Generator Set Ratings for Data Centers and Other Applications

PowerHour webinar series for consulting engineers
Experts you trust. Excellence you count on.

DATE 11:00 PDT / 13:00 CDT

(1PDH issued by Cummins)

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- Earn Professional Development Hours (PDH)

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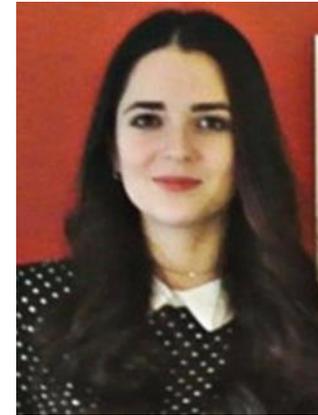
Meet your panelists

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Cummins facilitator:

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Sales Application Engineer

Cummins Inc.

Rich Scroggins

Technical Advisor - Data Center Markets

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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 it doubt, reach out to the Authority Having Jurisdiction.

Course Objectives

Generator Set Ratings for Data Centers and Other Applications

One of the first steps to a successful generator set application is selecting the appropriate generator set rating. This PowerHour will guide participants through the industry standards that define generator set ratings; such as ISO 8528-1 along with other industry adopted ratings. In particular, the instructors will discuss Uptime Institute generator set rating requirements for Tier III and Tier IV data centers as well as industry responses to those requirements.

After completing this course, participants will be able to:

- Define generator set ratings per ISO 8528-1 and identify their appropriate applications

- Recognize industry adopted ratings outside of ISO 8528-1

- Describe the impact of Uptime Institute Tier certifications on generator set ratings requirements
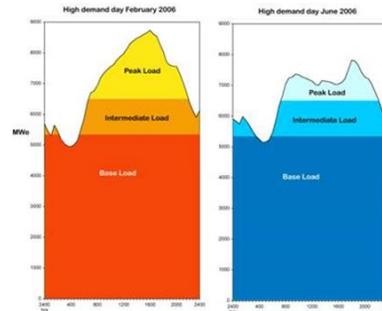
What factors impact generator set ratings?

Factors Affecting Choice of Generator Set Rating
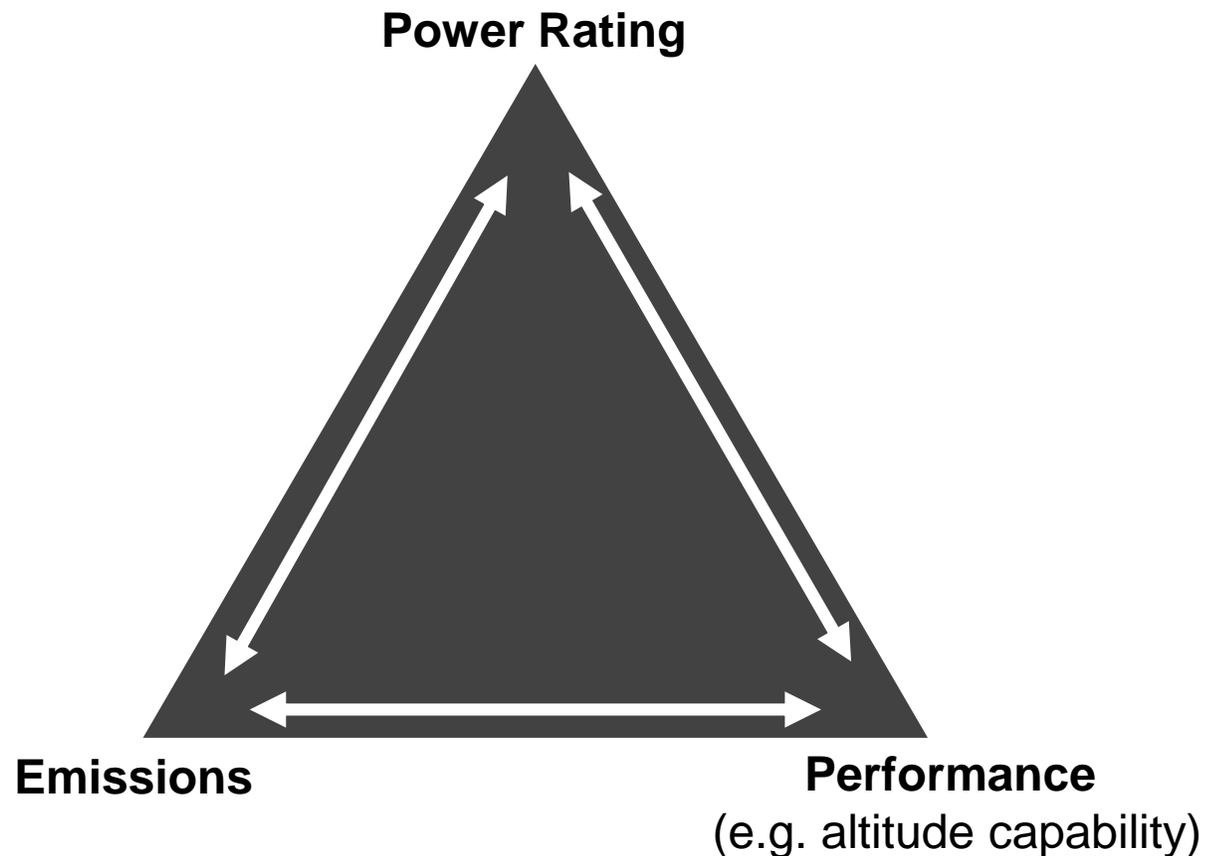

Annual
Generator Set
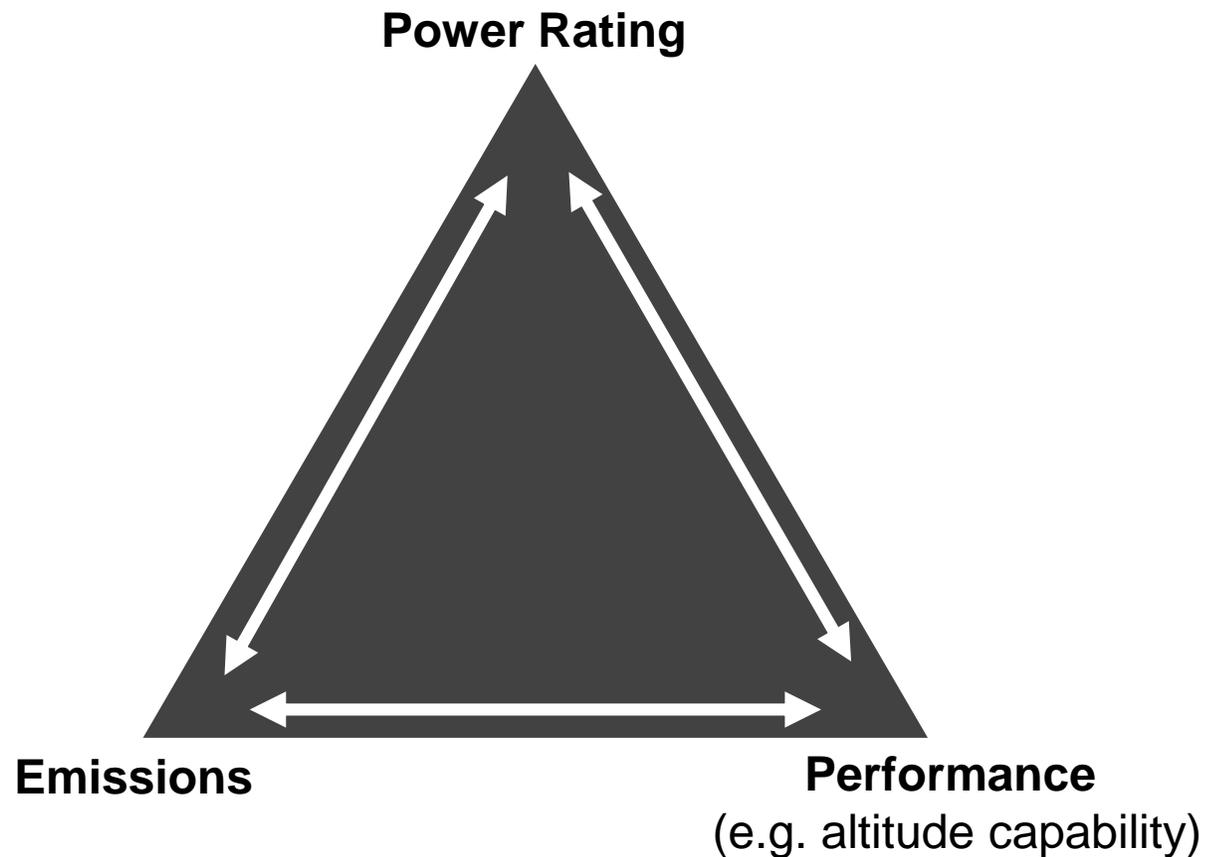Run Time

Applied Load
(Variable or
Constant)

Negotiated
Contracts (Rate
Curtailment
Programs)

Engineering Optimization: Flexibility vs Standard Offerings

Power Rating

Emissions

Performance
(e.g. altitude capability)

- Near infinite possibilities exist for taking an engine and alternator and creating a generator optimized between:
  - Max Power Rating
  - Performance (loads, derate, etc.)
  - Emissions constituents

- Standard offerings for products tend to default to a legal requirement for emissions, and performance that can serve most market needs.

- Max power also has one more layer of optimization, between duty cycle and life, established by the manufacturer's engineering standards.

Engineering Optimization: Flexibility vs Standard Offerings

Power Rating

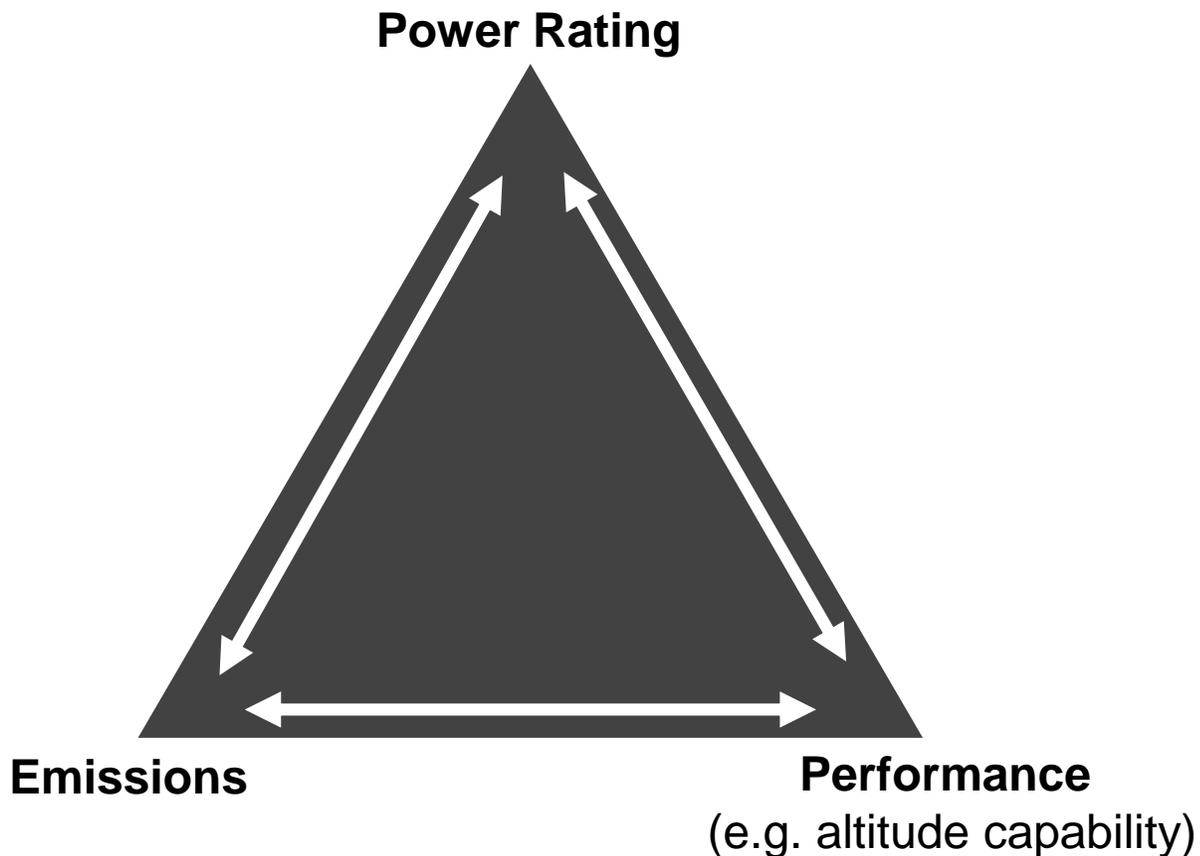**Emissions**

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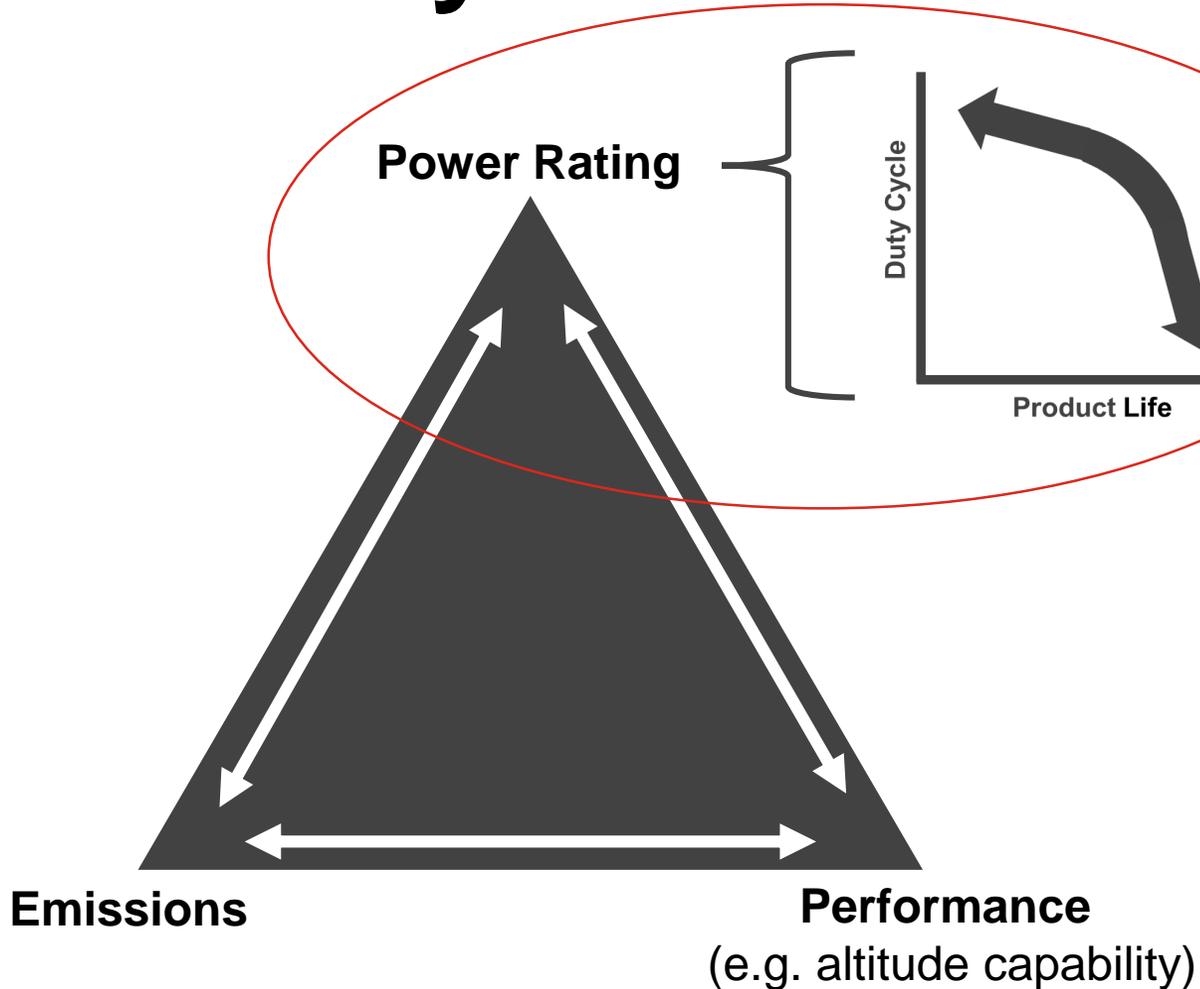Emissions

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Duty Cycle

Product Life

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Industry Standard for Generator Set Ratings

- ISO 8528-1: Defines application, ratings and performance of generator sets
  - Emergency Standby Power (ESP)
  - Prime Rated Power (PRP)
  - Limited Time Prime Power (LTP)
  - Continuous Operating Power (COP)
  - Data Centre Power (DCP)

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- "The power of the generating set is the power output available for consumer loads at the generating set terminals excluding the electrical power absorbed by the essential independent auxiliaries."

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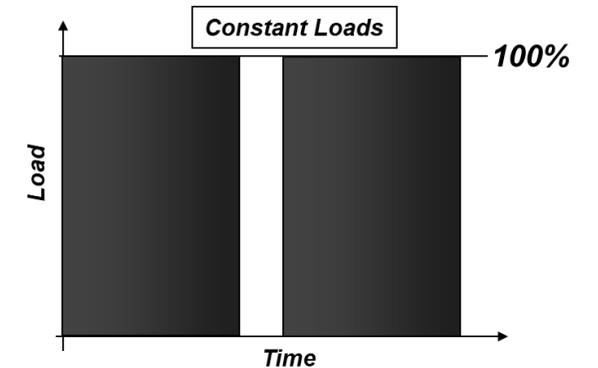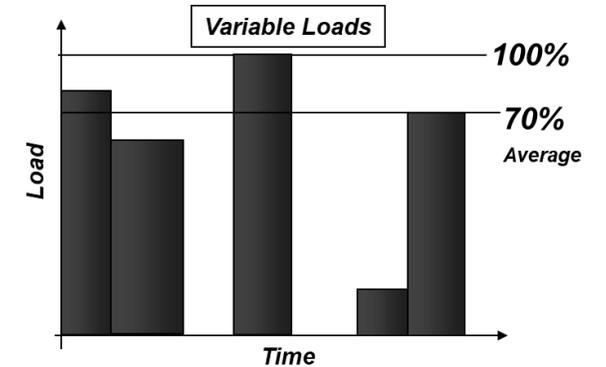**Include ISO 8528-1 power rating definitions in specifications**

ISO 8528-1 Ratings

Rating	Emergency Standby Power	Prime Rated Power	Limited Time Prime	Continuous Operating Power	Data Centre Power
Load Profile	Variable	Variable	Constant	Constant	Variable OR Constant
Max Annual Run Hours	200	Unlimited	500	Unlimited	Unlimited

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Variable Loads

Constant Loads

Emergency Standby Power (ESP)

- "Maximum power available during a variable electrical power sequence…for up to 200 h of operation per year"

- "The permissible average power output over 24 h of operation shall not exceed 70% of the ESP unless otherwise agreed by the RIC engine manufacturer"

- Examples for ESP applications include life safety, legally required, or critical loads

- Not required by the Authority Having Jurisdiction (AHJ), but desired to minimize economic losses or equipment damages at a site due to utility power interruptions

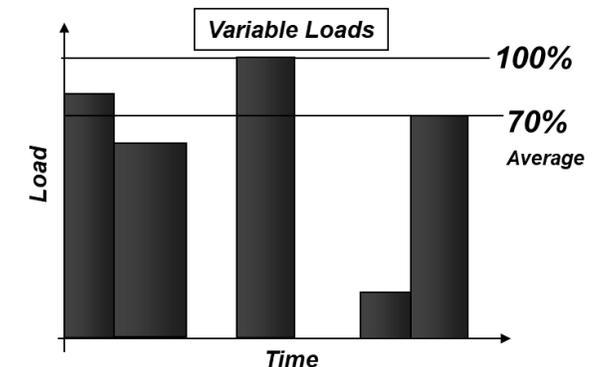| Rating	Emergency Standby Power	Prime Rated Power	Limited Time Prime	Continuous Operating Power	Data Centre Power
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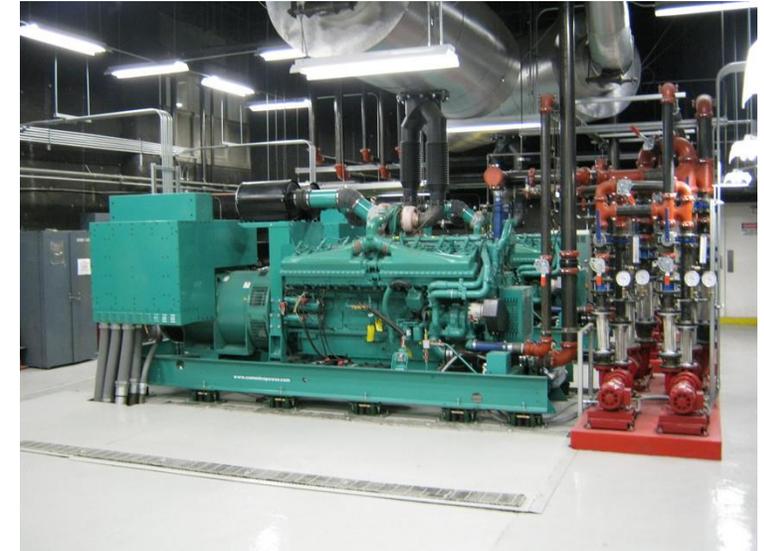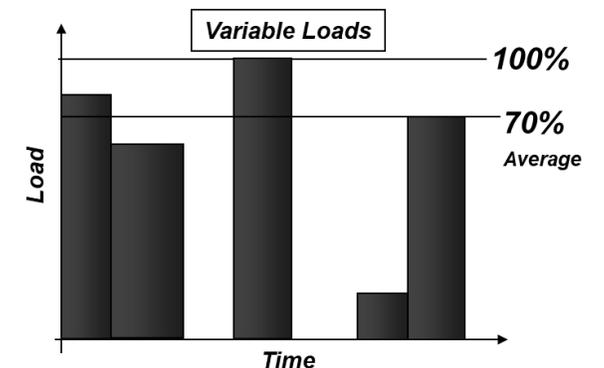

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Prime Rated Power (PRP)

- "Maximum power which a generating set is capable of delivering continuously while supplying a variable electrical load when operating for an unlimited number of hours per year"

- Examples include applications that use on–site generation in lieu of a utility electricity supply, typically where utility power is not available.

- Peak shaving and rate curtailment programs

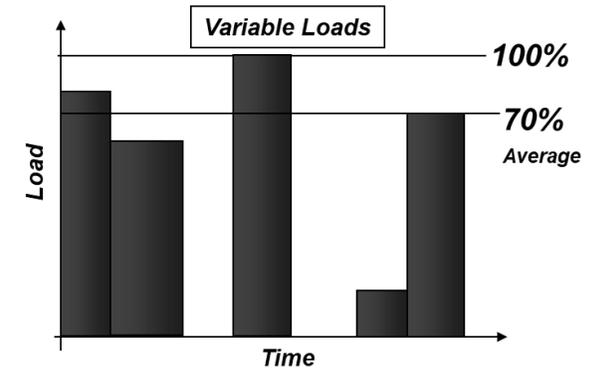| Rating	Emergency Standby Power	Prime Rated Power	Limited Time Prime	Continuous Operating Power	Data Centre Power
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Limited Time Prime (LTP)

- "Maximum power available, under the agreed conditions, for which the generating set is capable of delivering for up to 500 h of operation per year"

- Examples of LTP applications include base loading and rate curtailment programs

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Continuous Operation Power (COP)

- "Maximum power which the generating set is capable of delivering continuously while supplying a constant electrical load when operated for an unlimited number of hours per year"

- Examples of COP applications include is paralleling to the utility, base loading, or combined heat and power (CHP)

The Cummins Power Generation lean-burn generator set produces up to 1.75 MW of electricity and 4,000 pounds of steam per hour in a CHP application.

The lean-burn engine's radiator and critical exhaust silencer are roof mounted.

Combined heat and power - Chicago Museum of Science and Industry

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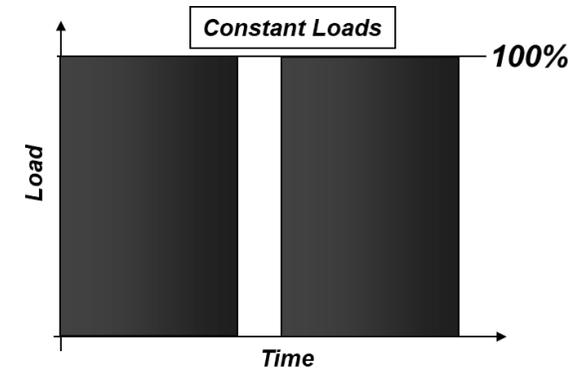
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Constant Loads — *100%*

Load / Time

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Data Centre Power (DCP)

- "Maximum power which a generating set is capable of delivering while supplying a variable or continuous electrical load and during unlimited run hours. Depending on the sites to supply and the availability of reliable utility, the generating set manufacturer is responsible to define what power level he is able to supply to fulfil that requirement"

- "Prolonged operation at load in parallel with a utility is not permitted"

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Concept Check

When selecting a generator set rating, what are some factors that would influence the correct decision?

a) Hours of intended operation

b) Load profile

c) Available power at output terminals

d) All of the above

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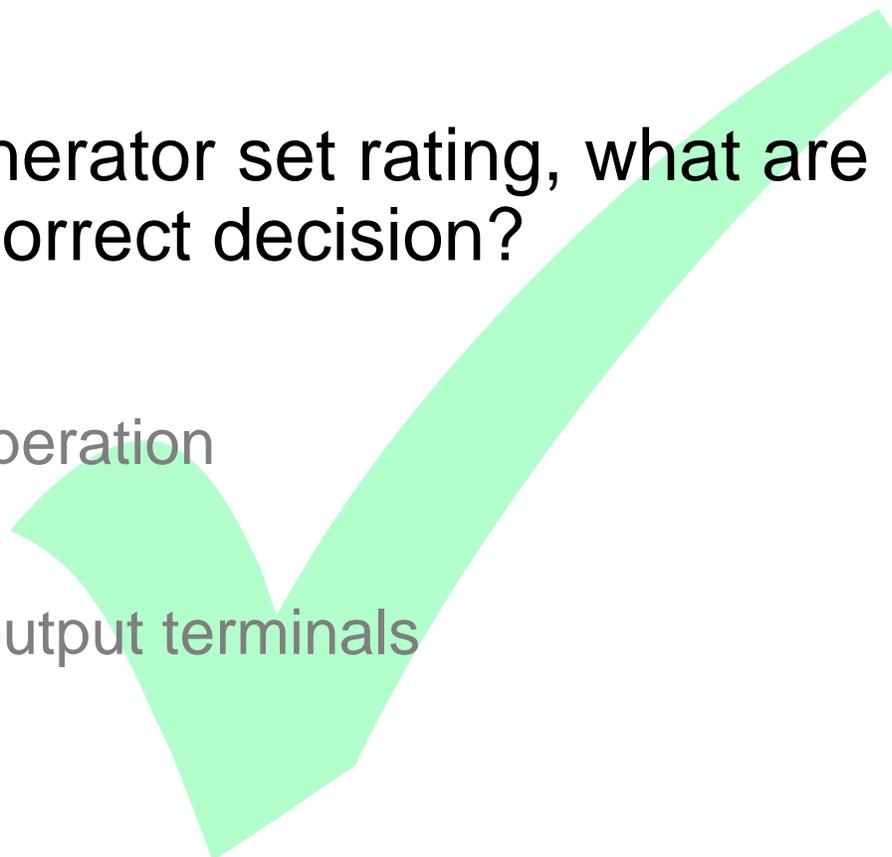
When looking at generator set ratings, make sure to ask yourself…

- How many hours is the generator set expected to run in a year?

- Are the loads variable or constant?

- Are there any negotiated contracts with the local utility or other companies?

- Do the defined ISO 8528-1 ratings fit the application?

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Spec Note Electrical output power rating for Emergency Standby Power operation of not less than 500.0 kW (625 kVA), at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 3 -wire, 60 hertz.

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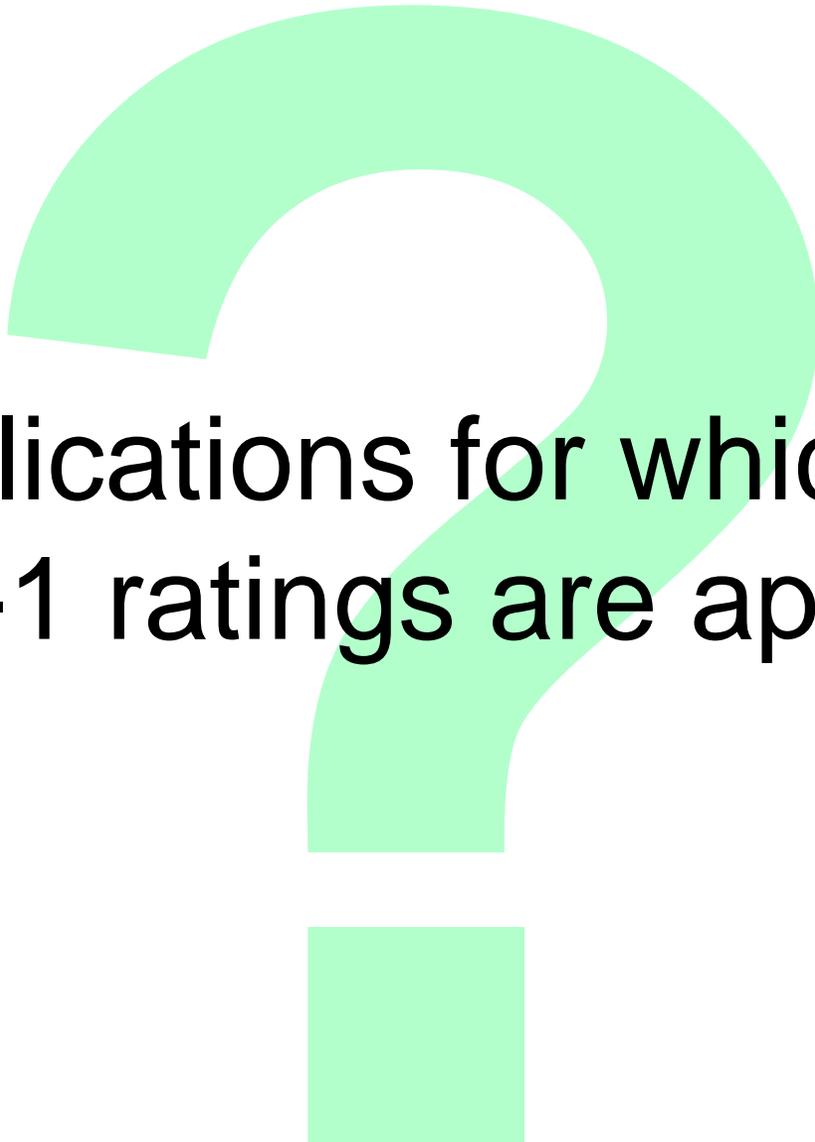
Are there applications for which none of the ISO 8528-1 ratings are appropriate?

Uptime Institute Tier Ratings

- The Uptime Institute tier rating system is an industry standard for benchmarking data center reliability
- Four tiers specifying levels of redundancy

	Tier I	Tier II	Tier III	Tier IV
Description	Basic	Redundant Capacity	Concurrently Maintainable	Fault Tolerant
Capacity	N	N + 1	N + 1	N after any failure
Distribution Paths	1	1	1 Active, 1 Alternate	2 Simultaneously Active

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- **Tier III** - Concurrent Maintainability
  - Every power distribution component can be removed or replaced during a planned event without loss of service to IT or cooling loads

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- **Tier IV** - Fault Tolerant (Uptime Institute Tier IV)
  - No single fault on any piece of equipment will result in loss of service to IT or cooling loads

	Tier I	Tier II	Tier III	Tier IV
Description	Basic	Redundant Capacity	Concurrently Maintainable	Fault Tolerant
Capacity	N	N + 1	N + 1	N after any failure
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Generator Sets for Uptime Tier III or Tier IV Systems

Uptime Institute

- **"The only reliable source of power for a data center is the on-site energy production"**

- "Disruptions to the utility power are not considered a failure but an operational condition for which the site must be prepared"

- "A Tier III or Tier IV engine-generator system, along with its power paths and other supporting elements shall meet … performance confirmation tests while they are carrying the site on engine-generator power"

- "Engine-generators for Tier III and Tier IV sites shall not have a limitation on consecutive hours of operation when loaded to 'N' demand"

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ISO 8528-1 Data Centre Power Rating

Data Centre Power (ISO 8528-1)

- "Depending on the sites to supply and the availability of reliable utility, the generating set manufacturer is responsible to define what power level he is able to supply"

- "Prolonged operation at load in parallel with a utility is not permitted"

Because ISO 8528-1 Data Centre Power Rating references a reliable utility, it is not sufficient for Uptime Institute Tier III or Tier IV Certification

Rating	Emergency Standby Power	Prime Rated Power	Limited Time Prime	Continuous Operating Power	Data Centre Power
Load Profile	Variable	Variable	Constant	Constant	**Variable OR Constant**
Max Annual Run Hours	200	Unlimited	500	Unlimited	**Unlimited**

ISO 8528-1 Ratings and Uptime Institute Tier III and IV Certification

Are these ratings sufficient for Uptime Certification?

- Emergency Standby Power (ESP)
- Prime Rated Power (PRP)
- Limited Time Prime Power (LTP)
- Continuous Operating Power (COP)
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Rating	Emergency Standby Power	Prime Rated Power	Limited Time Prime	Continuous Operating Power	Data Centre Power
Load Profile	Variable	Variable	Constant	Constant	Variable OR Constant
Max Annual Run Hours	200	Unlimited	500	Unlimited	Unlimited

ISO 8528-1 Ratings and Uptime Institute Tier III and IV Certification

Are these ratings sufficient for Uptime Certification?

- Emergency Standby Power (ESP) – No
    - 200 hr run time limitation
    - Maximum average power output of 70% of rating
- Prime Rated Power (PRP)
- Limited Time Prime Power (LTP)
- Continuous Operating Power (COP)
- Data Centre Power (DCP)

Rating	Emergency Standby Power	Prime Rated Power	Limited Time Prime	Continuous Operating Power	Data Centre Power
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Are these ratings sufficient for Uptime Certification?

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Are these ratings sufficient for Uptime Certification?

- Emergency Standby Power (ESP) - No
- Prime Rated Power (PRP) - No
- Limited Time Prime Power (LTP) - No
  - 500 hr run time limitation
- Continuous Operating Power (COP)
- Data Centre Power (DCP)

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Are these ratings sufficient for Uptime Certification?

- Emergency Standby Power (ESP) - No

- Prime Rated Power (PRP) - No

- Limited Time Prime Power (LTP) - No

- Continuous Operating Power (COP) – Yes
  - Results in an oversized, underloaded generator set
  - Sufficient for Uptime certification but not appropriate for a data center application

- Data Centre Power (DCP)

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- Emergency Standby Power (ESP) - No
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- Limited Time Prime Power (LTP) - No
- Continuous Operating Power (COP) – Yes
- Data Centre Power (DCP) – No
  - References availability of a utility

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Data Center Continuous Ratings

- Data Center Continuous (DCC) Ratings meet the Uptime Institute Tier III and Tier IV requirements

- Data Center Continuous (DCC) Rating is defined as:

  - *The maximum power which the generator is capable of delivering continuously to a constant or varying electrical load for unlimited hours in a data center application.*

Model:	C3500 D6e
Frequency:	60 Hz
Fuel type:	Diesel
kW rating:	3500 standby
	3000 prime
	2750 continuous

Model:	C3500 D6e
Frequency:	60 Hz
Fuel type:	Diesel
kW rating:	3350 Data Center Continuous

Specification sheet

Diesel generator set QSK95 series engine

2750 kW - 3350 kW 60 Hz
Data Center Continuous
EPA Tier 2 emissions regulated

Description

Cummins Power Generation commercial generator sets are fully integrated power generation systems providing optimum performance, reliability and versatility for Data Center applications.

Features

Data Center Continuous (DCC) - Applicable for supplying power continuously to a constant or varying electrical load for unlimited hours in a data center application.

Uptime Compliant - Meets the requirement of a Tier III and IV data center site by being rated to run for unlimited hours of operation when loaded to 'N' demand for the engine generator set.

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Case Study: ISO Ratings in Data Center Applications

Generator Set Model	Engine Model	ISO ESP	ISO LTP	ISO PRP	ISO COP
DQLE	QSK78-G12	2500	2275	2275	2000
DQLF	QSK78-G12	2750	2500	2500	2100
C3000D6e	**QSK95-G9**	**3000**	**2750**	**2750**	**2500**
C3500D6e	QSK95-G9	3500	3000	3000	2750

- Maximum Connected Load: 2500 kWe

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C3000D6e	**QSK95-G9**	**3000**	**2750**	**2750**	**2500**
C3500D6e	QSK95-G9	3500	3000	3000	2750

- Maximum Connected Load: 2500 kWe
- Typical Load: 1900 kWe
- Site Capacity: N+1 (2 paralleled generator sets)
- Generator Set Load: 950 kWe (less than 30% engine load)

Case Study: ISO Ratings in Data Center Applications

Generator Set Model	Engine Model	ISO ESP	ISO LTP	ISO PRP	ISO COP	DCC
DQLE	QSK78-G12	2500	2275	2275	2000	2275
DQLF	**QSK78-G12**	**2750**	**2500**	**2500**	**2100**	**2500**
C3000D6e	QSK95-G9	3000	2750	2750	2500	2750
C3500D6e	QSK95-G9	3500	3000	3000	2750	3350

- Maximum Connected Load: 2500 kWe

Case Study: ISO Ratings in Data Center Applications

Generator Set Model	Engine Model	ISO ESP	ISO LTP	ISO PRP	ISO COP	DCC
DQLE	QSK78-G12	2500	2275	2275	2000	2275
DQLF	**QSK78-G12**	**2750**	**2500**	**2500**	**2100**	**2500**
C3000D6e	QSK95-G9	3000	2750	2750	2500	2750
C3500D6e	QSK95-G9	3500	3000	3000	2750	3350

- Maximum Connected Load: 2500 kWe

- Typical Load: 1900 kWe

- Site Capacity: N+1 (2 paralleled generator sets)

- Generator Set Load: 950 kWe (greater than 35% engine load)

Generator Set Ratings for Tier III and Tier IV Certification

Generator Set Rating

- Must have no run time limitation while operating at full rated load

- Must not be dependent on the presence of a utility

Uptime Institute will accept site specific rating for Tier III or Tier IV certification

- Manufacturer issues a letter stating that there is no run time limitation for the generator set at the designated site

- Letter is only valid for the data center listed in the letter

Spec Note Generator set shall have no run time limitation when operating at rated load and must not be dependent on the presence of a utility

Concept Check

What are the advantages of specifying a Data Center Continuous (DCC) generator rating for applications requiring Uptime Institute Tier III or Tier IV certification?

a) The DCC rating has no run time limitation at rated load

b) The DCC rating does not reference an available utility

c) Specifying a DCC rating drives selection of an appropriately sized generator set rather than an oversized, underloading generator set

d) All of the above

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What are the advantages of specifying a Data Center Continuous (DCC) generator rating for applications requiring Uptime Institute Tier III or Tier IV certification?

a) The DCC rating has no run time limitation at rated load

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d) All of the above

Course Summary

Generator Set Ratings for Data Centers and Other Applications

- Define generator set ratings per ISO 8528-1 and identify their appropriate applications

- Recognize industry adopted ratings outside of ISO 8528-1

- Describe the impact of Uptime Institute Tier certifications on generator set ratings requirements

- Consult generator set manufacturer for site specific ratings

Specify:

- Specify generator set ratings based on intended use, load profile, and hours of operation

- Generator set shall have no run time limitation when operating at rated load (when Uptime Institute certification is required)

Avoid specifying:

- ISO 8528-1 Data Centre Power (DCP) if Uptime Institute certification is required

- A generator set rating that does not meet ALL requirements

Additional Resources

Cummins White Papers

- Understanding ISO 8528-1 Generator Set Ratings (Nov 2019)

- Data Center Continuous (DCC) Ratings: A Comparison of DCC Ratings, ISO Definitions and Uptime Requirements (Nov 2019)

Cummins On-Demand Webinars

- Common Failure Modes of Data Center Back Up Power Systems

- NFPA 110 Time to Readiness

- NEC 2017 Code Changes for Emergency Power Systems

- Introduction to Generator Set Sizing Software

BULLETIN 5600406 | TECHNICAL INFORMATION FROM CUMMINS

DATA CENTER CONTINUOUS RATINGS

White Paper
By David Matuseski

DATA CENTER CONTINUOUS (DCC) RATINGS: A COMPARISON OF DCC RATINGS, ISO DEFINITIONS AND UPTIME REQUIREMENTS

While Uptime Institute references the ISO8528-1 definitions for generator ratings in their publication Tier Standard: Topology, they do not require the use of these definitions for generators to meet the Tier III and Tier IV requirements, as described in the same publication. A more cost-effective and reliable generator rating that meets the Tier III and Tier IV requirements can be achieved when the generator manufacturer develops ratings specifically for data center applications.

DIESEL GENERATORS IN A TIER III OR TIER IV SYSTEM

In Tier III and Tier IV systems, Uptime Institute defines the diesel generators as the primary source of power and the utility as an economic alternative. This definition puts two important requirements on the diesel generators. First, they must be large enough to carry the entire data center load. Second, there can be no limit on the number of hours the diesel generators can run.

Figure 1 – Cummins QSK95-based generator sets offering ratings up to 3.5 MW based on ISO 8528-1.

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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Closing

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- Sizing and specification development tools

Upcoming PowerHour Webinars:
- November – Look out for more information in upcoming newsletter
- December – Distributed Generation Applications (Microgrids)

Please contact Mohammed Gulam if you have any questions related to the PowerHour webinar (mohammed.gulam@cummins.com)