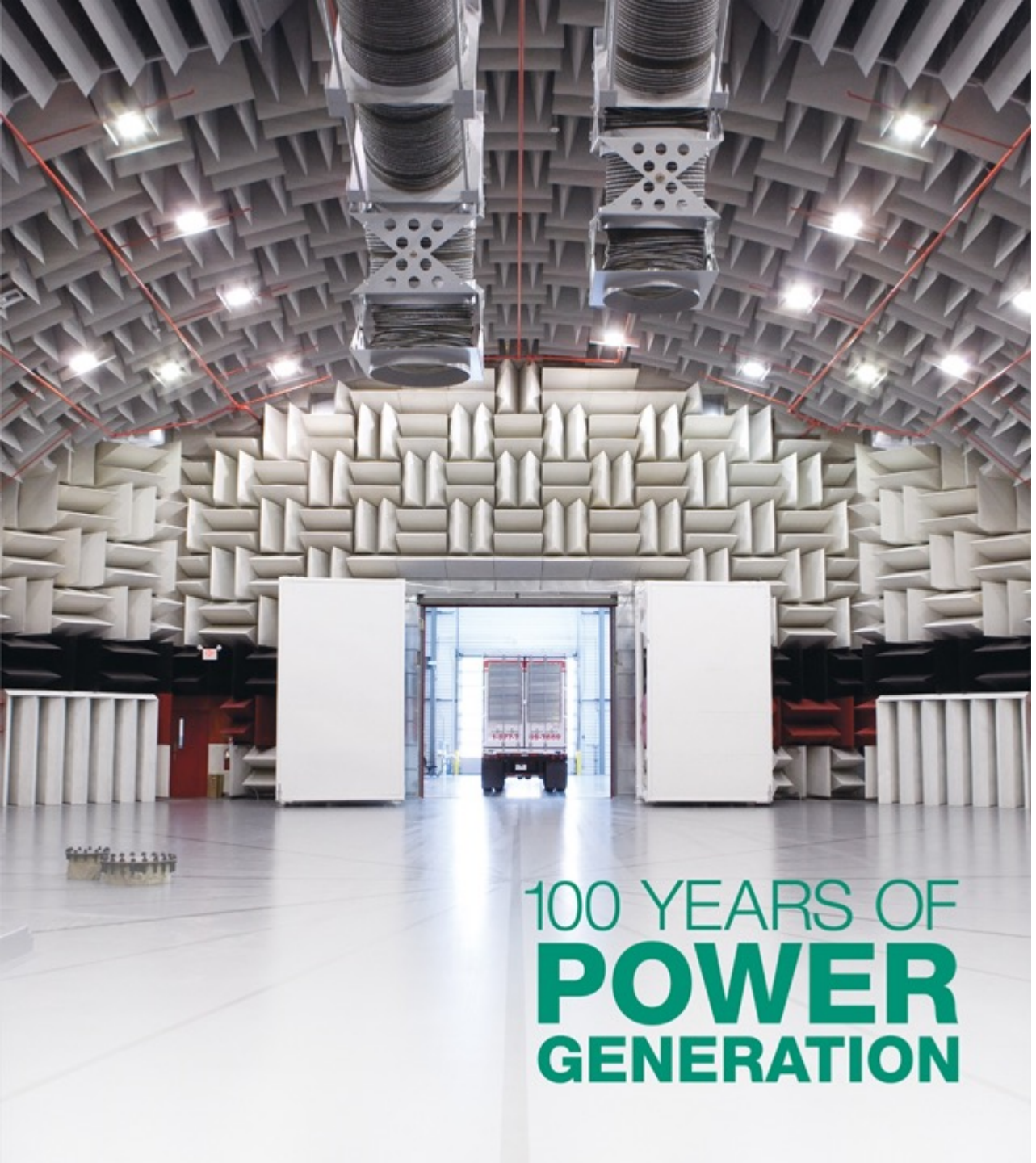


Cummins Power Systems

Ask the Experts: NFPA 110 for Emergency Power Systems

PowerHour webinar series for consulting engineers

Experts you trust. Excellence you count on.

March 25, 2021 2:00pm Eastern Time / 11:00am Pacific Time
(1 PDH issued by Cummins Inc.)

Welcome!

Cummins PowerHour webinar series is designed to help our engineer partners to…

- Keep up to date on products, technology, and codes and standards development
- Interact with Cummins experts and gain access to ongoing technical support
- Participate at your convenience, live or on-demand
- Earn Professional Development Hours (PDH)

Technical tips:

- Audio is available through teleconference or Zoom application.
- Attendees are in “listen only” mode throughout the event.
- Use the Zoom Q&A Panel to submit questions, comments, and feedback throughout the event. Time is allotted at the end of the PowerHour to address Q&A.
- If the audio connection is lost, disconnected or experiences intermittent connectivity issues, please check your audio connection through the "Join Audio" or "Audio Connectivity" button at the bottom left of the Zoom application.
- Report technical issues using the Zoom Q&A Panel.

Course Objectives

Ask the Experts: NFPA 110 for Emergency Power Systems

NFPA 110, the Standard for Emergency and Standby Power Systems, sets the baseline for emergency power system performance requirements and is critical to installation of nearly every backup power system. This Ask the Experts session will address a number of key topics related to NFPA 110 and will offer an opportunity to connect directly with power system experts at Cummins! Topics addressed during this session will range from fuel and battery testing to Type 10 requirements and complexities arising from paralleled power sources serving life safety loads. Bring your questions and be prepared to engage in open discussion and Q&A with an expert panel.

After completing this course, participants will be able to:

- Identify key topics related to NFPA 110 impacting emergency power supply system design and installation.
- Describe common pitfalls, challenges and misconceptions often encountered when validating power system design.
- Recognize common code requirements mandated by NFPA 110 and their practical application.

Asking a Question:

Q&A Button:

- For technical questions on today's topic
- Ask at anytime
- Not all questions may get answered but we'll do our best!

Chat Button:

- For general PowerHour or Zoom questions

Disclaimer

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.

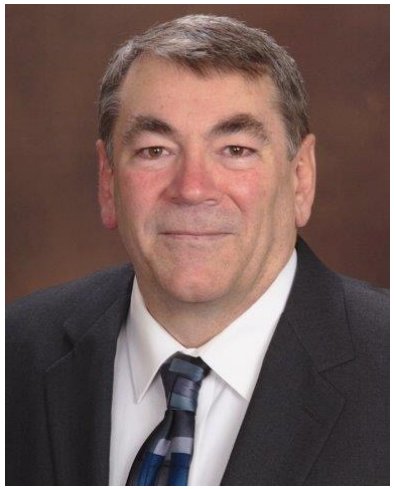
Meet your panelists

Cummins Panelists:

Michael Sanford

Product Strategy and Sales Enablement Leader

Cummins Inc.



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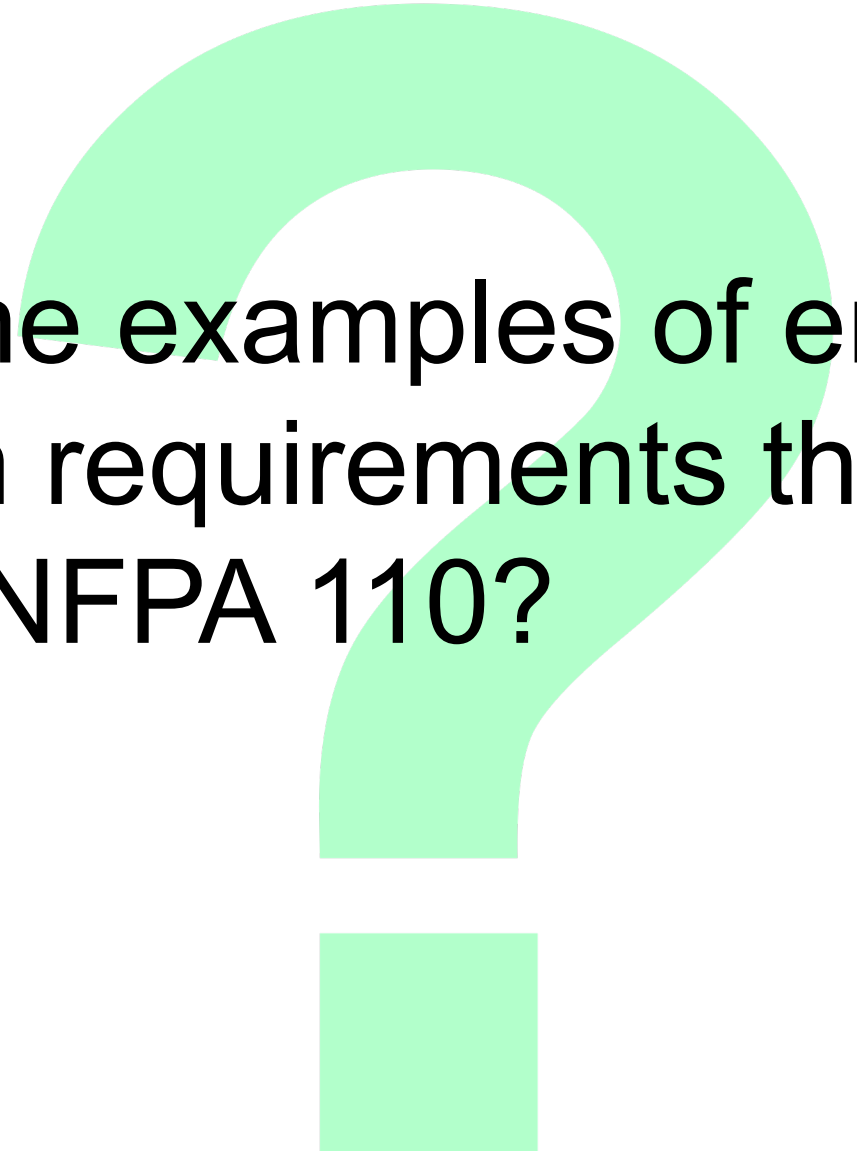
What are some examples of emergency power system requirements that are derived from NFPA 110?



NFPA 110 Overview

Standard for Emergency and Standby Power Systems

Requirements covering the performance of emergency and standby power systems providing an alternate source of electrical power to loads in buildings and facilities in the event that the primary power source fails.

Covers installation, maintenance, operation, and testing requirements as they pertain to the performance of the emergency power supply system (EPSS).

Intent of standard is to achieve maximum system reliability.

NFPA 110 Overview

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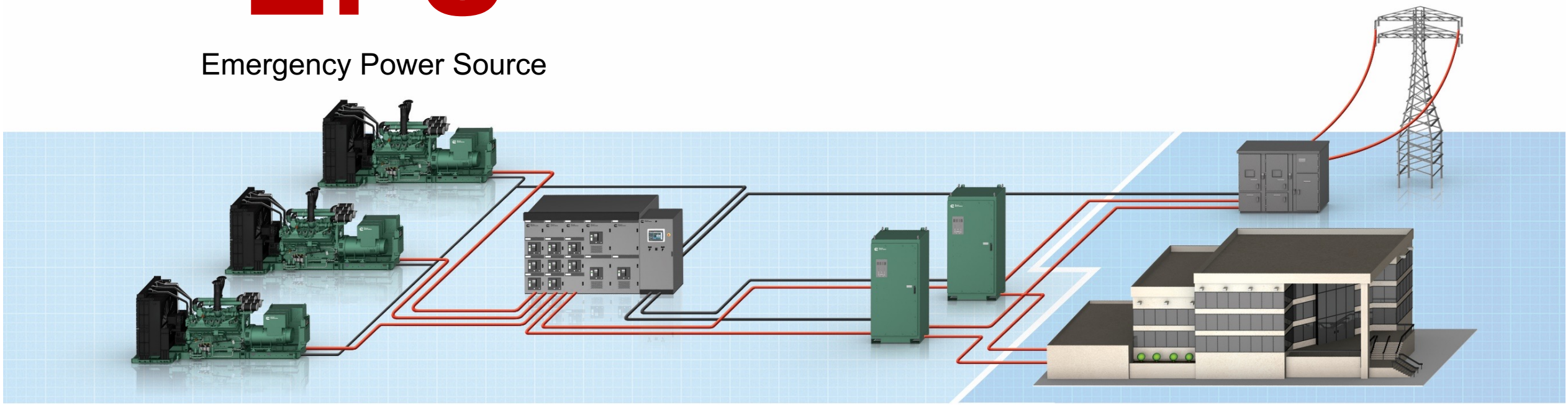
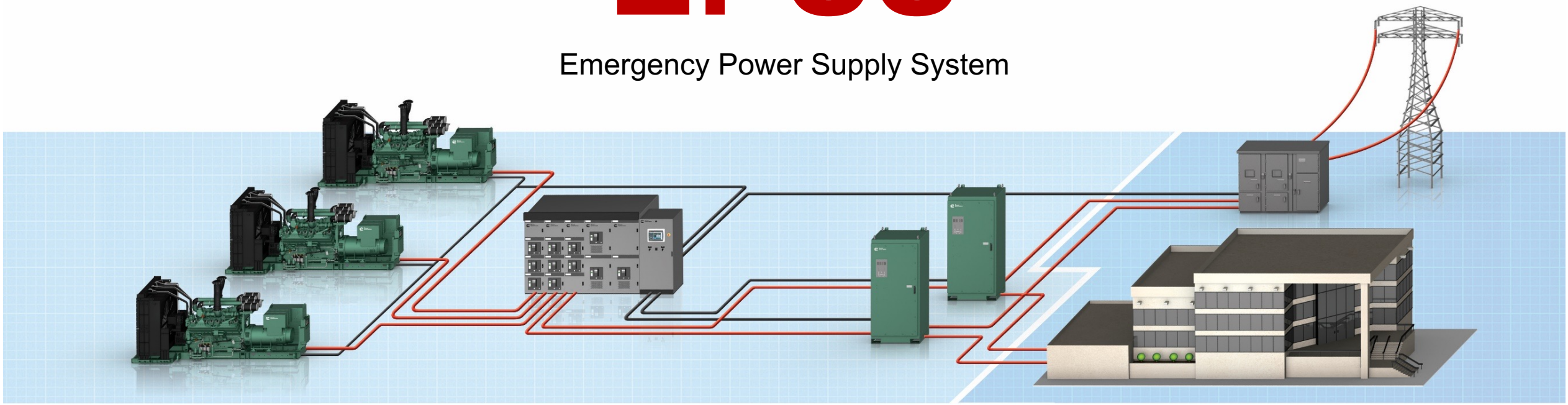
EPS

Emergency Power Source

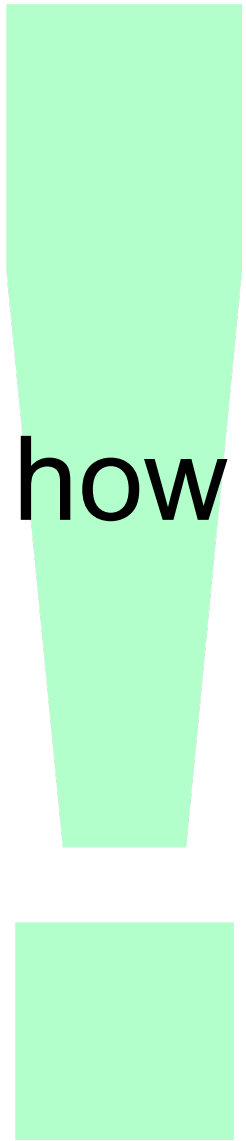


EPSS

Emergency Power Supply System



What is “Type” and how is it defined and measured?



NFPA 110 Overview

Classification of Emergency Power Supply Systems

4.2 Class. The class defines the minimum time, in hours, for which the EPSS is designed to operate at its rated load without being refueled or recharged.

4.3 Type. The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power.

4.4 Level. This standard recognizes two levels for equipment installation, performance and maintenance requirements.

4.4.1 Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

4.4.2 Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

NFPA 110 Overview

Classification of Emergency Power Supply Systems

4.3 Type. The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power.

Table 4.1(b) Types of EPSSs

Designation	Power Restoration
Type U	Basically uninterruptible (UPS systems)
Type 10	10 sec
Type 60	60 sec
Type 120	120 sec
Type M	Manual stationary or nonautomatic — no time limit

NFPA 110 Overview

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Related Content

NFPA 110 Time to Readiness
PowerHour
White Paper

Why is there a time delay on start? What is the purpose? Is it required?

Utility Outage

Time Delay on Start

6.2.5 Time Delay on Starting of EPS. A time-delay device shall be provided to delay starting of the EPS. The timer shall prevent nuisance starting of the EPS and possible subsequent load transfer in event of harmless momentary power dips and interruptions of the primary source.

A.6.2.5 For most applications, a nominal delay of 1 second is adequate. The time delay should be short enough so that the generator can start and be on line within the time specified for the type classification.

Utility Outage

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When we talk about or specify Class of the EPS, how does that differ from the recommended or requested onsite fuel storage?

NFPA 110 Overview

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NFPA 110 Overview

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Table 4.1(a) Classification of EPSSs

Class	Minimum Time
Class 0.083	0.083 hr (5 min)
Class 0.25	0.25 hr (15 min)
Class 2	2 hr
Class 6	6 hr
Class 48	48 hr
Class X	Other time, in hours, as required by the application, code, or user

Is regular testing of diesel fuel required and if so, how frequently should it be conducted?

NFPA 110 – Generator Set Subsystems

Engine Fuel System

7.9.1.2 Fuel system design shall provide for a supply of clean fuel to the prime mover.

7.9.1.3 Tanks shall be sized so that the fuel is consumed within the storage life, or provisions shall be made to remediate fuel that is stale or contaminated or to replace stale or contaminated fuel with clean fuel.

8.3.7 A fuel quality test shall be performed at least annually using appropriate ASTM standards or the manufacturer's recommendations.

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Spec Note Require vendors to provide service and maintenance contracts that include fuel testing at least annually.

How and when should I be testing the emergency power supply system?

EPS Testing with Load

8.4.2 Generator sets in service shall be exercised at least once monthly, for a minimum of 30 minutes, using one of the following methods:

(1) Loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer

(2) Under operating temperature conditions and at not less than 30 percent of the EPS standby nameplate kW rating

8.4.2.3 Diesel-powered EPS installations that do not meet the requirements of 8.4.2 shall be exercised monthly with the available EPSS load and shall be exercised annually with supplemental loads at not less than 50 percent of the EPS nameplate kW rating for 30 continuous minutes and at not less than 75 percent of the EPS nameplate kW rating for 1 continuous hour for a total test duration of not less than 1.5 continuous hours.

Recommendation Test emergency generator sets at least monthly for at least 30 minutes with a load bank at no less than 30% of the generator set rating.

Transfer Switch Operational Testing

8.4.6 Transfer switches shall be operated monthly.

8.4.6.1 The monthly test of a transfer switch shall consist of electrically operating the transfer switch from the primary position to the alternate position and then a return to the primary position.

Spec Note Employ transfer switch functionality that enables seamless transition from normal to emergency source and back with minimal interruption to loads (active sync in-phase transition).

NFPA 110 36 Month Testing

8.4.9 Level 1 EPSS shall be tested at least once within every 36 months.

8.4.9.1 Level 1 EPSS shall be tested continuously for the duration of its assigned class.

8.4.9.2 Where the assigned class is greater than 4 hours, it shall be permitted to terminate the test after 4 continuous hours.

8.4.9.3 The test shall be initiated by operating at least one transfer switch test function and then by operating the test function of all remaining ATSs, or initiated by opening all switches or breakers supplying normal power to all ATSs that are part of the EPSS being tested.

8.4.9.4 A power interruption to non-EPSS loads shall not be required.

NFPA 110 36 Month Testing

8.4.9.5 The minimum load for this test shall be as specified in 8.4.9.5.1, 8.4.9.5.2, or 8.4.9.5.3.

8.4.9.5.1 For a diesel-powered EPS, loading shall be not less than 30 percent of the nameplate kW rating of the EPS. A supplemental load bank shall be permitted to be used to meet or exceed the 30 percent requirement.

8.4.9.5.2 For a diesel-powered EPS, loading shall be that which maintains the minimum exhaust gas temperatures as recommended by the manufacturer.

8.4.9.5.3 For spark-ignited EPSs, loading shall be the available EPSS load.

Spec Note Specify a permanent load bank to the system to allow for proper loading during weekly testing.

NFPA 110 36 Month Testing

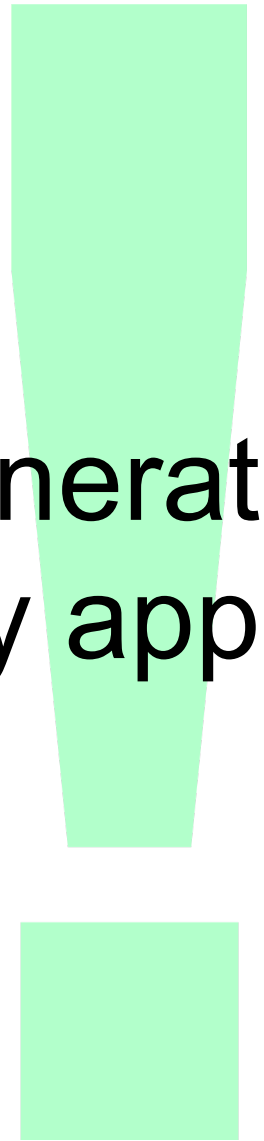
8.4.9.6 The test required in 8.4.9 shall be permitted to be combined with one of the monthly tests required by 8.4.2 and one of the annual tests required by 8.4.2.3 as a single test.

8.4.9.7 Where the test required in 8.4.9 is combined with the annual load bank test, the first portion of the test shall be at not less than the minimum loading required by 8.4.9.5, the last hour shall be at not less than 75 percent of the nameplate kW rating of the EPS, and the duration of the test shall be in accordance with 8.4.9.1 and 8.4.9.2.

Related Content

NFPA 110 Testing
PowerHour
White Paper

Can natural gas generator sets be used in Level 1 / Life Safety applications?

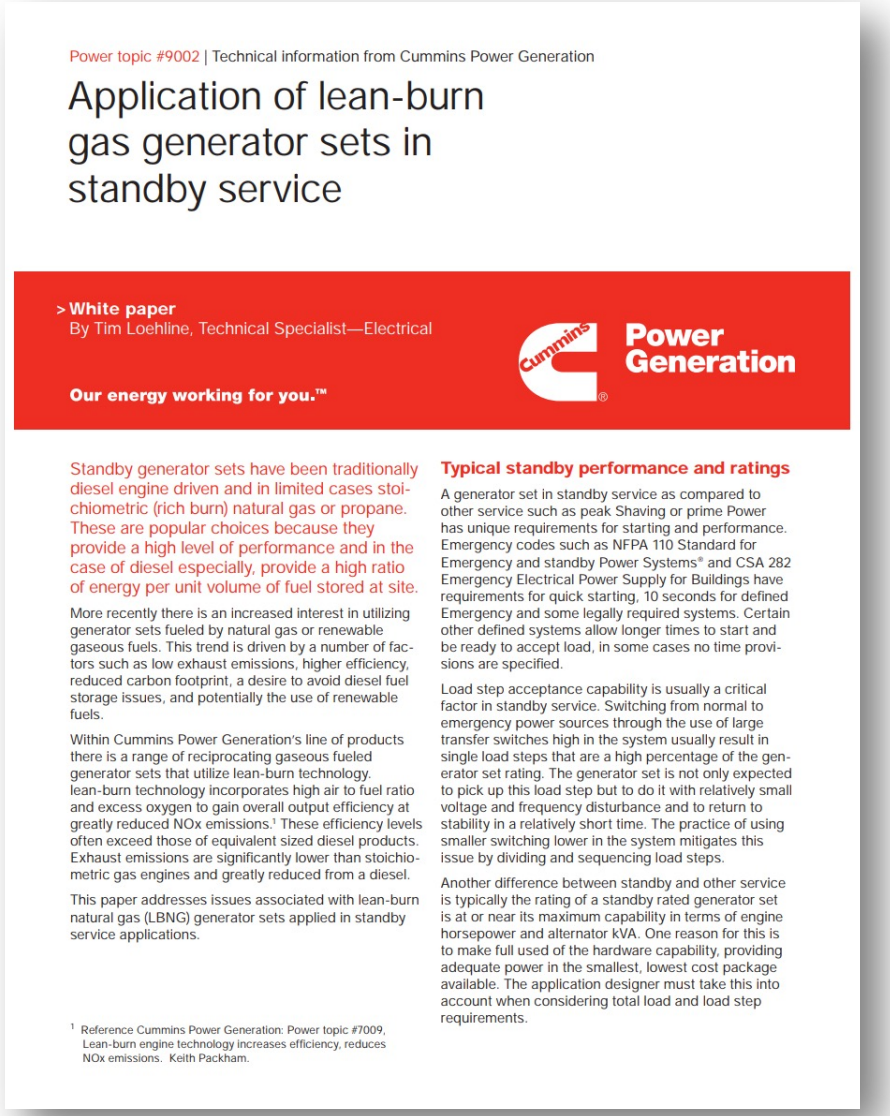


Compliance to Codes and Standards

Myths and Misconceptions

MYTH: "Gaseous generator sets are not allowed for emergency or life safety applications."

- ✓ Generator set manufacturers may be able to offer gaseous-fueled products that meet a wide range of applications.
- ✓ Natural gas may be acceptable to local authority having jurisdiction for life safety applications.
- ✓ Gaseous products may provide advantages over diesel products in applications due to fuel quality and logistics.



Power topic #9002 | Technical information from Cummins Power Generation

Application of lean-burn gas generator sets in standby service

> White paper
By Tim Loehline, Technical Specialist—Electrical

Our energy working for you.™

Cummins Power Generation

Standby generator sets have been traditionally diesel engine driven and in limited cases stoichiometric (rich burn) natural gas or propane. These are popular choices because they provide a high level of performance and in the case of diesel especially, provide a high ratio of energy per unit volume of fuel stored at site.

More recently there is an increased interest in utilizing generator sets fueled by natural gas or renewable gaseous fuels. This trend is driven by a number of factors such as low exhaust emissions, higher efficiency, reduced carbon footprint, a desire to avoid diesel fuel storage issues, and potentially the use of renewable fuels.

Within Cummins Power Generation's line of products there is a range of reciprocating gaseous fueled generator sets that utilize lean-burn technology. lean-burn technology incorporates high air to fuel ratio and excess oxygen to gain overall output efficiency at greatly reduced NOx emissions.[1] These efficiency levels often exceed those of equivalent sized diesel products. Exhaust emissions are significantly lower than stoichiometric gas engines and greatly reduced from a diesel.

This paper addresses issues associated with lean-burn natural gas (LBNG) generator sets applied in standby service applications.

[1] Reference Cummins Power Generation: Power topic #7009, Lean-burn engine technology increases efficiency, reduces NOx emissions. Keith Packham.

Typical standby performance and ratings

A generator set in standby service as compared to other service such as peak Shaving or prime Power has unique requirements for starting and performance. Emergency codes such as NFPA 110 Standard for Emergency and standby Power Systems® and CSA 282 Emergency Electrical Power Supply for Buildings have requirements for quick starting, 10 seconds for defined Emergency and some legally required systems. Certain other defined systems allow longer times to start and be ready to accept load, in some cases no time provisions are specified.

Load step acceptance capability is usually a critical factor in standby service. Switching from normal to emergency power sources through the use of large transfer switches high in the system usually result in single load steps that are a high percentage of the generator set rating. The generator set is not only expected to pick up this load step but to do it with relatively small voltage and frequency disturbance and to return to stability in a relatively short time. The practice of using smaller switching lower in the system mitigates this issue by dividing and sequencing load steps.

Another difference between standby and other service is typically the rating of a standby rated generator set is at or near its maximum capability in terms of engine horsepower and alternator kVA. One reason for this is to make full used of the hardware capability, providing adequate power in the smallest, lowest cost package available. The application designer must take this into account when considering total load and load step requirements.

Compliance to Codes and Standards

Fuel Source for Emergency Systems

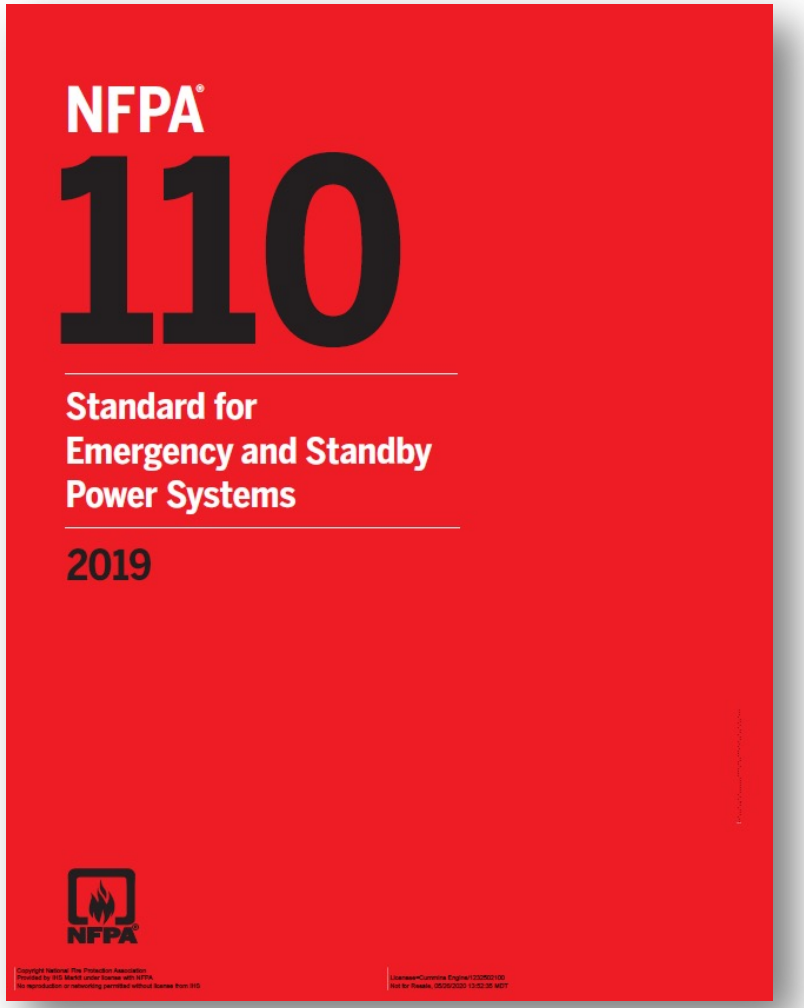
NFPA 110-2019

5.1.1 The following energy sources shall be permitted to be used for the emergency power supply (EPS):

(1) Liquid petroleum products…

(2) Liquified petroleum gas…

(3) Natural or synthetic gas



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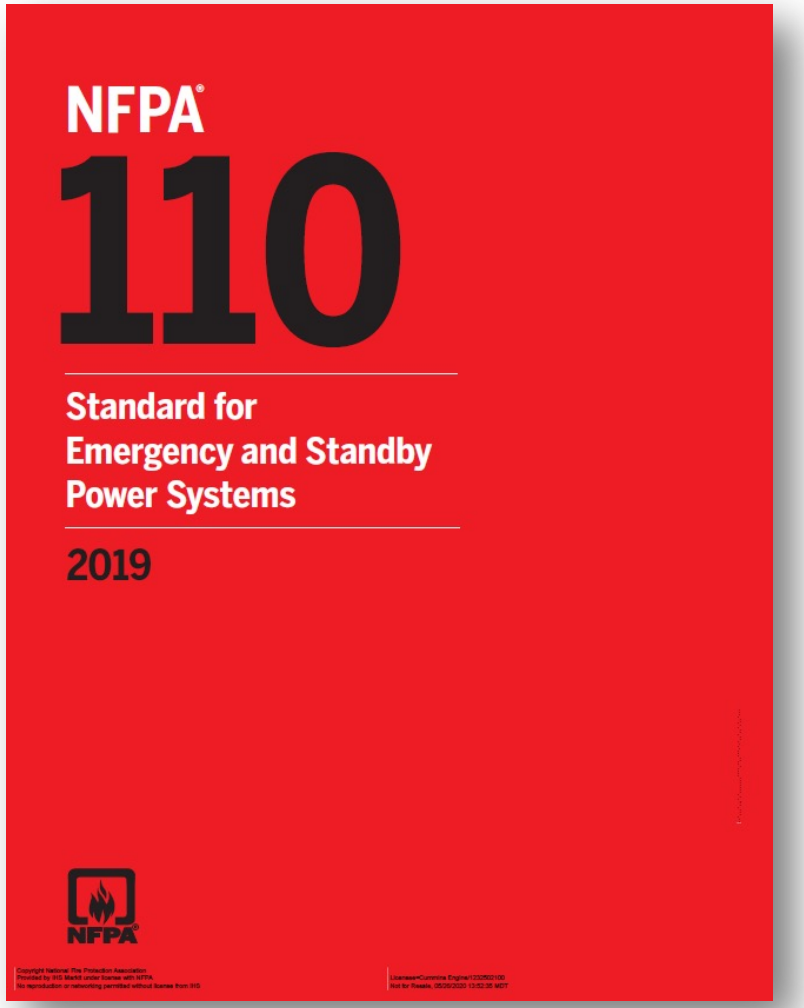
Exception: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high, on-site storage of an alternate energy source sufficient to allow full output of the EPSS to be delivered for the class specified shall be required, with the provision for automatic transfer from the primary energy source to the alternate energy source.



Compliance to Codes and Standards

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Natural Gas Council

Natural gas is a secure, reliable and resilient choice for customers

- Operational reliability
  - 2017 survey of 51 interstate pipelines – 99.97% of contractual commitments
  - Geographic dispersion of production reduces vulnerability to local weather
  - Transportation network interconnected, offering multiple pathways for rerouting

Compliance to Codes and Standards

Fuel Source for Emergency Systems

NFPA 70 – NEC Article:	Diesel	Gaseous (utility & on-site fuel source)	Gaseous (utility source only)
708 "COPS"	✓	✓	X**
700 "Life Safety"	✓	✓	✓*
701 "Legally Req'd"	✓	✓	✓
702 "Optional"	✓	✓	✓

* Follow exemption process w/ AHJ per NFPA 110 Level 1 Systems

** **NEC Article 708:** *Prime movers shall not be solely dependent on a public utility gas system for their fuel supply… Where internal combustion engines are used as the prime mover, an on-site fuel supply shall be provided…*

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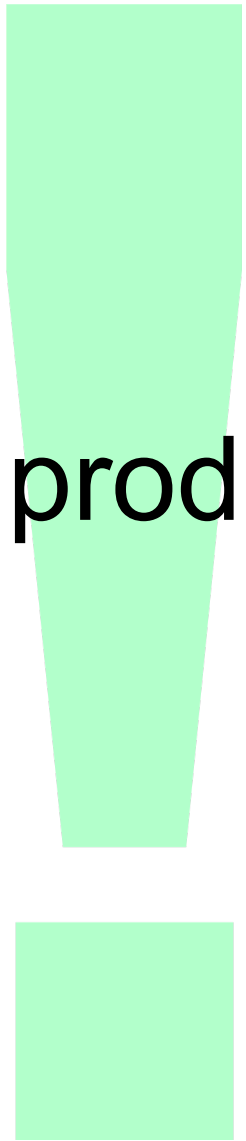
Related Content

Specifying Gaseous Sources
PowerHour

Can you talk about product testing and prototype testing?

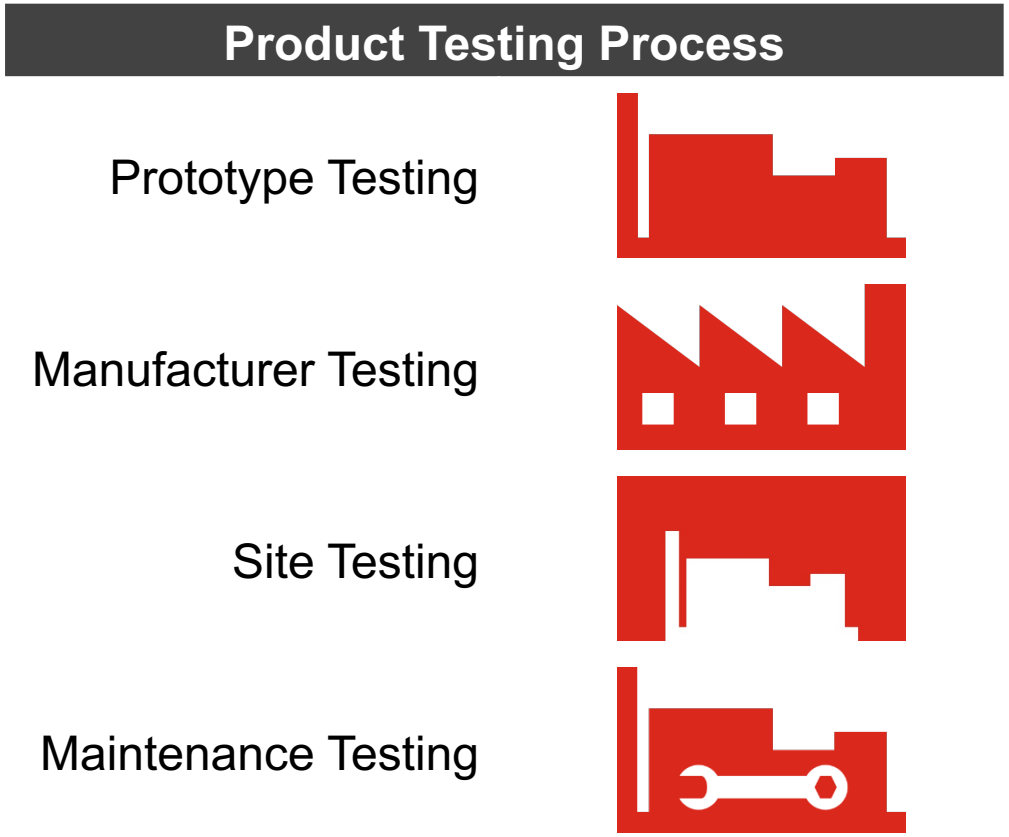


Product Testing Overview

Why is standby power system testing important?

- There is no single performance test standard for standby power systems.
- Existing test standards may be incomplete or may not address all potential failure modes adequately.
- Testing throughout the life of a product ensures adequate product performance at all stages of assembly and installation.
- Equipment testing is critical to the reliability of the product and the power system.

Product Testing Process



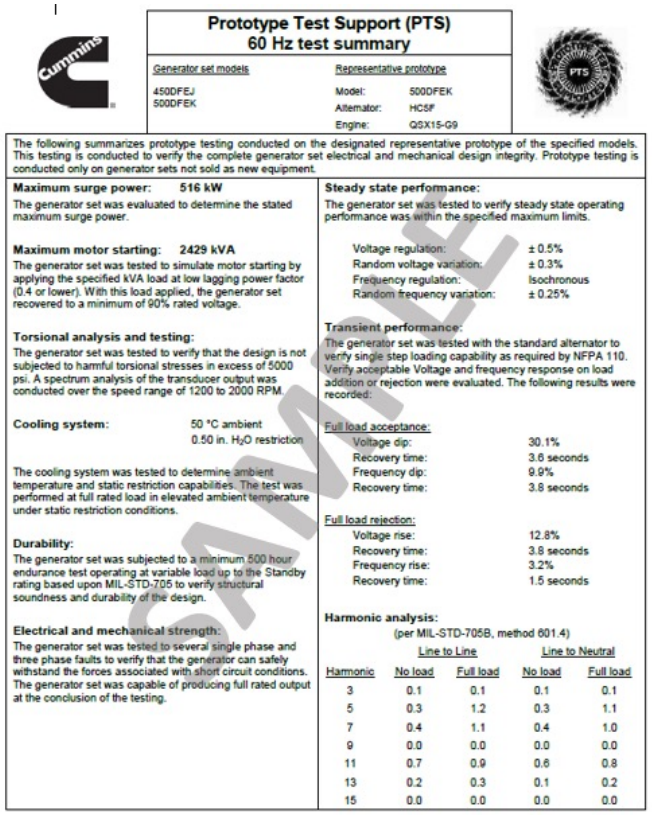
Prototype Testing Overview

Prototype testing…

- Validates a complete product's operating characteristics and limitations, as well as its ability to withstand "normally occurring abnormal events".
- Will include potentially destructive testing you wouldn't want to do on your customer's new generator (short circuits, bolted faults, endurance, harsh environments, seismic, etc.)
- Defines installation design parameters.
- Provides a realistic baseline for performance expectations.
- Is one part of product lifecycle testing critical to component and power system reliability.

Prototype Test Documentation

- NFPA 110 requires that a generator set manufacturer certify compliance to the prototype testing requirements of that standard.
- Each manufacturer is free to decide what testing is necessary for their product.
- Actual testing practices vary dramatically between suppliers.
- Designer is expected to understand what is required and evaluate the ability of a specific supplier to meet objectives of NFPA 110.



Prototype Test Support (PTS)
60 Hz test summary

Generator set models: 450DFEJ, 500DFEK

Representative prototype: Model: 500DFEK; Alternator: HC5F; Engine: QSX15-G9

The following summarizes prototype testing conducted on the designated representative prototype of the specified models. This testing is conducted to verify the complete generator set electrical and mechanical design integrity. Prototype testing is conducted only on generator sets not sold as new equipment.

Maximum surge power: 516 kW
The generator set was evaluated to determine the stated maximum surge power.

Maximum motor starting: 2429 kVA
The generator set was tested to simulate motor starting by applying the specified kVA load at low lagging power factor (0.4 or lower). With this load applied, the generator set recovered to a minimum of 90% rated voltage.

Torsional analysis and testing:
The generator set was tested to verify that the design is not subjected to harmful torsional stresses in excess of 5000 psi. A spectrum analysis of the transducer output was conducted over the speed range of 1200 to 2000 RPM.

Cooling system: 50 °C ambient, 0.50 in. H_2O restriction
The cooling system was tested to determine ambient temperature and static restriction capabilities. The test was performed at full rated load in elevated ambient temperature under static restriction conditions.

Durability:
The generator set was subjected to a minimum 500 hour endurance test operating at variable load up to the Standby rating based upon MIL-STD-705 to verify structural soundness and durability of the design.

Electrical and mechanical strength:
The generator set was tested to several single phase and three phase faults to verify that the generator can safely withstand the forces associated with short circuit conditions. The generator set was capable of producing full rated output at the conclusion of the testing.

Steady state performance:
The generator set was tested to verify steady state operating performance was within the specified maximum limits.

Voltage regulation:	± 0.5%
Random voltage variation:	± 0.3%
Frequency regulation:	Isochronous
Random frequency variation:	± 0.25%

Transient performance:
The generator set was tested with the standard alternator to verify single step loading capability as required by NFPA 110. Verify acceptable Voltage and frequency response on load addition or rejection were evaluated. The following results were recorded:

Full load acceptance:

Voltage dip:	30.1%
Recovery time:	3.6 seconds
Frequency dip:	9.9%
Recovery time:	3.8 seconds

Full load rejection:

Voltage rise:	12.8%
Recovery time:	3.8 seconds
Frequency rise:	3.2%
Recovery time:	1.5 seconds

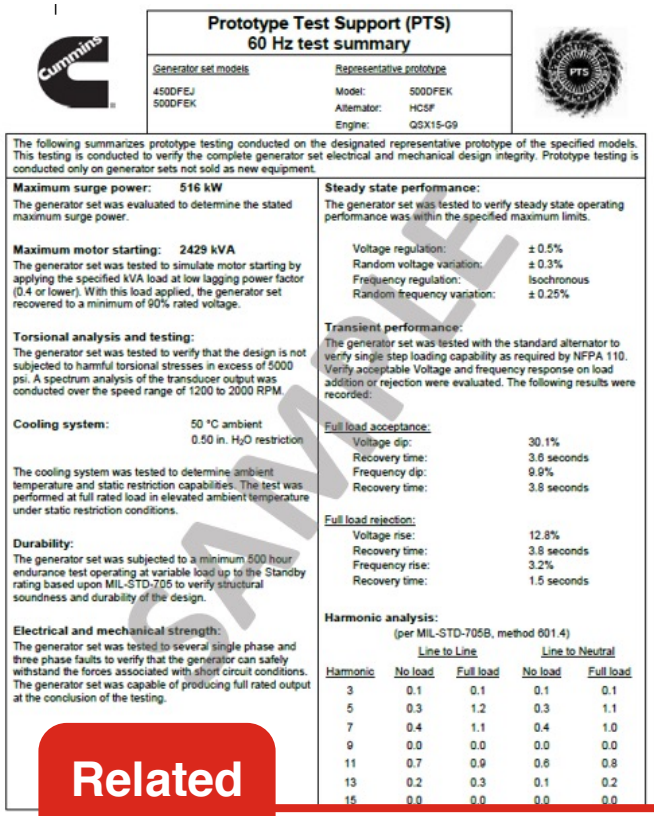
Harmonic analysis:
(per MIL-STD-705B, method 601.4)

	Line to Line		Line to Neutral	
Harmonic	No load	Full load	No load	Full load
3	0.1	0.1	0.1	0.1
5	0.3	1.2	0.3	1.1
7	0.4	1.1	0.4	1.0
9	0.0	0.0	0.0	0.0
11	0.7	0.9	0.6	0.8
13	0.2	0.3	0.1	0.2
15	0.0	0.0	0.0	0.0

SAMPLE

Prototype Test Documentation

- NFPA 110 requires that a generator set manufacturer certify compliance to the prototype testing requirements of that standard.
- Each manufacturer is free to decide what testing is necessary for their product.
- Actual testing practices vary dramatically between suppliers.
- Designer is expected to understand what is required and evaluate the ability of a specific supplier to meet objectives of NFPA 110.



Prototype Test Support (PTS)
60 Hz test summary

Generator set models: 450DFEJ, 500DFEK

Representative prototype: Model: 500DFEK; Alternator: HC5F; Engine: QSX15-G9

The following summarizes prototype testing conducted on the designated representative prototype of the specified models. This testing is conducted to verify the complete generator set electrical and mechanical design integrity. Prototype testing is conducted only on generator sets not sold as new equipment.

Maximum surge power: 516 kW
The generator set was evaluated to determine the stated maximum surge power.

Maximum motor starting: 2429 kVA
The generator set was tested to simulate motor starting by applying the specified kVA load at low lagging power factor (0.4 or lower). With this load applied, the generator set recovered to a minimum of 90% rated voltage.

Torsional analysis and testing:
The generator set was tested to verify that the design is not subjected to harmful torsional stresses in excess of 5000 psi. A spectrum analysis of the transducer output was conducted over the speed range of 1200 to 2000 RPM.

Cooling system: 50 °C ambient, 0.50 in. H_2O restriction
The cooling system was tested to determine ambient temperature and static restriction capabilities. The test was performed at full rated load in elevated ambient temperature under static restriction conditions.

Durability:
The generator set was subjected to a minimum 500 hour endurance test operating at variable load up to the Standby rating based upon MIL-STD-705 to verify structural soundness and durability of the design.

Electrical and mechanical strength:
The generator set was tested to several single phase and three phase faults to verify that the generator can safely withstand the forces associated with short circuit conditions. The generator set was capable of producing full rated output at the conclusion of the testing.

Steady state performance:
The generator set was tested to verify steady state operating performance was within the specified maximum limits.

Voltage regulation:	± 0.5%
Random voltage variation:	± 0.3%
Frequency regulation:	Isochronous
Random frequency variation:	± 0.25%

Transient performance:
The generator set was tested with the standard alternator to verify single step loading capability as required by NFPA 110. Verify acceptable Voltage and frequency response on load addition or rejection were evaluated. The following results were recorded:

Full load acceptance:

Voltage dip:	30.1%
Recovery time:	3.6 seconds
Frequency dip:	9.9%
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Full load rejection:

Voltage rise:	12.8%
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Frequency rise:	3.2%
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Harmonic analysis:
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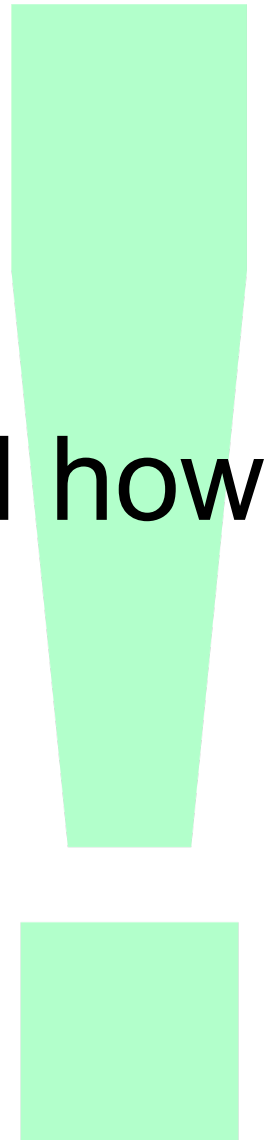
11	0.7	0.9	0.6	0.8
13	0.2	0.3	0.1	0.2
15	0.0	0.0	0.0	0.0

SAMPLE

Related Content

Equipment Testing Overview
PowerHour

What is "Level" and how is it defined and measured?



NFPA 110 Overview

Classification of Emergency Power Supply Systems

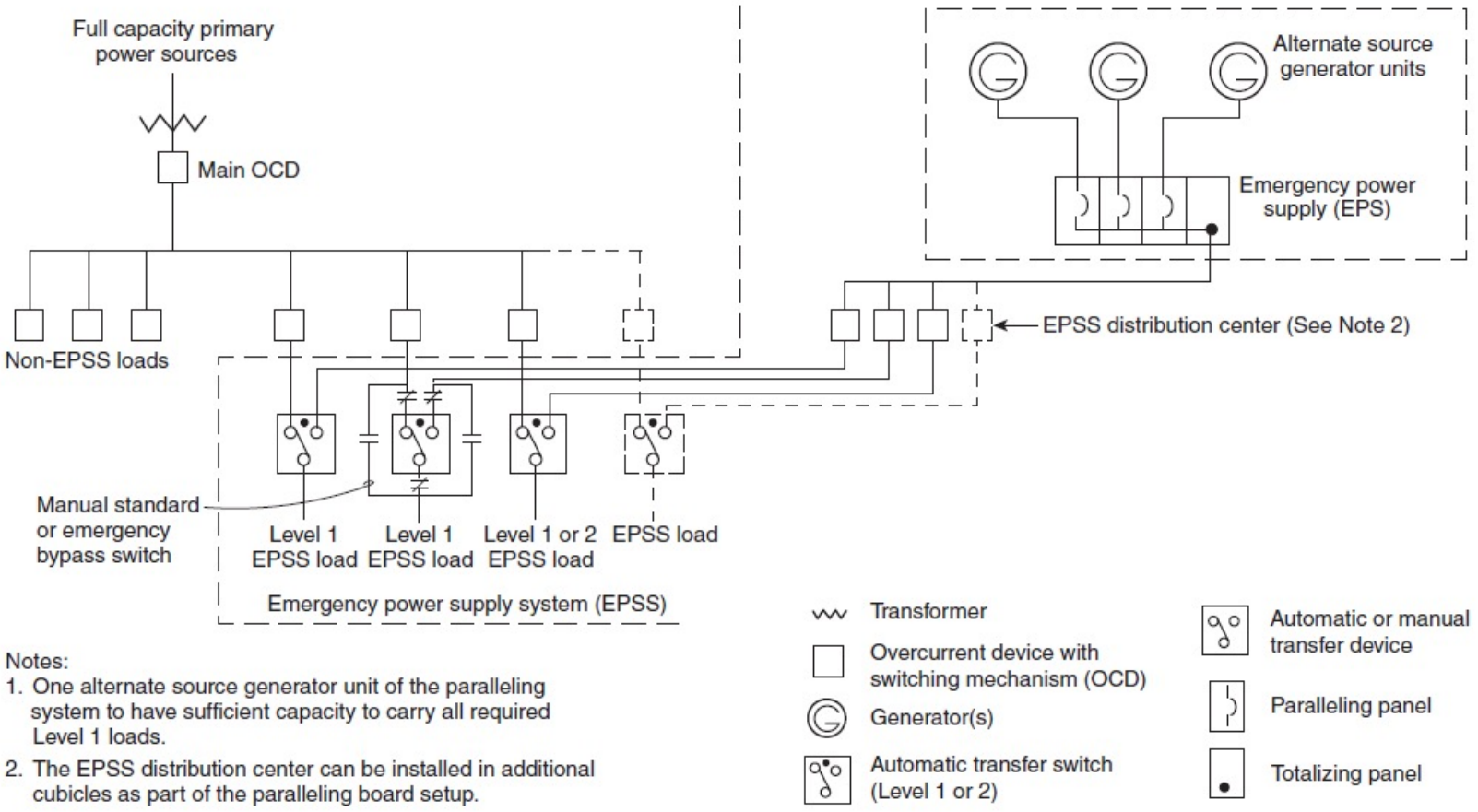
4.4 Level: This standard recognizes two levels for equipment installation performance and maintenance requirements.

4.4.1 Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries (Equates to NEC Article 700).

4.4.2 Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety (Equates to NEC Article 701).

What are the considerations for Type 10 EPSS when we parallel gensets?

Paralleled Generator Set EPSS



Notes:
1. One alternate source generator unit of the paralleling system to have sufficient capacity to carry all required Level 1 loads.
2. The EPSS distribution center can be installed in additional cubicles as part of the paralleling board setup.

FIGURE B.1(b) Typical Multiple-Unit Emergency Power Supply System.

Utility Outage with Single Generator Set System – Sequence of Events

1) ATS control detects failure of normal source
2) ATS programmed time before next step
3) ATS control sends start signal to generator set control
4) Generator set control initiates engine start sequence
5) Generator set engine starts
6) Generator set reaches “Ready to Load”
7) ATS transitions from normal to neutral position
8) ATS transfer time delay
9) ATS transitions from neutral to emergency position

0 – 1 Seconds based on application

4 – 8.5 Seconds based on generator set configuration

0.5 – 1.5 Seconds based on transfer switch and application

Utility Outage with Multiple Generator Set System – Sequence of Events

1) ATS control detects failure of normal source
2) ATS programmed time before next step
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0 – 1 Seconds based on application

4) Generator set control initiates engine start sequence
5) Generator set engine starts
6) Generator set reaches “Ready to Load”
7) Generator set paralleling controls begin “first start arbitration”
    1) Generator set that “wins” first start arbitration proceeds to next step
    2) All other generator sets must synchronize before proceeding to the next step
8) Generator set paralleling circuit breaker closes
9) ATS transitions from normal to neutral position
10) ATS transfer time delay
11) ATS transitions from neutral to emergency position

Utility Outage with Multiple Generator Set System – Sequence of Events

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4 – 8.5 Seconds based on generator set configuration

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4 – 8.5 Seconds based on generator set configuration

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    1) Generator set that “wins” first start arbitration proceeds to next step
    2) All other generator sets must synchronize before proceeding to the next step
8) Generator set paralleling circuit breaker closes

0.5 – 1 Second for first generator set
0.5 – 1 Second for each additional generator set

9) ATS transitions from normal to neutral position
10) ATS transfer time delay
11) ATS transitions from neutral to emergency position

Utility Outage with Multiple Generator Set System – Sequence of Events

1) ATS control detects failure of normal source
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10 Seconds

Spec Note The smallest generator set on the generator set paralleling bus shall have sufficient capacity to support all emergency loads.

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Related Content

NFPA 110 Time to Readiness
PowerHour
White Paper

10 Seconds

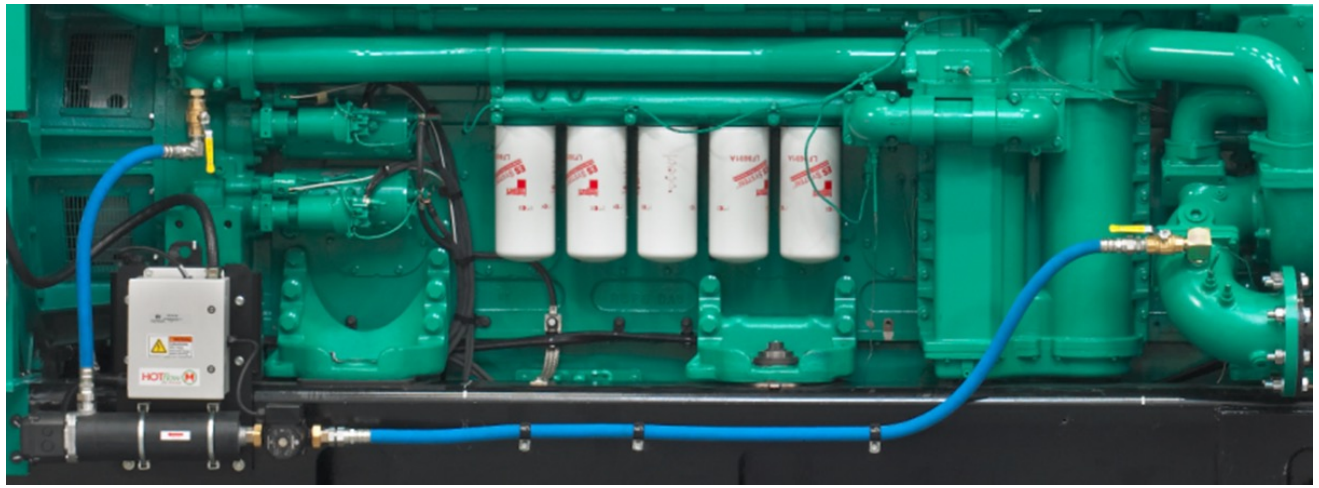
Spec Note The smallest generator set on the generator set paralleling bus shall have sufficient capacity to support all emergency loads.

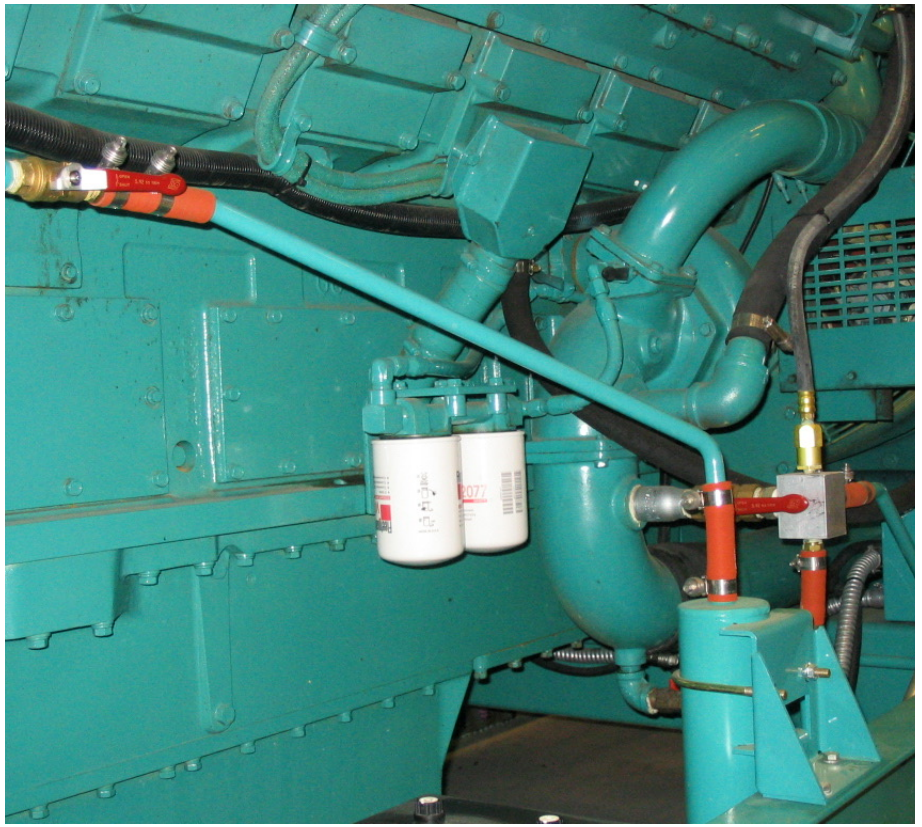
What are some of the commonly misinterpreted or misapplied portions of NFPA 110?

NFPA 110 – Generator Set Subsystems

Temperature Maintenance

5.3.1 The EPS shall be heated as necessary to maintain the water jacket and battery temperature determined by the EPS manufacturer for cold start and load acceptance for the type of EPSS.





NFPA 110 – Generator Set Subsystems

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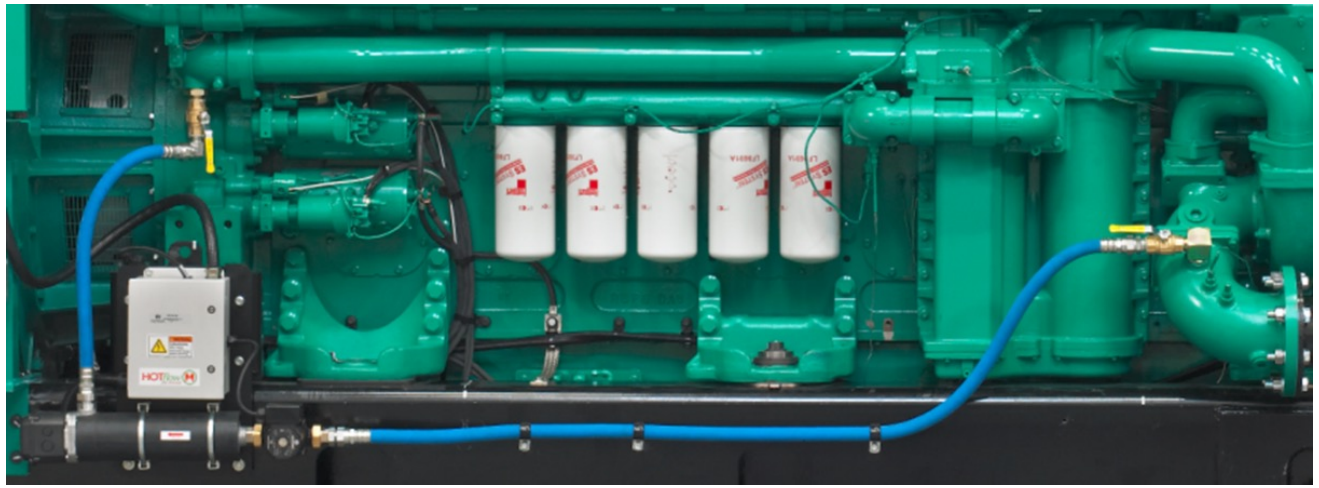

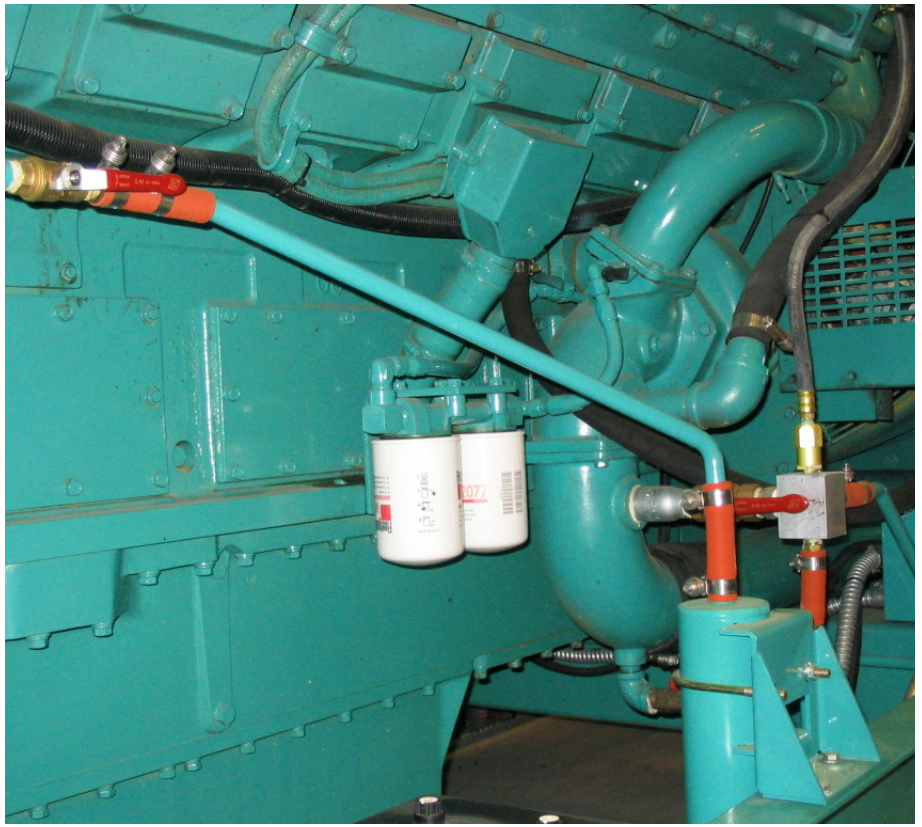

Spec Note Require the generator set vendor to provide an engine jacket water heater sized appropriately for the engine.

NFPA 110 – Generator Set Subsystems

Prime Mover Starting Equipment

5.6.4.1 Starting Systems. Starting shall be accomplished using either an electric or a stored energy starting system.

5.6.4.3 Number of Batteries. Each prime mover shall be provided with both of the following:

(1) Storage battery units as specified in Table 5.6.4.2

5.6.4.4 Size of Batteries. The battery unit shall have the capacity to maintain the cranking speed recommended by the prime mover manufacturer through two complete periods of cranking limiter time-outs as specified in Table 5.6.4.2, item (d).

Table 5.6.4.2 Starting Equipment Requirements

	Starting Equipment Requirements	Level 1
(a)	Battery unit	X
(b)	Battery certification	X
(c)	Cycle cranking	O
(d)	Cranking limiter time-outs	
	Cycle crank (3 cycles)	75 sec
	Continuous crank	45 sec
(e)	Float-type battery charger	X
	dc ammeter	X
	dc voltmeter	X
(f)	Recharge time	24 hr
(g)	Low battery voltage alarm contacts	X

X: Required. O: Optional. NA: Not applicable.

NFPA 110 – Generator Set Subsystems

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Table 5.6.4.2 Starting Equipment Requirements

	Starting Equipment Requirements	Level 1
(a)	Battery unit	X
(b)	Battery certification	X
(c)	Cycle cranking	O
(d)	Cranking limiter time-outs	
	Cycle crank (3 cycles)	75 sec
	Continuous crank	45 sec
(e)	Float-type battery charger	X
	dc ammeter	X
	dc voltmeter	X
(f)	Recharge time	24 hr
(g)	Low battery voltage alarm contacts	X

X: Required. O: Optional. NA: Not applicable.

Spec Note Require vendors to provide starting batteries sized appropriately for use with the generator set configuration.

One of the most important maintenance items that deserves some extra attention is about batteries. Can you tell us more about the key role of batteries and how we can ensure utmost reliability?

Maintenance Testing Overview

8.1.1 The routine maintenance and operational testing program shall be based on all of the following:

(1) Manufacturer's recommendations

(2) Instruction manuals

(3) Minimum requirements of this chapter

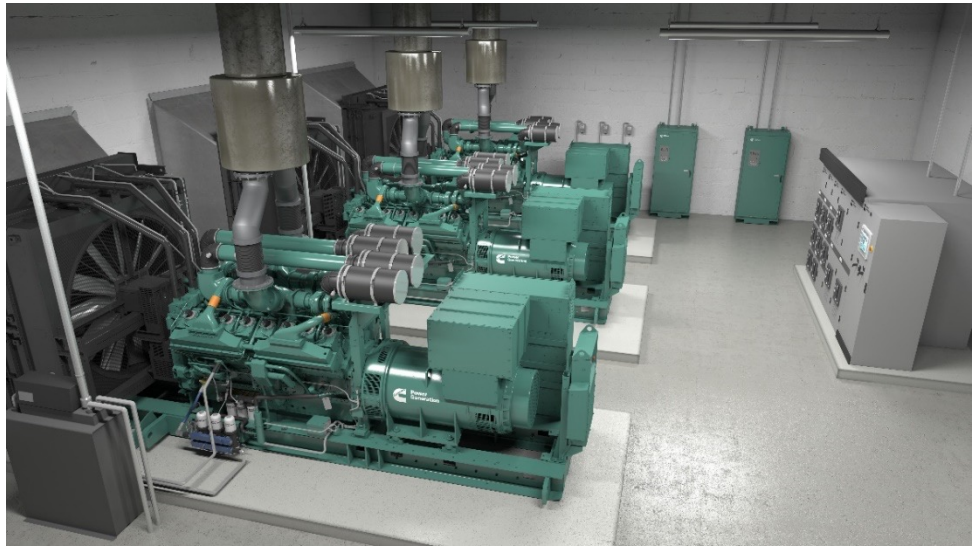
(4) The authority having jurisdiction

Spec Note Require equipment vendors to provide electronic or hard-copies of owner/operator manuals which include anticipated service intervals.

Parts Availability and Maintenance

8.2.4 Replacement for parts identified by experience as high mortality items shall be maintained in a secure location(s) on the premises.

8.3.2 A routine maintenance and operational testing program shall be initiated immediately after the EPSS has passed acceptance tests or after completion of repairs that impact the operational reliability of the system.



Spec Note Require equipment vendors to maintain an inventory of replacement parts and employ manufacturer trained service engineers capable of servicing the emergency equipment.

Starting Battery Maintenance

8.3.6 Storage batteries, including electrolyte levels or battery voltage, used in connection with systems shall be inspected weekly and maintained in full compliance with manufacturer's specifications.

8.3.6.1 Maintenance of lead-acid batteries shall include the monthly testing and recording of electrolyte specific gravity. Battery conductance testing shall be permitted in lieu of the testing of specific gravity when applicable or warranted.

8.3.6.2 Defective batteries shall be replaced immediately upon discovery of defects.

Spec Note Use starting batteries and battery chargers sized appropriately for use with the generator set configuration as recommended by the equipment manufacturer.

Course Summary

Ask the Experts: NFPA 110 for Emergency Power Systems

NFPA 110, the Standard for Emergency and Standby Power Systems, sets the baseline for emergency power system performance requirements and is critical to installation of nearly every backup power system. This Ask the Experts session will address a number of key topics related to NFPA 110 and will offer an opportunity to connect directly with power system experts at Cummins! Topics addressed during this session will range from fuel and battery testing to Type 10 requirements and complexities arising from paralleled power sources serving life safety loads. Bring your questions and be prepared to engage in open discussion and Q&A with an expert panel.

After completing this course, participants will be able to:

- Identify key topics related to NFPA 110 impacting emergency power supply system design and installation.
- Describe common pitfalls, challenges and misconceptions often encountered when validating power system design.
- Recognize common code requirements mandated by NFPA 110 and their practical application.

Additional Resources

Cummins White Papers

Maintenance is one key to diesel generator set reliability

Rated power factor tests and installation acceptance of emergency and standby power systems

The 10-second start: NFPA 110 Type 10 starting requirements for generator set applications

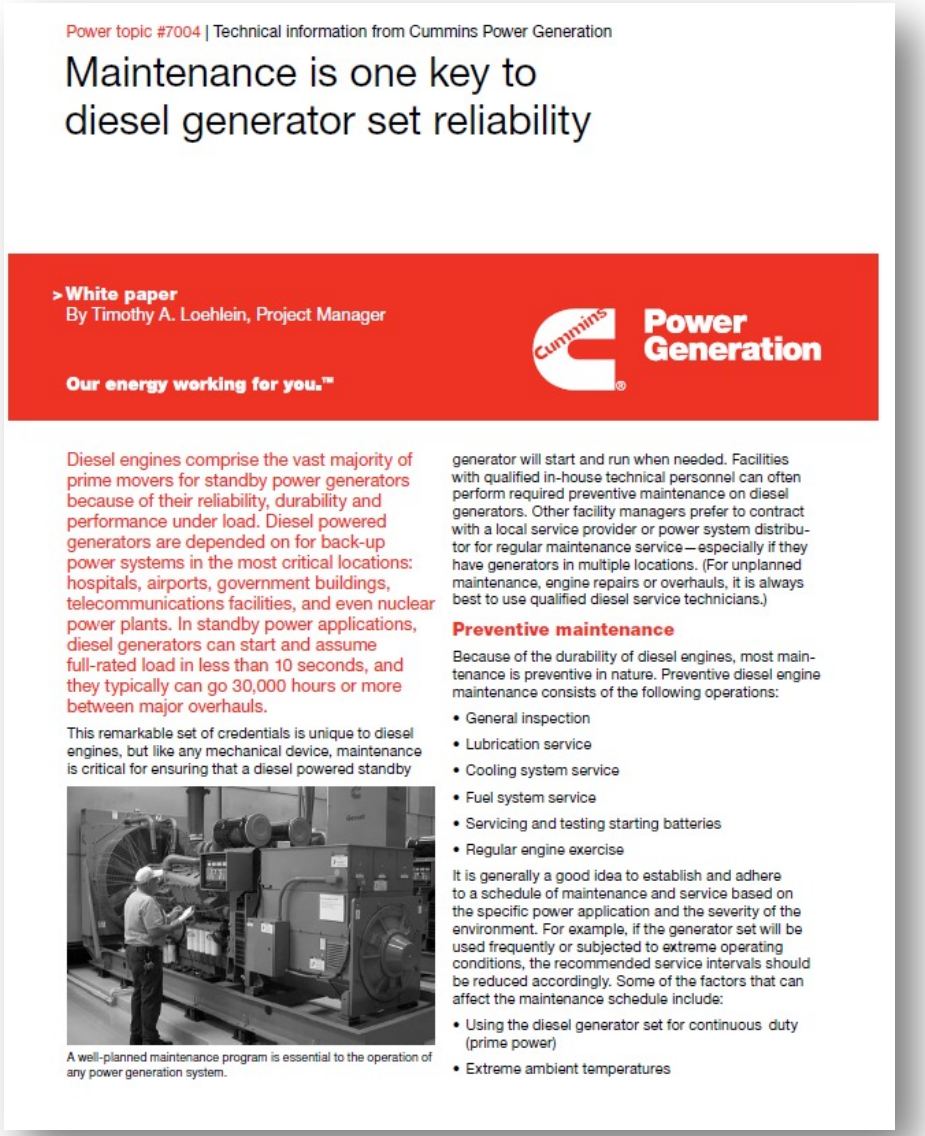
Design for safety and reliability-appropriate connection provisions for generator sets

Cummins PowerHour (Live and On-Demand Webinars)

Testing Requirements of Emergency Power Supply Systems in Critical Healthcare Facility

Specifying Generator Set Testing for Reliable Power Systems

NFPA 110 Type 10 Requirements for Emergency Power Systems



Power topic #7004 | Technical information from Cummins Power Generation

Maintenance is one key to diesel generator set reliability

>White paper
By Timothy A. Loehlein, Project Manager

Our energy working for you.™

Power Generation

Diesel engines comprise the vast majority of prime movers for standby power generators because of their reliability, durability and performance under load. Diesel powered generators are depended on for back-up power systems in the most critical locations: hospitals, airports, government buildings, telecommunications facilities, and even nuclear power plants. In standby power applications, diesel generators can start and assume full-rated load in less than 10 seconds, and they typically can go 30,000 hours or more between major overhauls.

This remarkable set of credentials is unique to diesel engines, but like any mechanical device, maintenance is critical for ensuring that a diesel powered standby generator will start and run when needed. Facilities with qualified in-house technical personnel can often perform required preventive maintenance on diesel generators. Other facility managers prefer to contract with a local service provider or power system distributor for regular maintenance service—especially if they have generators in multiple locations. (For unplanned maintenance, engine repairs or overhauls, it is always best to use qualified diesel service technicians.)

A well-planned maintenance program is essential to the operation of any power generation system.

Preventive maintenance

Because of the durability of diesel engines, most maintenance is preventive in nature. Preventive diesel engine maintenance consists of the following operations:

- General inspection
- Lubrication service
- Cooling system service
- Fuel system service
- Servicing and testing starting batteries
- Regular engine exercise

It is generally a good idea to establish and adhere to a schedule of maintenance and service based on the specific power application and the severity of the environment. For example, if the generator set will be used frequently or subjected to extreme operating conditions, the recommended service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule include:

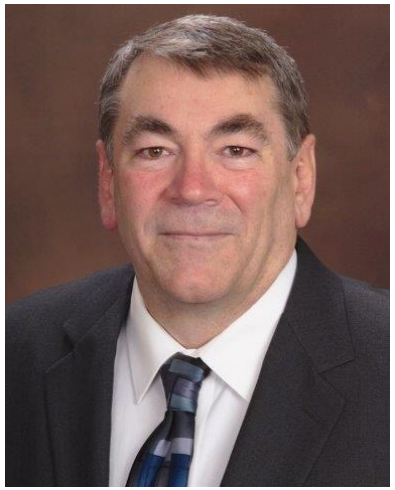
- Using the diesel generator set for continuous duty (prime power)
- Extreme ambient temperatures

Q&A

Please type your questions, comments and feedback in the **Zoom Q&A** window.

After the PowerHour, a complete list of questions and answers will be published on powersuite.cummins.com.

Michael Sanford
Product Strategy and Sales Enablement Leader
Cummins Inc.



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Q&A

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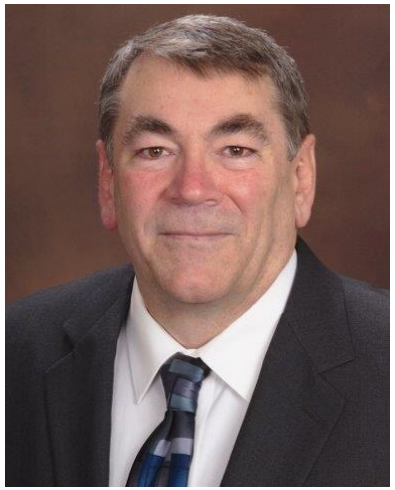

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Closing

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- A certificate issuing one professional development hour (1 PDH)

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