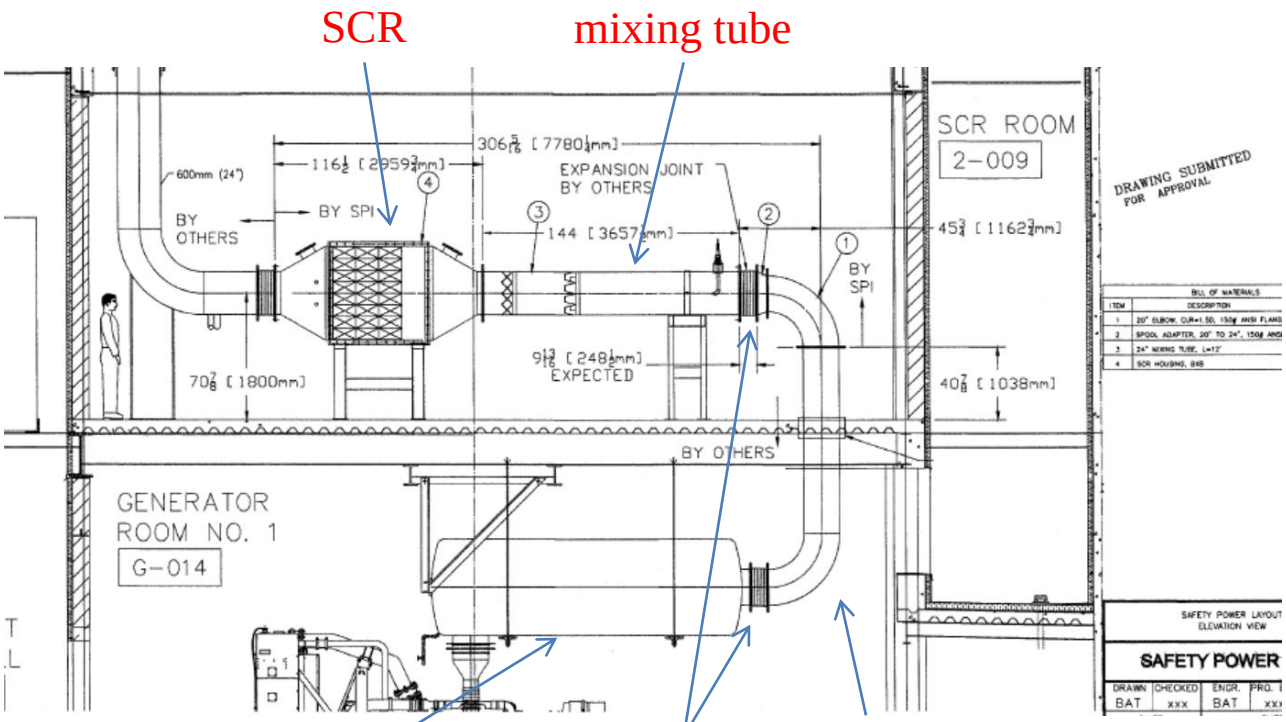
CAT 3616C

Mitsubishi 1.7MW

# Challenges Facing the Critical Power Engineer

- What air emission requirements have to be met?
  - The site location may not yet be finalized
  - The regulations may change between project concept stage and project implementation
- I want a design that can be used anywhere across the US (or Internationally)
- How much physical space and what costs must I allocate for the emission control equipment

# Challenges Facing the Critical Power Engineer

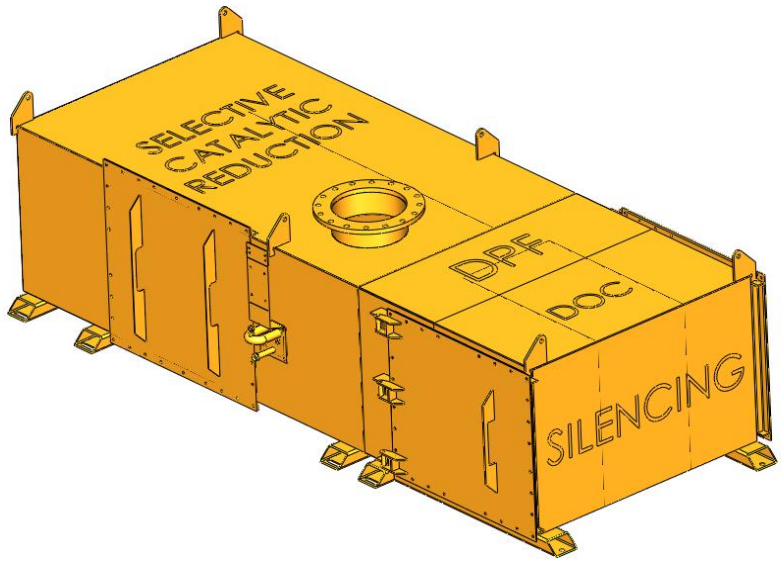



- Traditional approach:
  - Many devices
  - Lots of expansion joints
  - Uses too much space
  - Complex mechanical design
  - High installed cost

# Possible Solutions to the Challenges

- Select a modular system that can combine as many functions as possible into a single package. Functions may include:
  - Acoustic control (exhaust silencing) – required for most all installations
  - NOx control (requires SCR) – required for many installations if DC is large and in a non-attainment area
- **DOC** or **DPF** – likely not required today, but may be required when the site seeks its air permit – specify a design which allows these functions to be upgraded with no required change in space or piping configuration

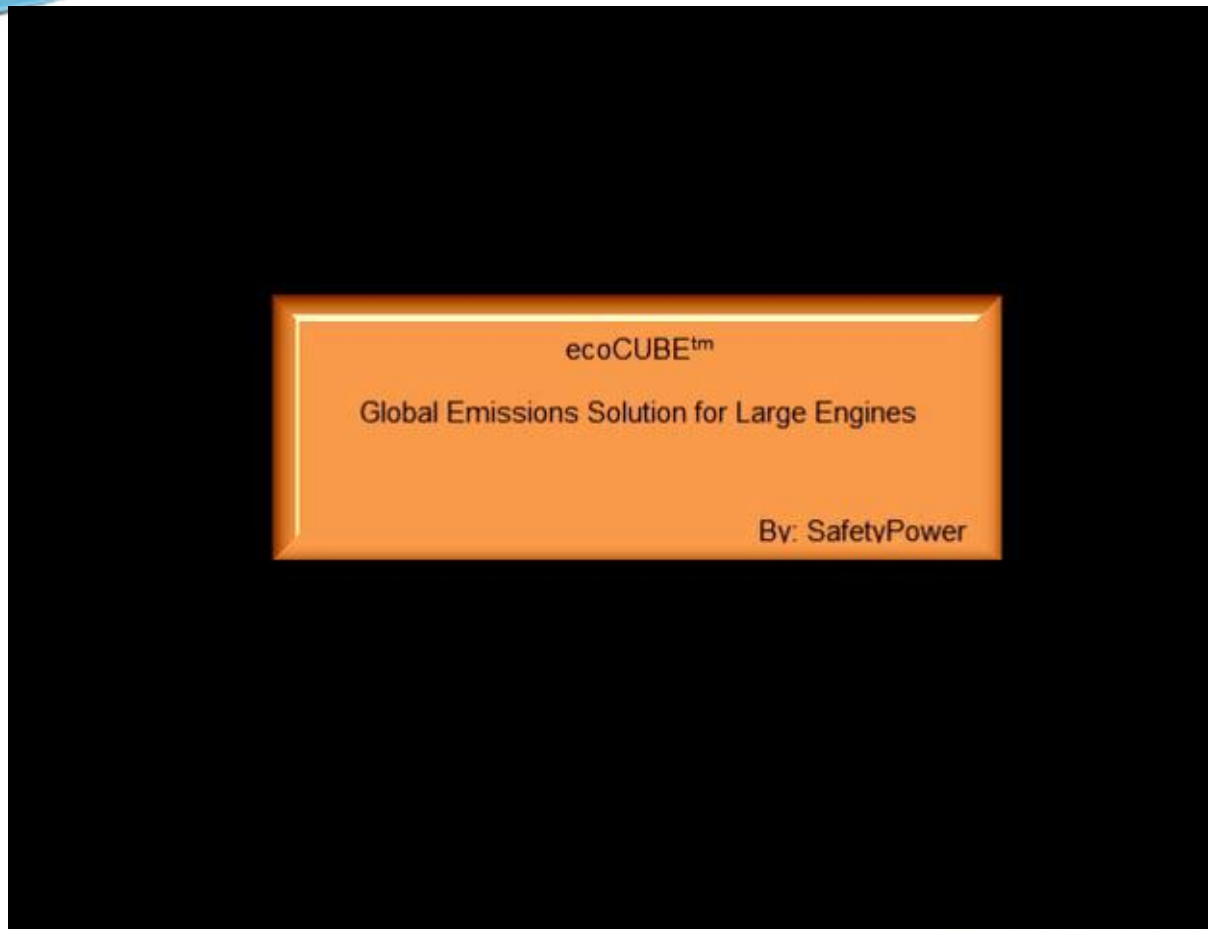
# Possible Solutions to the Challenges




Modular design allows a single cube to house any combination of **Selective Catalytic Reduction (SCR)** with:

- **Diesel Oxidation Catalyst (DOC)**
- **Diesel Particulate Filter (DPF)**
- **Silencing**

# Space Saving Modular Design



# Summary

- EPA rules are very complex and constantly changing
- Large diesel emergency generators in data centers may be more constrained by NAAQS requirements than other regulation
- For large installations, the Critical Power Engineer should consider space saving approach with a **Silencer/SCR** combination that can be upgraded with no required change in space or piping configuration

# Thank you

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