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# Developing Performance Based Generator Set and System Specifications

Thursday May 12 1:00 CDT / 2:00 EDT  
(1PDH issued by Cummins)



**Power  
Generation**



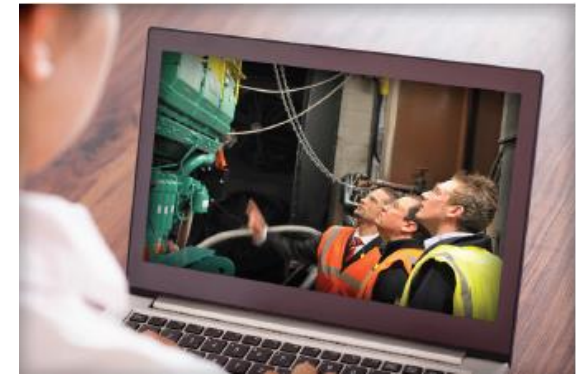
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# Meet your panelists

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Group Leader, North America and  
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Technical Specialist, Application Engineering

## Cummins facilitator:

Tom Bakritztes, Global Sales Training Manager

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# Course Objectives

## Participants will be able to:

- Recognize performance-based requirements for generator set, transfer switch and switchgear specifications.
- Identify common specification pitfalls and provide performance-based alternatives.
- Recognize current technology trends that impact the power generation industry and learn how they can be applied to existing specifications.
- Discuss the benefits of specification generation tools and how they can improve efficiency by specifying competitive and thorough system requirements.

# What is a Performance-based Spec?

- Driven by a functional requirement
  - Why is it needed?
- Incorporates technology relevant in the current market
- Requires an understanding of underlying principles
- Improves system efficiency and reliability by optimizing equipment for specific applications
- Inclusive of “functional equivalents”

# Generator Set Specification Items

# Diesel Engine Requirement

Each engine shall be of the full diesel compression ignition, liquid cooled type, 16 cylinder, four cycle, 1800 rpm and shall utilize No.2 diesel fuel. The engine shall be turbo-charged, after-cooled and equipped with crosshead malleable iron pistons, replaceable cylinder liners, counter balanced forged steel crankshaft, forged steel connecting rods, replaceable main and connecting rod bearings...

# Diesel Engine Requirement

- Specificity of content may limit the design choices for product
  - Requiring detail on such a section may distract from key performance drivers
  - By including this text in the spec, if a new technology is released, it may limit the potential of adopting a better technology
  - Suggest including the functional requirements (fuel type, cooling type, etc.)
- ✓ Fuel: ASTM D975 #2 Diesel Fuel



# Fuel Filtration

The genset shall be provided with heavy duty, high capacity fuel pre-filter/water separators as manufactured by Brand X. Filters shall be Model Y, and provide two stages of filtration: 30 micron primary and 7 micron secondary.

# Fuel Filtration

- Specifying a brand of filters limits product options (a different brand may provide something better)
- The filter micron requirement should be removed, filtration requirements are not common across all engine manufacturers.
- ✓ Fuel oil filters shall be provided per engine manufacturer's requirements.
- ✓ Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.

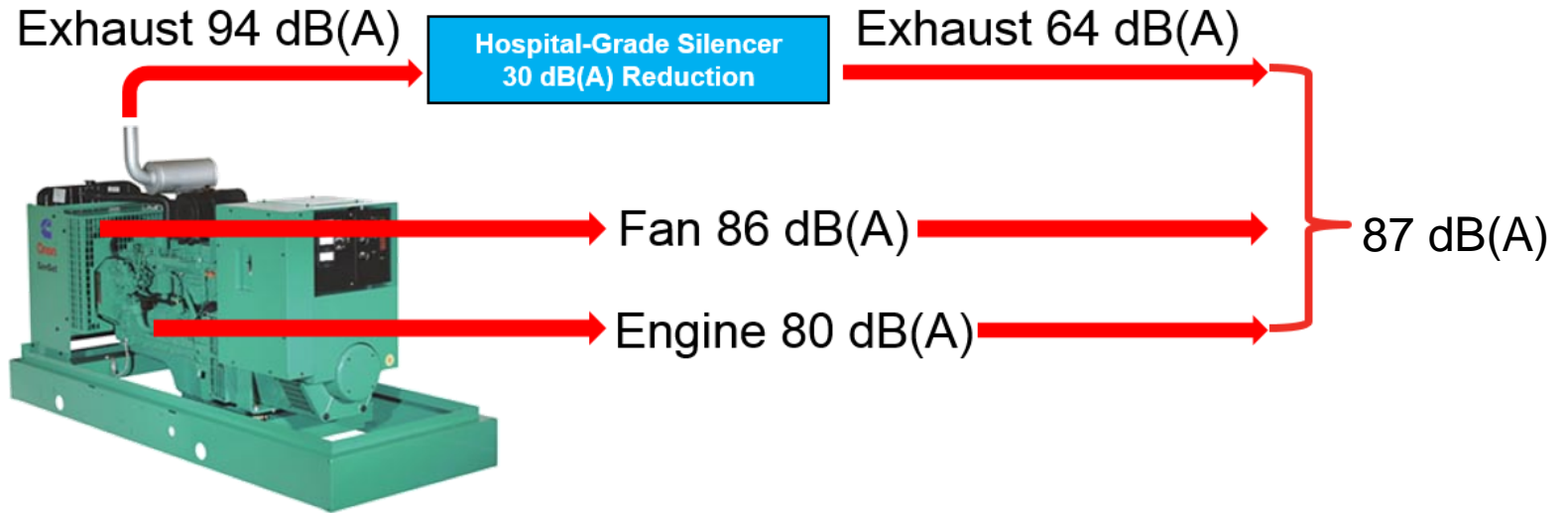
# Sound Performance

Housing should provide sound reduction capabilities up to Critical Grade Silencing.

Exhaust silencer(s) shall be critical grade.

- Does not specify overall sound pressure level at a given distance (property line)
- May not comply with local noise ordinances
- ✓ Sound pressure level measured at the property line (23 feet from the generator set), shall not exceed 85 dB(A).

# Sound Performance



# Fuel Coolers

Engine generator shall be equipped with a fuel oil cooler.

Fuel return temperature must not exceed 38°C.

- Fuel oil coolers are application specific
- Maintaining the returned fuel temperature at an excessively low value may not be achievable
- ✓ A fuel oil cooler shall be provided per the application as required by the engine manufacturer.

# Design Calculations

Calculations provided in the submittal package to include:

- Calculations of the engine and generator output power capability, including efficiency and parasitic load data.
- Calculations for the capacity of each day tank, including allowances for recirculated fuel, usable tank capacity, and duration of fuel supply.

# Design Calculations

- Design calculations are considered proprietary data in most organizations
- Test data of actual output based on prototype and production units is a much more accurate and relevant piece of information
- ✓ Generator set manufacturer shall provide a certified summary of prototype-unit test report.
- ✓ Generator set manufacturer shall provide a list of factory tests to be performed on units prior to shipment.
- ✓ Generator set manufacturer shall provide a report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

# Turbocharger Loads

Manufacturer shall submit turbocharger load bearing calculations for the proposed engine-generator set.

- The intent of this section is to determine the weight which the turbo can hold, not the electrical or mechanical load of the turbo impeller/housing.



# Turbocharger Loads



Turbocharger  
Exhaust Outlet  
Elbow / Flange

# Turbocharger Loads

- Turbochargers are not built to hold weight, the flange is provided as a connection point only.
- ✓ Exhaust system shall be installed per engine manufacturer's requirements.

# Transient Performance Expectations

The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

Max Step Load Increase 100 % of Service Load at 0.8 PF

Maximum Voltage Deviation with Step Load Increase:

10 % of rated voltage

Maximum Frequency Deviation with Step Load Increase:

5 % of rated frequency

# Transient Performance Expectations

- 10% voltage dip on 100% step load of nameplate is virtually impossible
- 10% voltage dip on 100% step load of facility requirement is possible, but requires a significantly oversized genset
- For loads which are sensitive to voltage dip, apply them in steps and later in the loading sequence
- ✓ Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

# ISO Transient Performance

Engine-generator shall be capable of transient performance per ISO 8528 class G3.

- Common misinterpretation of this:

A. **Performance Class:** Diesel generator set is to be class G3 (15 percent voltage drop / free drop at 100 percent loading) to ISO 8528-1.

- ISO 8528 lists an acceptable voltage and frequency surge based on 100% load **rejection** and an acceptable voltage and frequency drop based on a calculated load percentage

# O & M Manuals

Six copies of the operation manual (approved prior to commencing onsite tests) in 8-1/2 by 11 inch format, including a minimum of 3 rings from which material may readily be removed and a separate section for each system or subsystem. Sections shall be bound with heavy plastic dividers with tabs which identify the material in the section. All pages shall be folded blue lines, with the title block visible, and placed in 8-1/2 by 11 inch booklets with reinforced holes. One full size reproducible mylar of each drawing shall accompany the booklets. Mylars shall be rolled and placed in a heavy cardboard tube with end caps on each end. The manual shall include: step-by-step procedures for start-up, operation, and shutdown; drawings, diagrams, and single-line schematic diagrams; and define the electrical, mechanical, and hydraulic systems together with the nomenclature, terms, and safety systems; the manufacturer's name, model number, and location of equipment in the system. The instructions shall include procedures for interfacing the system with related systems to include automatic transfer switches, fire alarm systems, load shedding systems, uninterruptible power supplies. Each booklet shall include a CDROM containing an ASCII file of the procedures.

**Keep the specification current!**

# Common Specification References

# Performance Spec Values

- Safety and protection:
  - UL 2200 listed generator set, CSA, CE
- Emergency system usage:
  - NFPA 110 Level 1, Type 10
- Emissions Levels:
  - Emergency Stationary, Stationary Non-emergency, or Non-road mobile
- Seismic
  - IBC 2006, 2009, 2012, 2015
  - OSHPD Pre-certification





# System/Switchgear Specifications

# Control Circuit Board

The ATS control logic shall be provided on multi-layer printed circuit boards

- How would a single-layer verses a multi-layer impact the performance of the ATS?
- Almost all circuit boards are multi-layered
- ✓ Possibly specify radio frequency emission compliance, surge withstand rating and operating temperature

# Synchronizer and Load Control

Include in the switchgear a Woodward MSLC and DSLC:

All paralleling control components shall be compatible with each proposed generator manufacturer. *Digital paralleling controls as part of the generator controller are not acceptable.*

- What is the technical justification for not allowing the paralleling control to be part of the generator set?
- Relying on a master for paralleling introduces a single point of failure

# Synchronizer and Load Control

- ✓ Provide a paralleling control panel for each generator set in the emergency/standby power system. Each paralleling control shall be independent and autonomous, requiring no interaction with other controls for synchronizing

# Multi-function Relays

Provide each generator circuit breaker with a multi-function generator relay in a drawout case to provide protection, control, metering and monitoring of the generator. Locate one 9600 baud RS232 port .... The relay shall have Windows® based PC software to enable setpoint programming file storage, on-line help, and real time display of status and measured data. General Electric Multilin SR489 series

- This portion specifically calls out a brand of relay, but does not address the functions that the relay should carry

# Multi-function Relays

- ✓ The generator controller shall have the following protection:
  1. High AC voltage shutdown
  2. Low AC voltage shutdown
  3. Over/Under frequency
  4. Reverse power
  5. Overcurrent
  6. Synch check
  7. ...

# Synchronizing Panel

Provide Synchronizing panel with:

1. One bus AC voltmeter, Crompton digital analog type
  2. One synchroscope
  3. Two synchronizing lamps
- Why not take advantage of the modern digital paralleling technology? Manual operation needed?
  - ✓ The generator set operator panel shall provide manual and automatic functions for control of the generator set



# Metering

Provide digital/analog ammeter suitable for the display of all phases (1% accuracy) with ammeter switch for all generators

- Are the analog meters necessary?
  
- ✓ The generator and Master HMI should display:
  - Line to line voltage (all three phases simultaneously)
  - Line to Neutral voltage (all three phases simultaneously)
  - Alternator frequency
  - ...

# Paralleling Time

All generators shall be paralleled and on-line within 10 seconds following the utility outage

- May be possible in some situations
  - Size the smallest generator set to handle the critical loads requiring a 10 second compliance time
- ✓ Critical loads should be online within 10 seconds

# Specification Building Tool

- GenSpec
  - Generators
  - Automatic Transfer Switches
  - Switchgear

Home > GenSize > GenSize Edit Project > GenSet Recommendations

GenSet Recommendations : [REDACTED]


Navigation Options		Recommendation Options		Report Options		
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Report	Model	Max. Step Voltage Dip	Max. Step Frequency Dip	Peak Voltage Dip	Peak Frequency Dip	Site Rated Standby kW/kVA
<input checked="" type="checkbox"/>	1500DQGAS	12	2	14	2	1500/18
<input type="checkbox"/>	1500DQGAF	12	2	14	2	1500/18
<input type="checkbox"/>	1500DQGAS	12	2	14	2	1500/18
<input type="checkbox"/>	1500DQGAF	12	2	14	2	1500/18
<input type="checkbox"/>	1500DQGAS	11	2	13	2	1500/18

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# Summary

- Remember to write specifications based on functions and performance
- Listing brand-specific components can limit design options and increase cost
- Assess how realistic and relevant the specified performance metrics are
- Be sure to keep specifications current with modern technology

# Q&A

- Type your questions, comments, feedback in the **WebEx Q&A box**. We will get to as many questions as we can
- We will publish consolidated FAQ along with presentation and webinar recording on [powersuite.cummins.com](http://powersuite.cummins.com)

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