

Generator Set Sizing Software: Transient Performance and Motor Load Capabilities

PowerHour webinar series for consulting engineers
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March 26th, 2020

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Meet your panelists

Cummins presenter:



Obinna Igwe
Senior Application Engineer – Distribution Support
Cummins Inc.

Cummins facilitator:



Chad Hale,
Technical Marketing Specialist
Cummins Inc.

Your local Cummins contacts:

- Western Canada: Ian Lindquist (ian.Lindquist@cummins.com), Western Canada Region
- Eastern Canada: Gianluca Ianiro (gianluca.ianiro@cummins.com), Eastern Canada Region
- AZ, ID, NM, NV: Carl Knapp (carl.knapp@cummins.com), Rocky Mountain Region
- CO, MT, ND, UT, WY: Chris Scott (chris.scott@cummins.com), Rocky Mountain Region
- Northern IL, IA: John Kilinskis (john.a.kilinskis@cummins.com), Central Region
- UP of MI, MN, East ND, WI: Michael Munson (michael.s.munson@cummins.com), Central Region
- NE, SD, West MO, KS: Earnest Glaser (earnest.a.glaser@cummins.com), Central Region
- South IL, East MO: Jeff Yates (jeffrey.yates@cummins.com), Central Region
- TX, OK, AR, LA, MS, AL, Western TN: Scott Thomas (m.scott.thomas@cummins.com), Gulf Region
- FL, GA, NC, SC, Eastern TN: Robert Kelly (robert.kelly@cummins.com), South Region
- NY, NJ, CT, PA, MD: Charles Attisani (charles.attisani@cummins.com), East Region
- CA, HI: Brian E Pumphrey (brian.pumphrey@cummins.com), Pacific Region
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The views and opinions expressed in this course shall not be considered the official position of any regulatory organization and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents. In addition, when in doubt, reach out to the Authority Having Jurisdiction.



Course Objectives

Generator Set Sizing Software: Transient Performance and Motor Load Capabilities

When sizing a generator set, one must consider the various loads in the power system and their effect on transient response. Due to their challenging starting requirements, motor loads may drastically impact generator sizing and selection inadvertently disrupting the balance between transient performance and avoiding oversizing. This session will explore the process of generator set selection for motor loads using a commercially available sizing and selection platform. Participants are encouraged to sign up for Power Suite at powersuite.cummins.com beforehand, and are welcome to follow along with the demonstration.

After completing this course, participants will be able to:

- Describe the unique nature of motor loads and their characteristics that may impact starting requirements
- Recognize the impacts of motor starting requirements on transient performance
- Identify solutions to better manage motor load induced transient response as related to generator set sizing

Basic Characteristics of Motor Loads

- When a motor is first connected to the generator, an instantaneous voltage dip occurs which is a function of alternator transient reactance, $X'd$, and the motor impedance. This is highlighted in the Locked rotor kVA curve on alternator datasheets
- Motor loads cause difficulty because a motor draws high current when started at full voltage. Starting current is typically six times a motor's rated full-load current, and this inrush current stays high until the motor reaches about 75 percent of rated speed
- This presents a unique problem where the voltage and frequency dips considerably during the starting process on Generator Sets as opposed to Utility due to its robust nature
- Various methods are employed to limit these instantaneous voltage and frequency dips in order to avoid oversizing a generator set for conditions only seen during startup e.g. soft starters, VFDs etc.

Understanding a Motor Nameplate

SIEMENS									
PE•21 PLUS™					PREMIUM EFFICIENCY				
ORD.NO.	1LA02864SE41				E NO.				
TYPE	RGZESD				FRAME	286T			
H. P.	30.00				SERVICE FACTOR	1.15		3 PH	
AMPS	34.9				VOLTS	460			
R.P.M.	1765				HERTZ	60			
DUTY	CONT 40°C AMB.				DATE CODE				
CLASS INSUL	F	NEMA DESIGN	B	K.V.A. CODE	G	NEMA. NOM. EFF.	93.6		
SH. END BRG.	50BC03JPP3				OPP. END BRG.	50BC03JPP3			
MILL AND CHEMICAL DUTY QUALITY INDUCTION MOTOR									
Siemens Energy & Automation, Inc. Little Rock, AR						MADE IN U.S.A.			

When modeling a motor load, pay close attention to the following parameters:

- Horsepower
- Phase
- Voltage
- Frequency
- Efficiency
- NEMA Code
- Service Factor

Figure 1: Siemens 286T 30HP Motor Name Plate

Effects of Nameplate Parameters

Efficiency:

Efficiency does not affect the starting characteristics of the motor load, however, it does directly affect its running kW and amps

NEMA Code:

The Locked Rotor KVA Code or NEMA Code defines the locked rotor current kVA on a per horsepower basis. The letter code consists of letters from A to V. The farther away from the letter code A, the higher the inrush current per horsepower

Code Letter	Factor	Code Letter	Factor	Code Letter	Factor
A	2	H	6.7	R	15
B	3.3	J	7.5	S	16
C	3.8	K	8.5	T	19
D	4.2	L	9.5	U	21.2
E	4.7	M	10.6	V	23
F	5.3	N	11.8		
G	5.9	P	13.2		

Table 1: Multiplying factors corresponding with code letters, T-030

Effects of Nameplate Parameters cont.

Service Factor:

- A motor's service factor represents its ability to deliver horsepower beyond its nameplate rating under specified conditions
- Thus, a motor with 1.15 service factor motor can be operated at 15% higher than the motor's nameplate power

Voltage:

- The NEMA standard for motor voltage ratings assumes that there is a voltage drop from the utility supply to the motor terminals
- Thus, a 460V motor is appropriate for a 480V supplied system
- Most motors are designed with a $\pm 10\%$ tolerance for voltage

Frequency:

There are some drawbacks in service of a 50Hz motor on a 60Hz system

- Increased core loss which causes overheating of core
- Reduced motor bearing life (marginal) due to increased speed and load

Alternator Motor Starting

- The Locked Rotor Curves are used as a guide to indicate the expected transient voltage dip/rise upon impact/rejection of load
- It starts from an assumption that the alternator is operating at rated voltage and then a block load is suddenly applied
- The curves are based on results from tests conducted in accordance with the requirements of IEC 60034
- The voltage dip is a product of the alternator's reactances, both sub-transient (X''_d) and transient (X'_d),

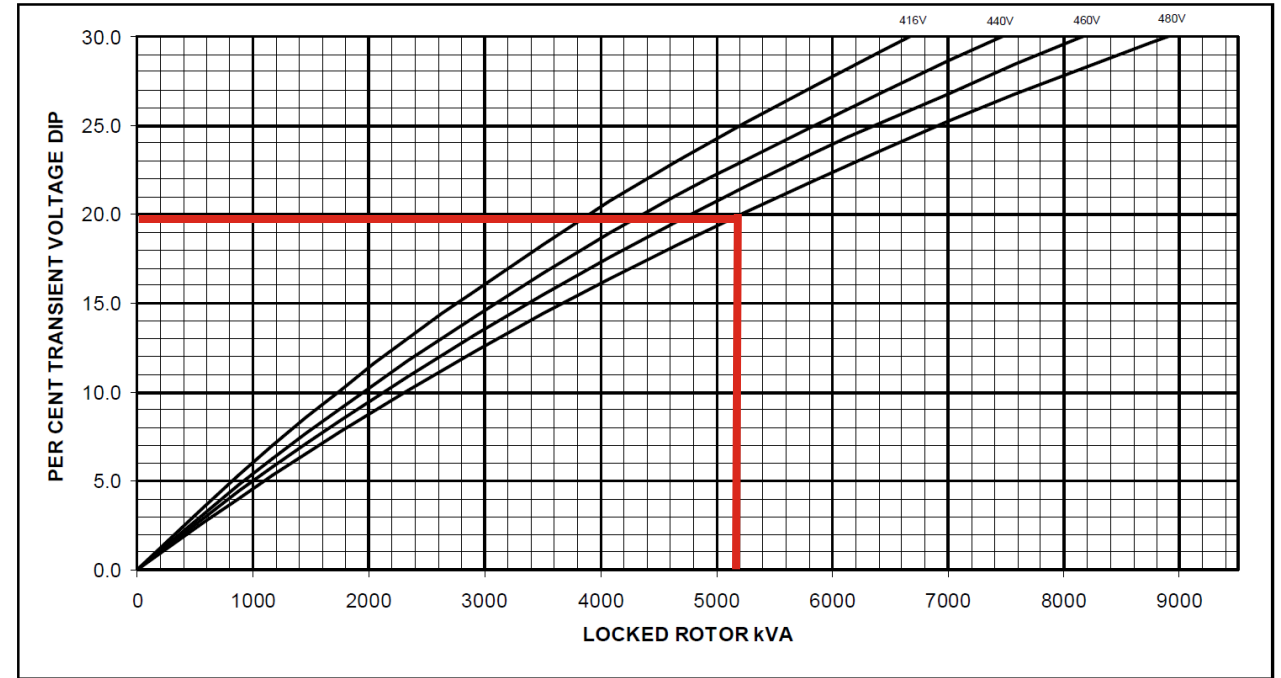


Figure 2: Alternator Locked Rotor Motor Starting Curve

Spec Note Transient data from generator set testing should be employed for accurate characterization of performance

Alternative Starting Methods

- Motors typically start DOL/Across-The-Line where the starter applies full voltage, current, and torque immediately upon starting
- Alternative starting methods are employed to help reduce the mentioned motor starting requirements. Some of the popular methods include:
 - Variable Frequency Drives (VFD): A type of motor controller that drives an electric motor by varying the frequency and voltage supplied to the electric motor. These drives induce varying levels of harmonics on the power system depending on quality and configuration
 - Soft Starters: Devices or configurations used with AC electrical motors to temporarily reduce the load and torque in the power train and electric current surge of the motor during start-up e.g. Wye-Delta, Part-Windings, Auto Transformer

Load Sequencing

- Load sequencing is a technique used to enhance transient performance of a generator set by limiting the maximum starting kW put on the generator set by breaking it down into various steps.
- There are several options available:
 - Multiple Transfer Switches
 - Breakers
 - Programmable Logic Controllers
- Here are some recommendations:
 - Apply loads in multiple steps
 - Allow recovery between steps (5-10 Sec)
 - Start larger loads first (after critical loads)

Generator Set Sizing Software Demo

- We shall move on to the demonstration portion of this webinar
- Users are encouraged to follow along on [PowerSuite.cummins.com](https://powersuite.cummins.com)

Course Summary

Generator Set Sizing Software: Transient Performance and Motor Load Capabilities

- Get as much information as possible on load attributes and site conditions prior to sizing
- Apply proper load sequencing techniques to ensure ideal transient performance
- Employ the use of alternative starting methods for high inrush loads like motors
- Collaborate with your local generator set provider e.g. using the “project share” feature on Gensize

Key Software features for properly sizing motor loads

- Fully customizable motor load options to ensure available starting methods can be simulated
- Generator Set derate functionality to assure performance at extreme ambient temperature and altitudes
- Data-Driven transient performance calculations for accuracy
- Ability to generate a comprehensive report showing load attributes, model information, performance etc.

Additional Resources

Cummins White Papers

- Transient Performance Of Generating Sets
- Specifying And Validating Motor Starting Capability
- How to size a genset: Proper generator set sizing requires analysis of parameters and loads

Cummins On-Demand Webinars

- Introduction to Generator Set Sizing Software

Power topic #7007 | Technical information from Cummins Power Generation

How to size a genset: Proper generator set sizing requires analysis of parameters and loads

> **White paper**
By Jim Iverson, Senior Applications Engineer



Our energy working for you.™

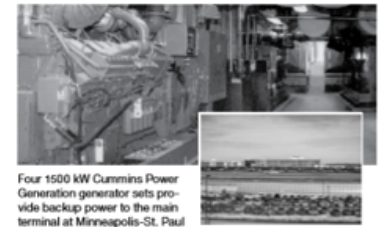
While most sizing exercises are best done with sizing programs or with the help of a manufacturer's representative, it is still important to understand the factors that affect the operation of your generator set so you can be confident you have the right equipment for your application.

Project parameters

The first step in sizing and selecting a generator set is to establish project parameters.

- **Minimum generator set load/capacity:** Running a generator set under light load can lead to engine damage, reducing reliability. Cummins Power Generation does not recommend running generator sets at less than 30 percent of rated load. Load banks should supplement the regular loads when loading falls below the recommended value.
- **Maximum allowable step voltage dip** (starting and running): As you reduce the maximum allowable step voltage dip during initial startup, when loads cycle under automatic controls or when high peak loads operate, you need to increase the size of the generator set specified. Choosing lower allowable voltage dip requires a larger generator set.
- **Maximum allowable step frequency dip:** As you reduce the maximum allowable frequency dip, you increase the size of the generator set needed.
- **Altitude and temperature:** Based on the site location, the size of the generator set must increase for a given level of performance as altitude and ambient temperature rise.

- **Duty cycle:** Generator set size is also influenced by whether the application is for standby power, prime power or utility paralleling. Standby power systems generally have no overload capability. Prime power systems generally have a minimum of 10 percent overload capacity. Generator sets that are intended to operate extended hours at steady constant load should not be operated in excess of the continuous rating.
- **Fuel:** The preference for gas, diesel, or LP will affect generator set choices. Often, generator sets running on gas or LP must be oversized due to derating. Emergency systems typically must be supplied by fuel stored locally.
- **Phase:** Select either single- or three-phase. The three-phase selection permits single-phase loads but the assumption is that the single-phase loads will be balanced across the three phases.
- **Frequency:** Either 50 Hz or 60 Hz.
- **Voltage:** Voltage choices are usually a function of selected frequency.



Four 1500 kW Cummins Power Generation generator sets provide backup power to the main terminal at Minneapolis-St. Paul International Airport.

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

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- Western Canada: Ian Lindquist (ian.lindquist@cummins.com), Western Canada Region
- Eastern Canada: Gianluca Ianiro (gianluca.ianiro@cummins.com), Eastern Canada Region
- AZ, ID, NM, NV: Carl Knapp (carl.knapp@cummins.com), Rocky Mountain Region
- CO, MT, ND, UT, WY: Joe Pekarek (joe.a.pekarek@cummins.com), Rocky Mountain Region
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- FL, GA, NC, SC, Eastern TN: Robert Kelly (robert.kelly@cummins.com), South Region
- NY, NJ, CT, PA, MD: Charles Attisani (charles.attisani@cummins.com), East Region
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- WA, OR, AK: Tom Tomlinson (tom.tomlinson@cummins.com), Pacific Region
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Please contact Mohammed Gulam if you have any questions related to the PowerHour webinar (mohammed.gulam@cummins.com)

Q+A

