



# Connecting For Success...

ELECTRIC POWER DAYS 2017

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# Generator Ratings: Protecting your Application

Raphael Timms

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## Balance Value and Durability

- Over ***aggressive*** use of ratings could result in accelerated wear and unplanned downtime
- Over ***conservative*** use of ratings does not provide optimum value

**The Right Rating** → Maximize Efficiency and Uptime  
while Maximizing Life and Durability

# Ratings Confusion

## Specification:

**Section 5.A “Generator shall be rated 2 MW Standby, 1825 kW Prime”**

- Engine iron is the same however product cannot be applied in two application types
  - Standby is for applications that expect 500 hours per year
  - Prime allows for unlimited hours at 1825 kW (+10%)
- Illustrates the confusion regarding ratings inherent in the marketplace
  - Requests for multiple ratings is not feasible
  - Ratings are driven by design and application
  - Ratings are a pre-approved methods of equipment application

## Ratings Confusion

Assume we are discussing a 1000 kVA product:

- 70% Load Factor means that my generator set cannot operate above 700 kVA?
- What are the major differences between a Standby and a Prime rated product ?
- I need a generator capable of operating continuously, but for a Standby application ?



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# Agenda

- Generator Set Ratings
- Ratings versus Application
- Uptime Institute Requirements

# Generator Set Ratings

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# Ratings? ...What for?

## Example – Lifecycles of a Dodge 5.9 L Engine



Engine Parameter	'68 Jeep	#22 CAT	Dragster
Displacement	5.9 L	5.9 L	5.8 L
Horsepower	245-290	750	7000
Aspiration	NA	Turbo Charger	Super Charger
Normal Top Speed	95 km/hr	250-330 km/hr	>500 km/hr
Time Between Overhaul (km)	150,000 +	~1000	~1.0

\*\* 4.6 seconds per ¼ mile (400m)

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## What is ISO-8528?

- International standard for diesel and gas generator sets
- Applies to engine driven generator sets for land and marine use
- Part 1 refers to application, ratings and performance
- Targeted for continuous, peak-load and standby applications
- Intended to help ***understanding between manufacturer and customer***
- ISO 8528 defines four ratings
  - Continuous Power (COP)
  - Prime Power (PRP)
  - Limited-Time Running Power (LTP)
  - Emergency Standby Power (ESP)

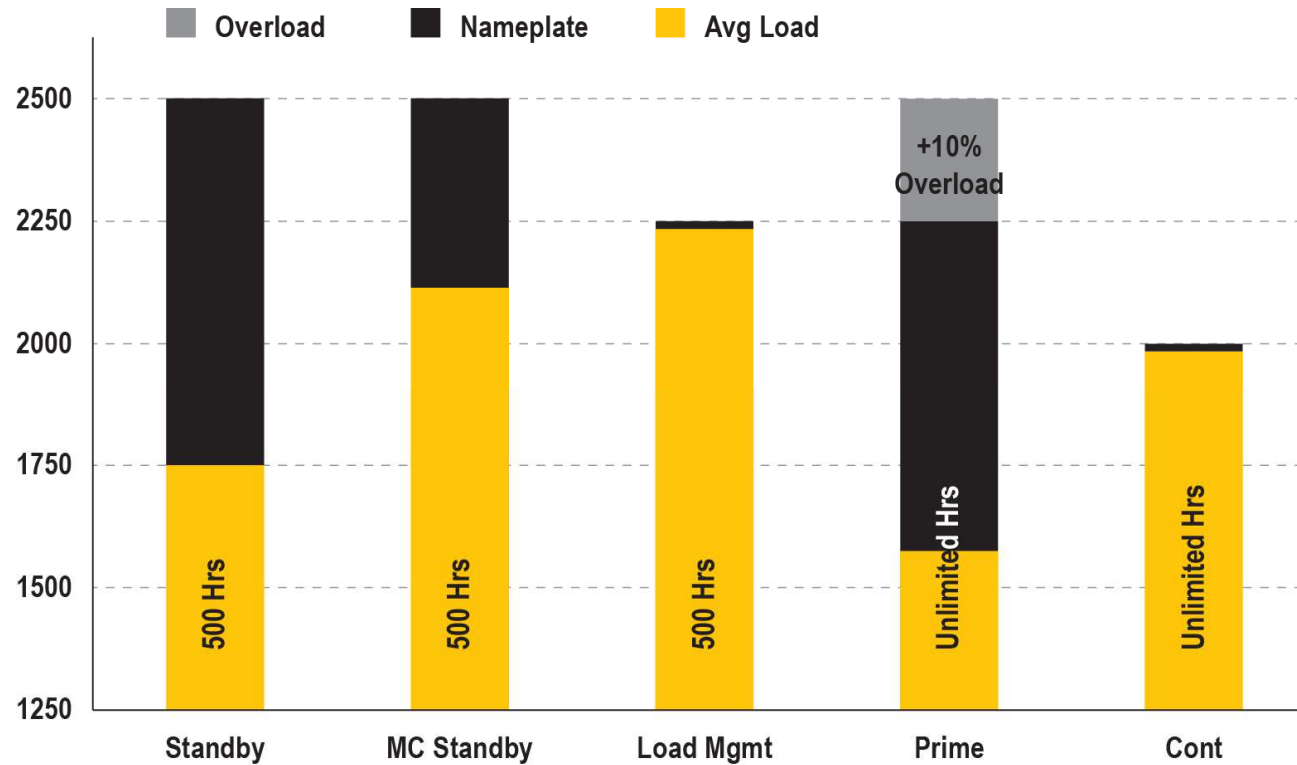
**Note:** Should be considered as a minimum standard for manufacturers to meet.

# ISO 8528 compared to Industry Usage

ISO 8528-1 Ratings	Common Industry Ratings
➤ Emergency Standby (ESP)	➤ Emergency Standby ESP (limited use)
➤ No ISO equivalent	➤ Standby
➤ No ISO equivalent	➤ Mission Critical Standby
➤ No ISO equivalent	➤ Data Center Continuous
➤ Limited Time Running (LTP)	➤ Load Management (Prime Power)
➤ Prime Running (PRP)	➤ Prime Power
➤ Continuous Operating (COP)	➤ Continuous Power

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## Rating Trade-off (2.5 MVA Standby Example)



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## What is Load Factor?

- Ratio of load requirements to full power capacity
- Load Factor does **NOT** indicate a generator set capability to provide nameplate load and should not be the only factor when choosing a rating
  - Load factor – Time at nameplate load – Running hours  
→ all factors in a sizing equation.
- Typical load factor questions:
  - How does load factor impact my warranty?
  - Can my generator operate above the load factor?

# Rating Vs Application

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## Design versus Application

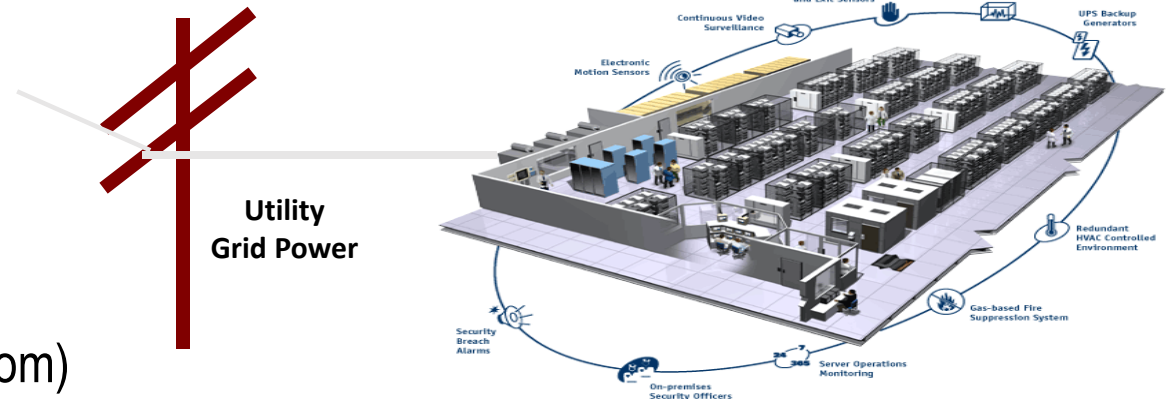
- Some designs have moved to a ***theoretical*** world where 100% load is desired for 100% of the time
- Not a realistic demand in ***real world*** applications:
  - Lower value for customer
  - Under-loading concerns
  - “System” Integration issues
    - UPS Harmonics vs Alternator sizing

**Question:** What is the cost and impact on efficiency?

# Design versus Application – Data Center Example

## Total Facility Power

- IT Equipment (Servers, Storage, Telecom)
- UPS / Batteries
- Chillers
- Computer Room Air Conditioning (CRAC)
- Non-critical equipment (i.e. lights)



5-20 % recharge rate

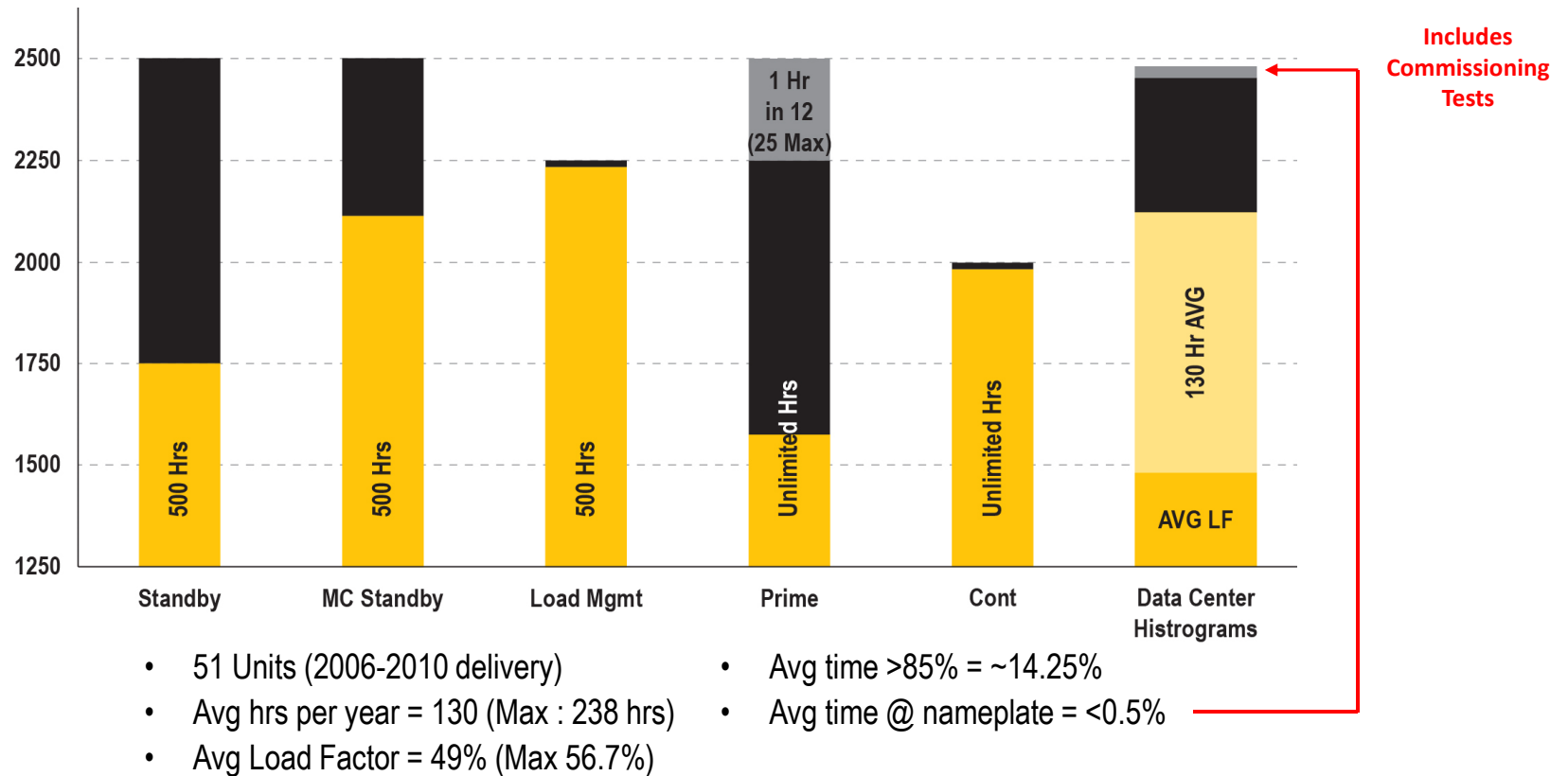
Function to  
Day/Season

**Variable Loads !!!**

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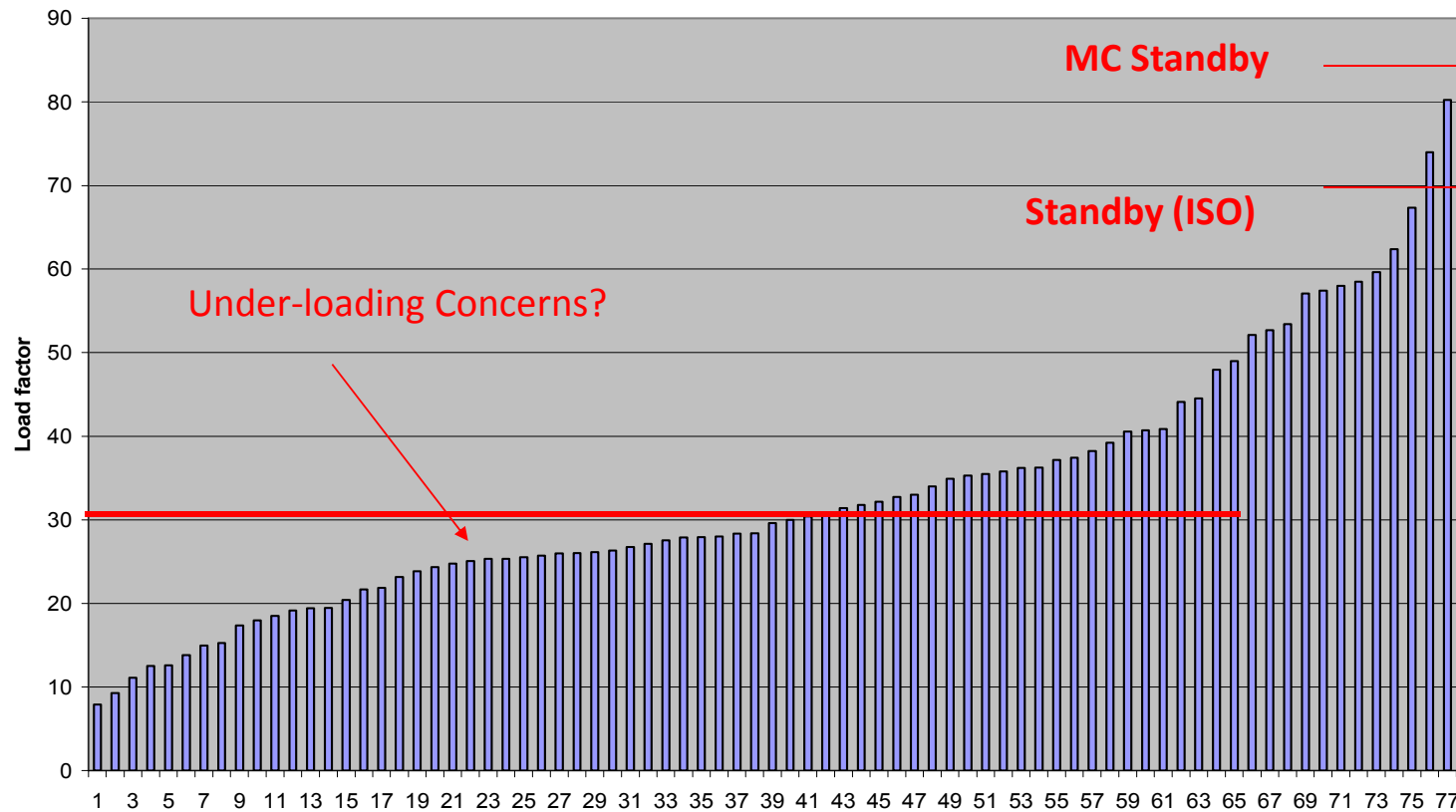


## When designing, keep actual operational data in mind



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## Standby Research (78 unit sample) **AVG Load Factor**



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# Uptime Institute Requirements

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## Accredited Tier Designer Technical Paper Series: Engine-Generator Ratings

Engine generators for Tier III and IV sites shall not have a limitation on consecutive hours of operation when loaded to 'N' demand. Engine generators that have a limit on consecutive hours of operation at N demand are appropriate for Tier I or II.

Engine Generator Requirements	Tier I	Tier II	Tier III	Tier IV
Rating to Support design load	Any; up to nameplate rating to support design load	Any; up to nameplate rating to support design load	Capable of supporting design load for unlimited hours at site conditions	Capable of supporting design load for unlimited hours at site conditions
Continuous	No additional requirement for hours of operation limitations		Full nameplate capacity	
Prime			Option 1: 70% of nameplate capacity Option 2: Larger capacity than Option 1 with manufacturer letter	
Standby			Can be used for Tier III and Tier IV with manufacturer letter; Tier Certification capacity dependent on manufacturer letter	
Derating for Site Conditions	Additional derating may be required due to site conditions (ambient temperatures, elevation)—consult manufacturer requirements			

Table 1: Tier Requirements Summary—Engine Generators

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From Accredited Tier Designer Technical Paper Series: Engine-Generator Ratings by the Uptime Institute

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## Compliance with UTI Standards

- No limitations on running hours
- No limitations on load factor at “N”
- DC Market – limited load fluctuation
  - Generator set will not see 100% load factor over extended periods of time
    - UPS recharge: +5% to +20% of UPS load
    - Chillers/CRACS will cycle based on time of day/season
  - Fluctuation should keep the generator set below 85% load factor

Worked with Uptime on pre-approved Caterpillar letter and process

# UTI Compliance – Overview

## Two Parts to Compliance

- White paper
  - Publicly states Cat generator set compliance with UTI Tier III and Tier IV standards
- Project letter
  - Project specific letter stating the specified generator set will provide power for unlimited hours
  - Two templates available
    - Standard (no generator set derate)
    - Generator set derate
  - Letter to be signed by authorized Caterpillar representative

# UTI White Paper



## Application of Cat® Generator Sets in Tier III and Tier IV Data Centers

This positioning paper will provide detail regarding the application of Cat® generator sets into data center installations that will be certified as either a Tier III or Tier IV data center, as defined by the Uptime Institute's Tier Standard: Topology paper. Section 2.5.2.

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

exceeds the parameters outlined in ISO 8528-1. ISO 8528-1 imposes a runtime limit of 200 hours a year on Emergency Standby Power (ESP) ratings. Cat Standby and Cat Mission Critical ratings have a maximum expected usage of 500 hours per year. Further, both ratings state that: "output is available with varying load for the duration of the outage" and "output is available with varying load for the duration of the interruption of the normal source power." A Cat Standby or Cat Mission Critical Standby generator set will provide uninterrupted power for the duration of an outage related to failure of the local utility source. In working with the Uptime Institute, Caterpillar can assure customers that our Cat Standby, Cat Mission Critical and all other nameplate ratings are in compliance with the requirements outlined by the Uptime Institute for Tier III and Tier IV data centers. Please work with your Cat dealer for a site specific letter regarding 'N' design load of your project.

Operating outside of the published Caterpillar rating definitions, in terms of hours and/or load factor, could have an impact of the service and overhaul intervals. While the product will continue to operate beyond this expected usage, we encourage customers to develop a detailed contingency plan for extended outages which allows for scheduled maintenance of individual pieces of equipment. Your Cat dealer is ready and available to assist you with such a plan.

When selecting the correct generator set for a Tier III or Tier IV installation, also be aware of federal and local emissions regulations. These regulations are regional in nature, and may impose operating limits on the generator set outside of the published generator set rating definitions. Your Cat dealer is knowledgeable about the emissions regulations for your installation, and can help to ensure the correct equipment is specified to allow continued operation under the Uptime Institute guidelines and within the emissions regulations for your region.

### References:

Uptime Institute, LLC. "Data Center Site Infrastructure Tier Standard: Topology", TS102120-0812 <http://www.uptimeinstitute.com/publications>

Caterpillar Inc. "Electric Power Generator Set Ratings Definitions", LEXE0244, April 2011

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LEXE0599-01

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# UTI Approved Letter



Caterpillar Sàrl

Electric Power Division  
P.O. Box 6000  
1211 Geneva 6  
Switzerland

Subject: Uptime Institute Ratings Certification – Tier III or IV  
Customer Project: [REDACTED] Data Center  
February 10, 2016

To whom it may concern,

The Caterpillar 3516B-HD generator sets being applied at the above referenced project have a nameplate rating of 2500 kVA (2000 kW). Given the specified site conditions there is no altitude or ambient power derate for this product. All Caterpillar products are capable of providing power for an outage of unlimited duration. For this specific project this model is capable of providing 2500 kVA (2000 kW) for an unlimited number of hours.

A handwritten signature in blue ink, appearing to read "R. Timms".

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## Summary

- Generator Set Ratings can be confusing, but we can help
- Working with your local Cat Dealer will ensure you get the right size generator for your design and application

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