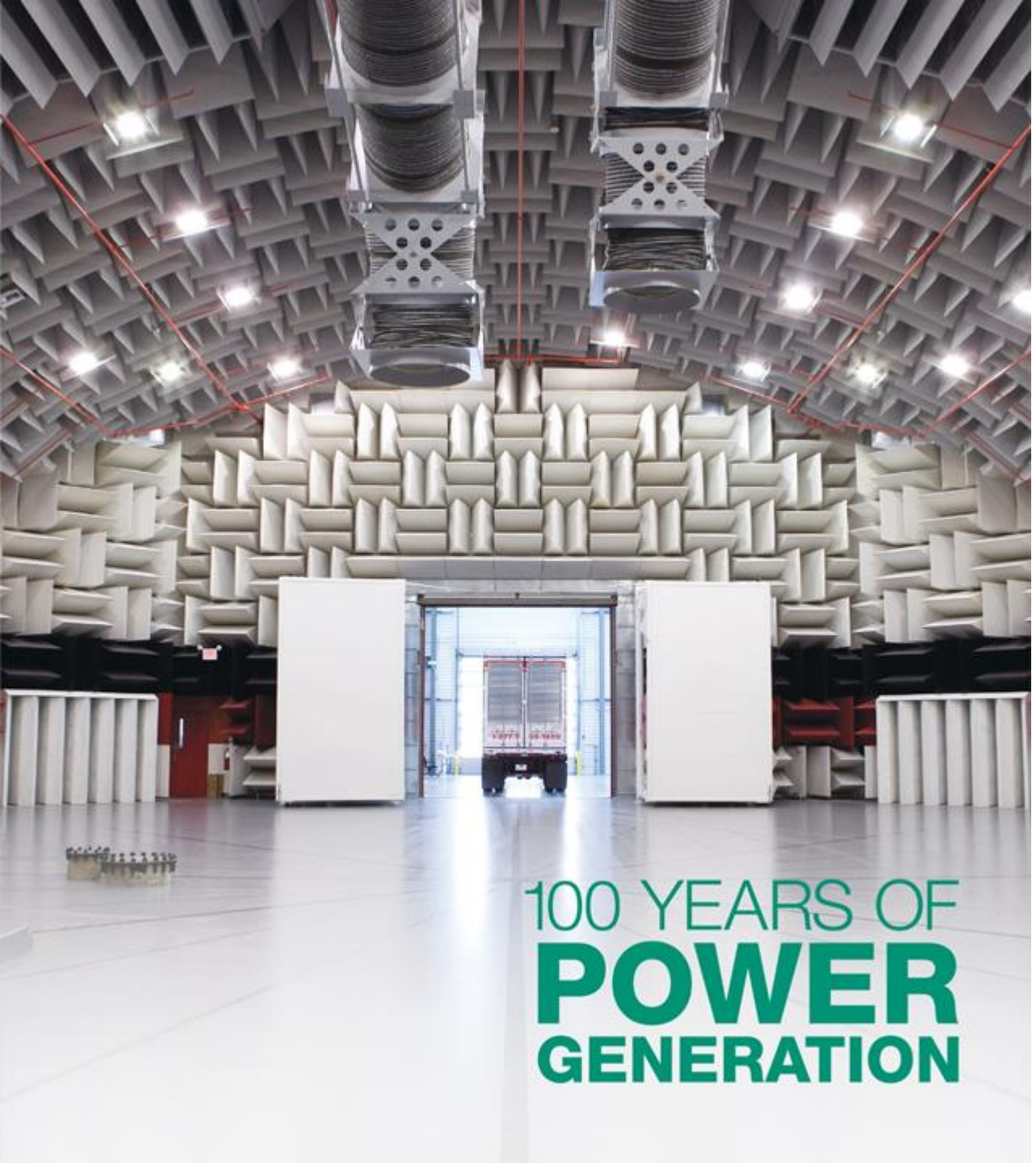

Power Systems

NFPA 110 Testing and Service Requirements For Standby Power Systems

PowerHour webinar series for consulting engineers

Experts you trust. Excellence you count on.

December 15, 2020 12:000pm Eastern Time / 9:00am Pacific Time
(1 PDH issued by Cummins Inc.)

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- Interact with Cummins experts and gain access to ongoing technical support
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- Earn Professional Development Hours (PDH)

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Product Strategy and Sales Enablement Leader
Cummins Inc.

Cummins Facilitator:

John Chen
Technical Marketing Specialist
Cummins Inc.

Cummins Panelist:

Mariano Rojas
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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.

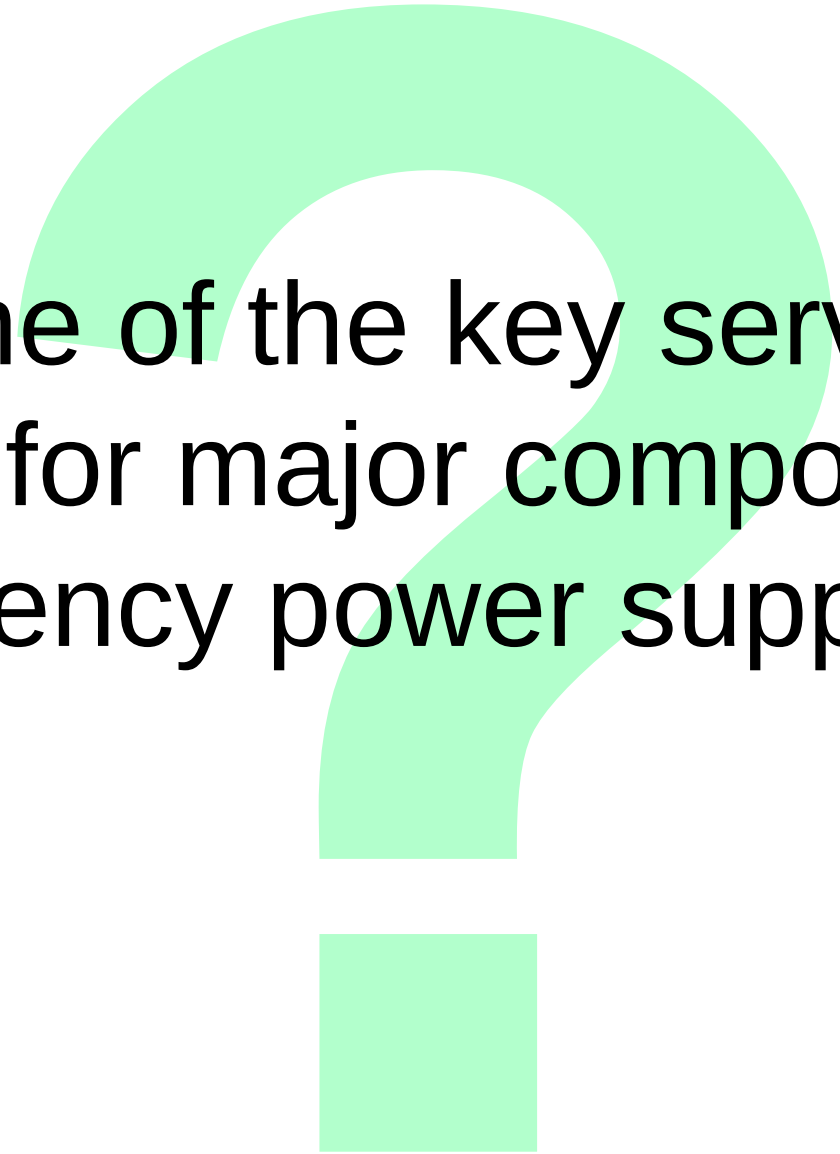
Course Objectives

NFPA 110 Testing and Service Requirements For Standby Power Systems

Standby power systems testing, and service is critical to the reliability of the system. This course will walk participants through site acceptance and in-service testing and will review best practices that will empower facility owners and managers to administer appropriate test strategies and service programs to maintain a reliable power system. This course will also look at common specification standards such as NFPA 110 that provide product testing and service guidelines while also addressing potential pitfalls. After completing this course, participants will be able to:

- Describe generator set testing and service guidelines and best practices.
- Identify commonly adopted test standards such as NFPA 110 and their relevance to on-site testing best practices.
- Recognize the power system reliability benefits associated with a complete testing and service strategy.
- Describe advancements in technology that impact power system testing and service strategies.

What are some of the key service requirements for major components in a typical emergency power supply system?

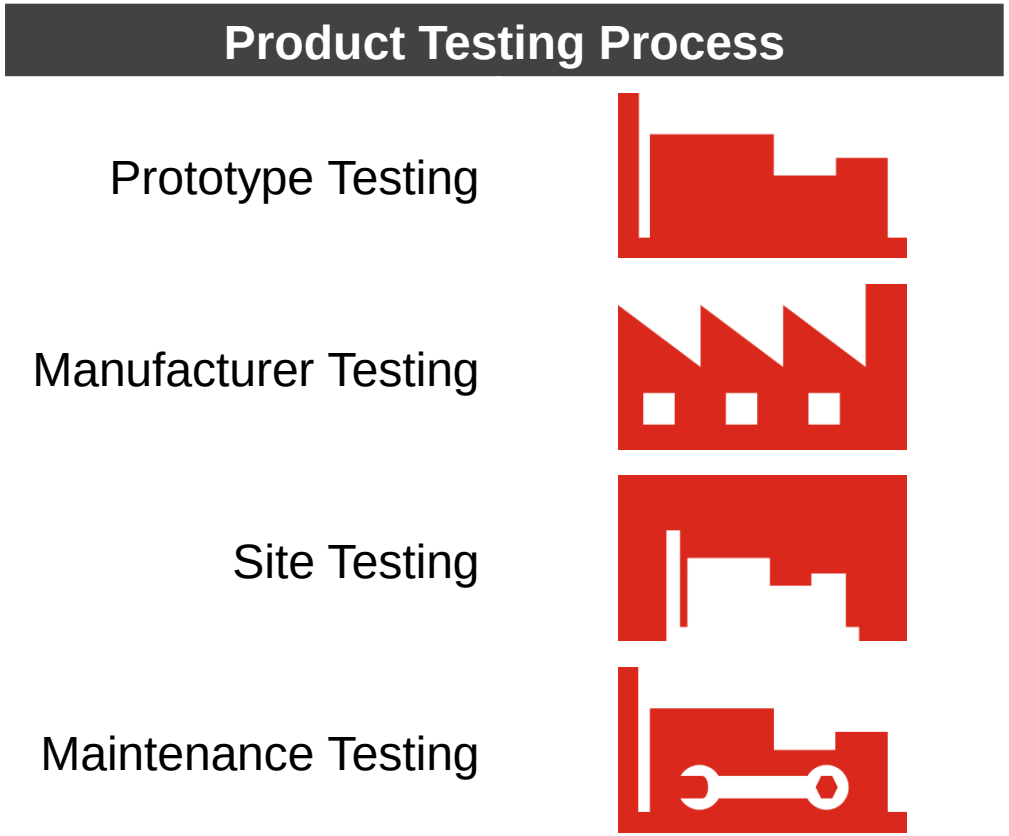


Product Testing Overview

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.

Product Testing Process

Manufacturer Testing Overview

Manufacturer testing…

- Validates the assembly of the generator set.
- Relies on prototype testing to establish baseline performance criteria.
- Establishes baseline performance criteria for subsequent site testing.
- Relies on a qualified manufacturer with adequate facilities and personnel to conduct the testing.
- Is one part of product lifecycle testing critical to component and power system reliability.

Product Testing Process

Site Testing Overview

Site testing…

- Validates the ability of the generator set to perform as installed.
- Relies on manufacturer testing to establish baseline performance criteria.
- Establishes baseline performance criteria for subsequent maintenance testing.
- Relies on qualified technicians to conduct the testing adequately.
- Is one part of product lifecycle testing critical to component and power system reliability.

Product Testing Process

Site Testing Expectations

Cold Start Test

- Validation of generator set starting system, load readiness and operation of starting aids (coolant heater, lube oil heater, etc.).

Full Load Acceptance and Operation

- Verification that the generator set can achieve full nameplate rating in one step and achieve acceptable steady state operation for a specified period of time.
- Testing at 1.0 PF is acceptable for site testing.

Transient Testing

- Conducted to establish baseline performance of frequency and voltage deviations at various step loads.

7.13.4.1.4 The tests conducted in accordance with 7.13.4.1.1 and 7.13.4.1.2 shall be performed in accordance with (1) through (12).

(1) When the EPSS consists of paralleled EPSs, the quantity of EPSs intended to be operated simultaneously shall be tested simultaneously with building load for the test period identified in 7.13.4.1.4(10).
(2) The test load shall be all loads that are served by the EPSS. There is no minimum loading requirement for this portion of the test.
(3) The time delay on start shall be observed and recorded.
(4) The cranking time until the prime mover starts and runs shall be observed and recorded.
(5) The time taken to reach operating speed shall be observed and recorded.
(6)* The engine start function shall be confirmed by verifying operation of the initiating circuit of all transfer switches supplying EPSS loads.
(7) The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.
(8) The voltage, frequency, and amperes shall be recorded.
(9) Where applicable, the prime mover oil pressure and water temperature shall be recorded.
(10) The load test with building load, or other loads that simulate the intended load as specified in Section 5.4, shall be continued for not less than 1.5 hours, and the run time shall be recorded.
(11) When normal power is restored to the building or facility, the time delay on retransfer to normal power for each switch with a minimum setting of 5 minutes shall be recorded.
(12) The time delay on the prime mover cooldown period and shutdown shall be recorded.

Site Testing Expectations

Sound Performance

- Testing of the complete assembled product as it is installed on site accounting for all site variables.
- May be mandated by local AHJ.

Engine Emissions

- Consult equipment manufacturer for testing and analysis recommendations.
- May be mandated by local environmental quality / air board.

Third-Party System Verification

- May be included on complex projects to validate system and subsystem functionality.
- Make vendors aware of testing requirements.

Maintenance Testing Overview

Maintenance testing…

- Addresses common failure modes of both a component and the complete power system through routine inspection and service.
- Relies on site testing to establish baseline performance criteria.
- Establishes baseline performance criteria for subsequent site testing.
- Relies on qualified technicians to conduct the work adequately.
- Is one part of product lifecycle testing critical to component and power system reliability.

Product Testing Process

Concept Check

Factory testing validates the _____ of the generator set while site testing validates the generator set's ability to operate _____.

a) Installation, as configured
b) Assembled configuration, as installed
c) Prototype, when maintained properly
d) Performance, in an emergency

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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

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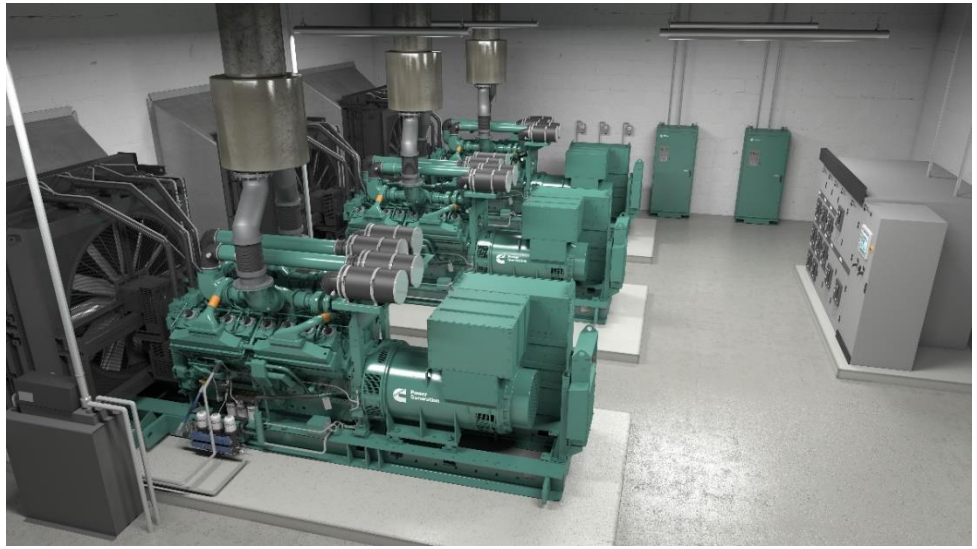
Recommendation Require equipment vendors to provide electronic or hard-copies of owner/operator manuals which include anticipated service intervals.

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.



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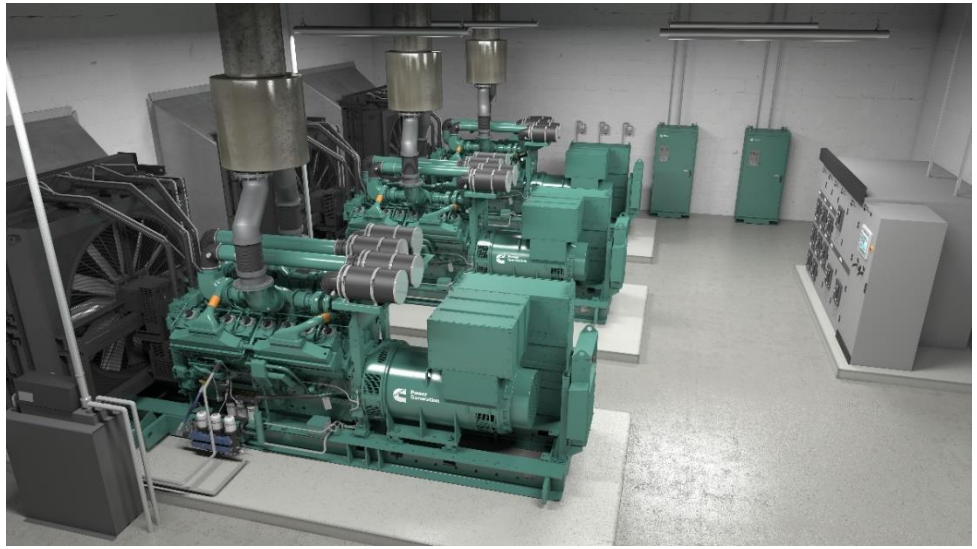

Recommendation Require equipment vendors to maintain an inventory of replacement parts and employ manufacturer trained service engineers capable of servicing the emergency equipment.

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.

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

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Fuel Quality Testing

Diesel fuel quality critical to equipment operation.

- Typical stable lifespan of diesel is 12 – 16 months in ideal conditions. (most EPSS installations are NOT in ideal conditions)
- Diesel sulfur content reduction (ULSD) limits fuel's anti-microbial properties.
- Bio-diesel blending may reduce fuel stability (up to 6 months), promotes water absorption and biomass growth.

Recommendation Test fuel quality at least annually. Consult equipment vendor to verify biodiesel fuel compatibility and fuel quality standards.

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TIA

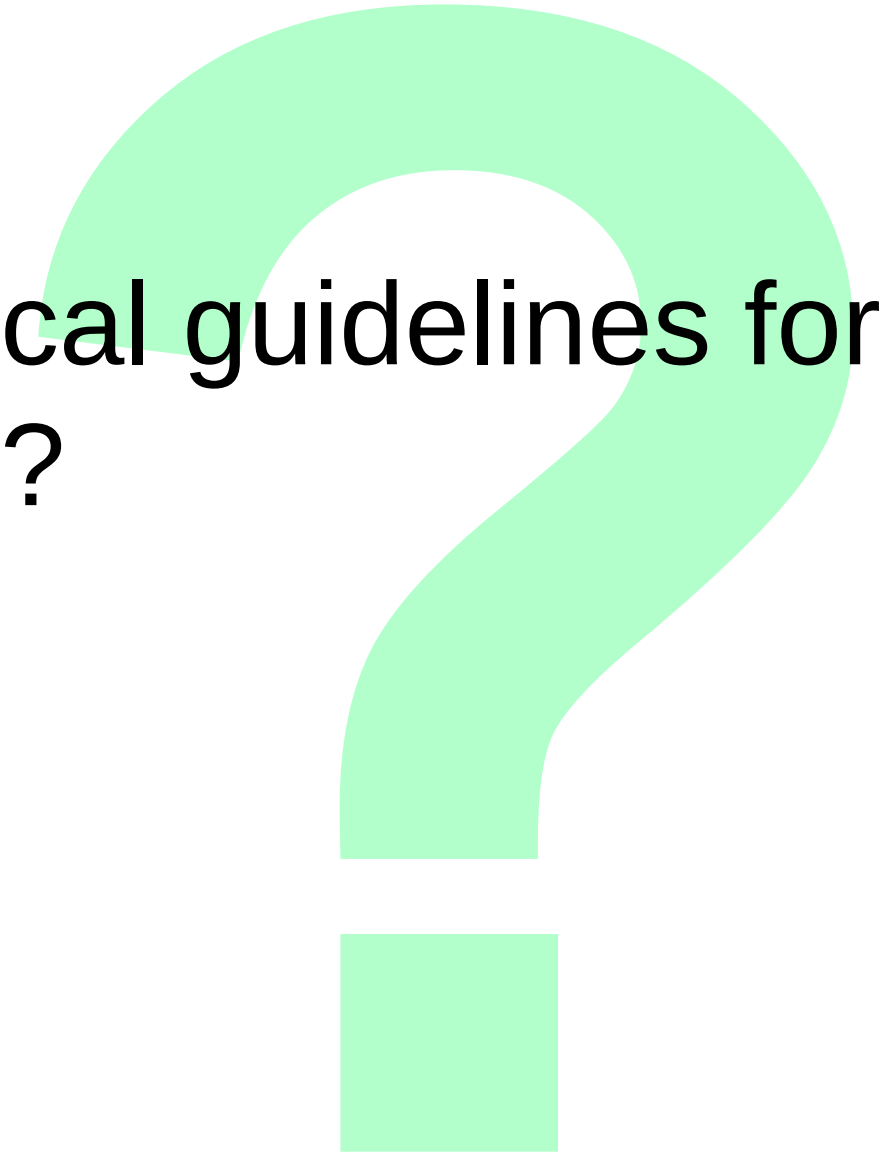
8.3.7.1 Diesel fuel maintenance and testing shall begin the day of installation and first fill in order to establish a benchmark for future comparison.

8.3.7.1.1 Diesel fuel shall be tested for degradation no less than twice annually with a minimum of 6 months between testing.

8.3.7.1.2 All testing shall be performed using ASTM-approved test methods and meet engine manufacturer's requirements.

8.3.7.1.3 Fuel testing shall be performed on all diesel fuel sources of EPSS.

What are typical guidelines for exercising a generator set?



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.

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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.

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EPS Low Load Operation

Minimize EPS operation below 30% load to mitigate adverse maintenance interval impact.

- “Wet stacking” may deposit unburnt fuel into engine exhaust system.
- Low combustion temperature may increase soot formation and aftertreatment “fouling”.

Consult EPS manufacturer or equipment manual for low load operation limitations.

Transfer Switch Operational Testing

8.4.6 Transfer switches shall be operated monthly.

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Recommendation 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.

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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.

Recommendation Specify a permanent load bank to the system to allow for proper loading during weekly testing

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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.

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Per NFPA 110 8.1.1, the routine maintenance and operational testing program shall be based on which of the following:

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e) All of the above

Maintenance Record Requirements

8.3.3 A written schedule for routine maintenance and operational testing of the EPSS shall be established.

8.5.1 Records shall be created and maintained for all EPSS inspections, operational tests, exercising, repairs and modifications.

8.5.2 Records required in 8.5.1 shall be made available to the authority having jurisdiction on request.

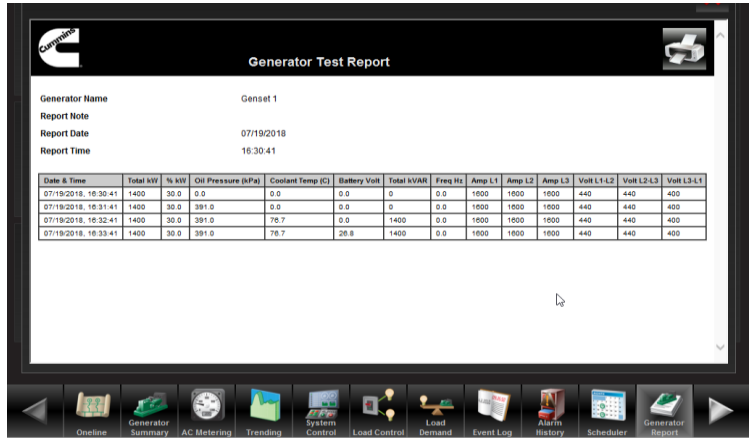
8.5.3 The permanent record shall include the following:

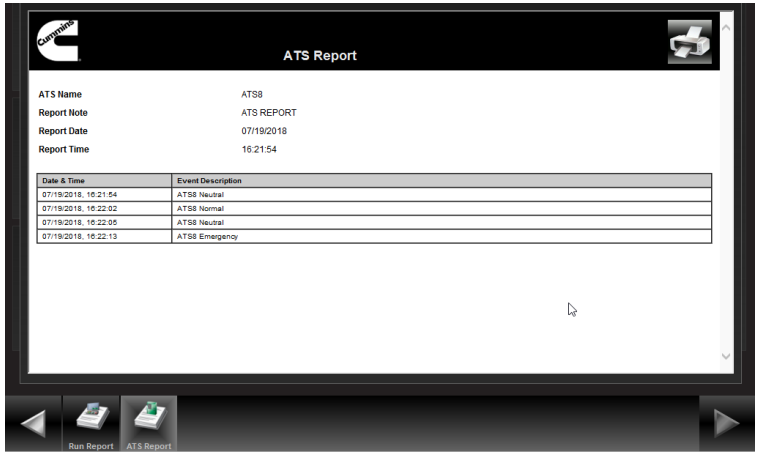
(1) The date of the maintenance report

(2) Identification of the servicing personnel

(3) Notation of any unsatisfactory condition and the corrective action taken, including parts replaced

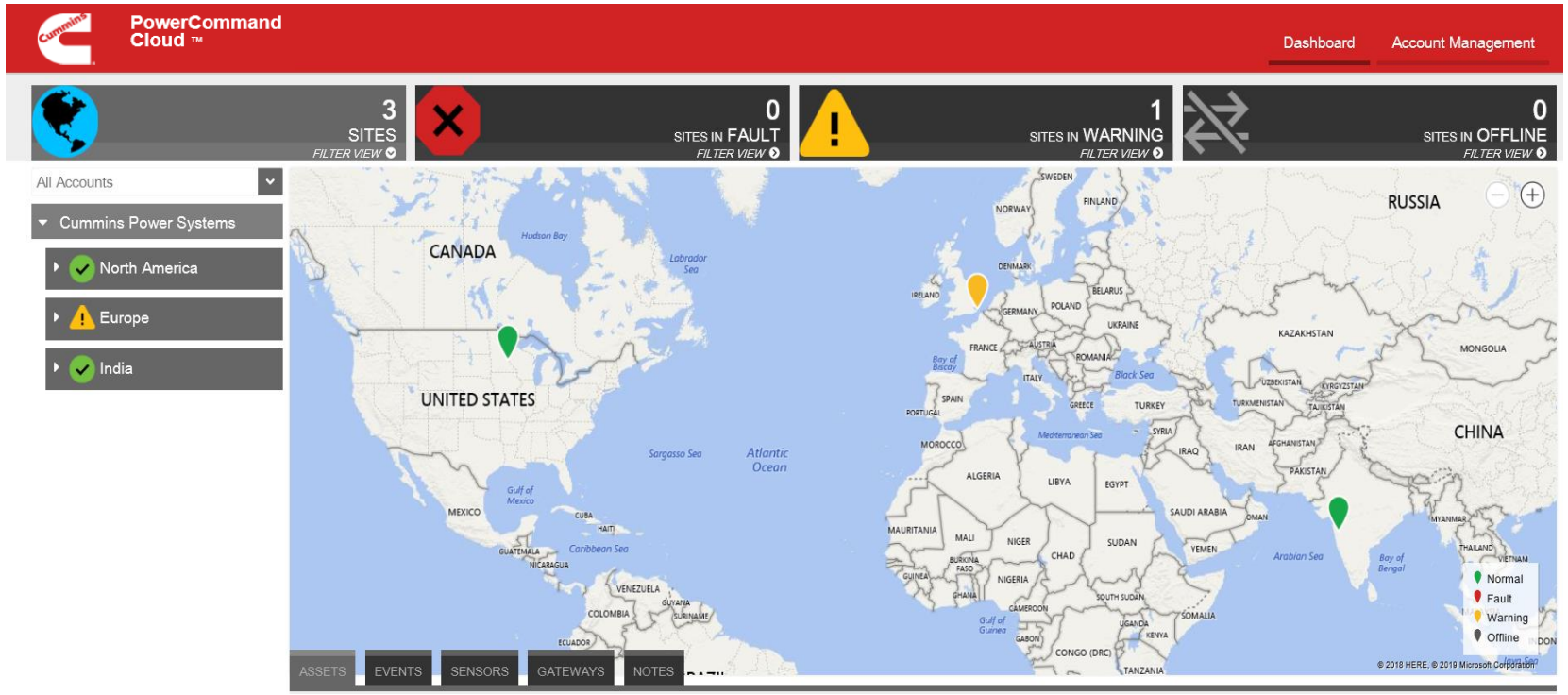
(4) Testing of any repair for the time as recommended by the manufacturer





Equipment Remote Monitoring

Single point visibility to assets and site performance anytime anywhere.



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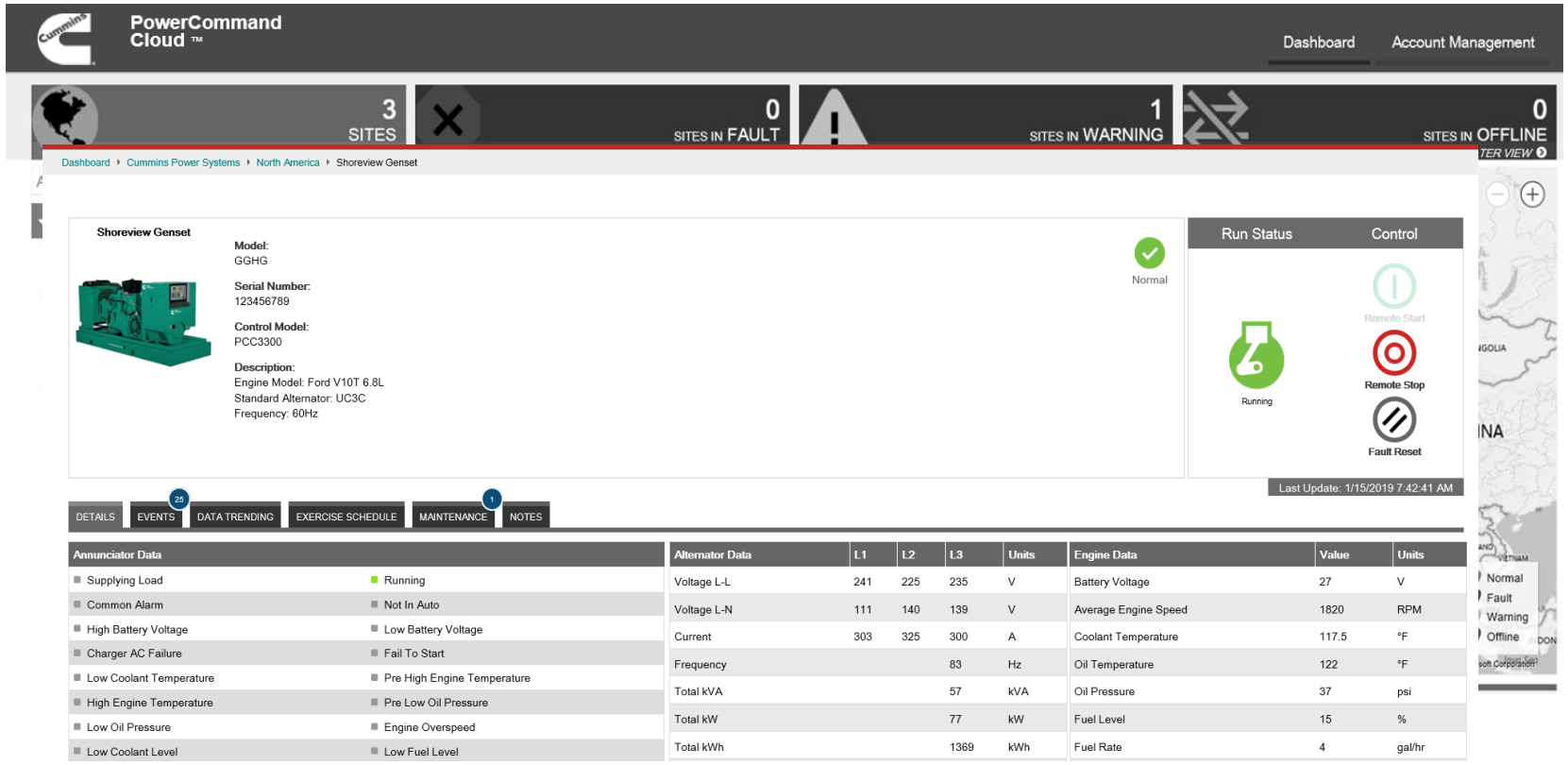

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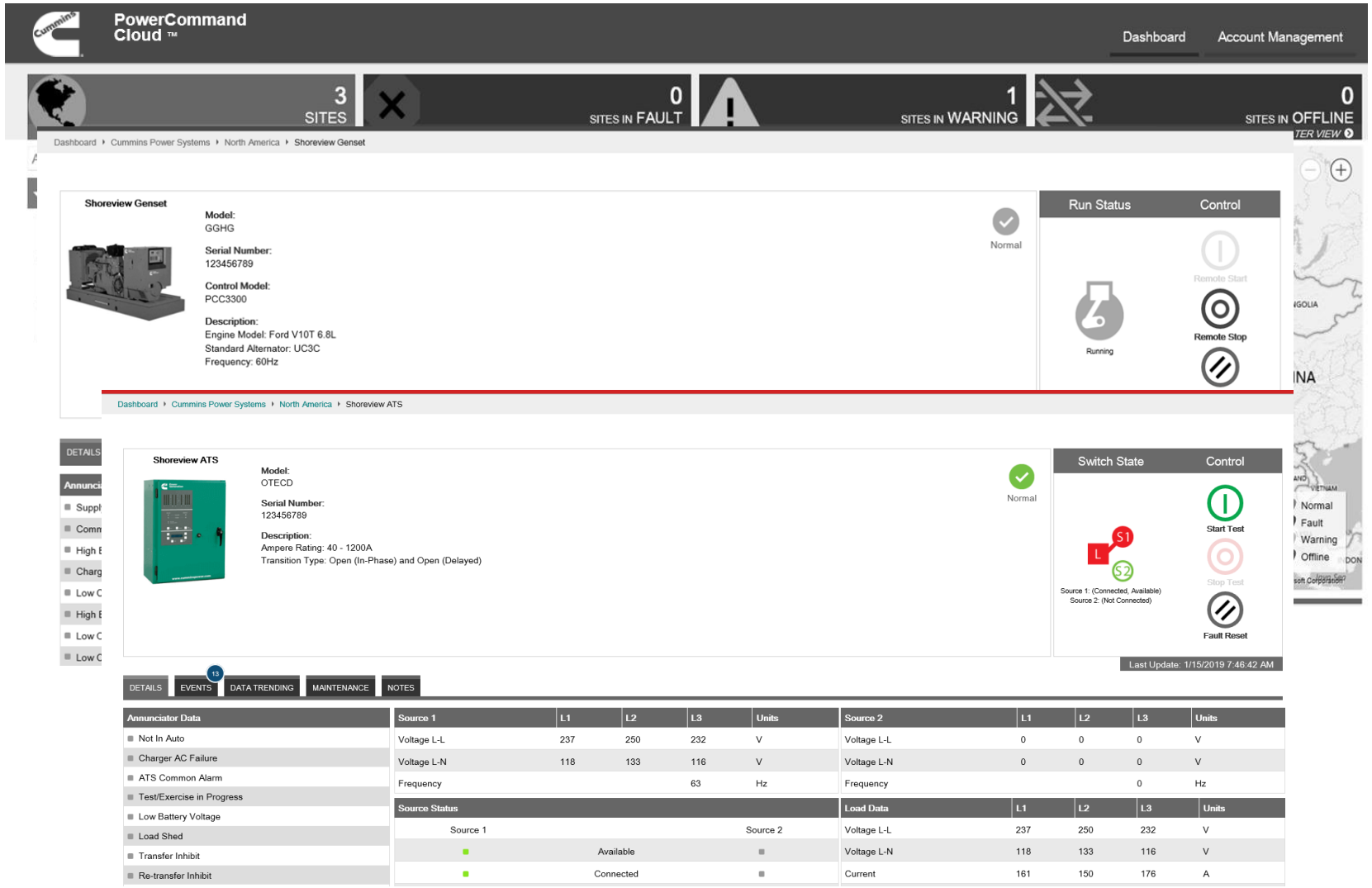
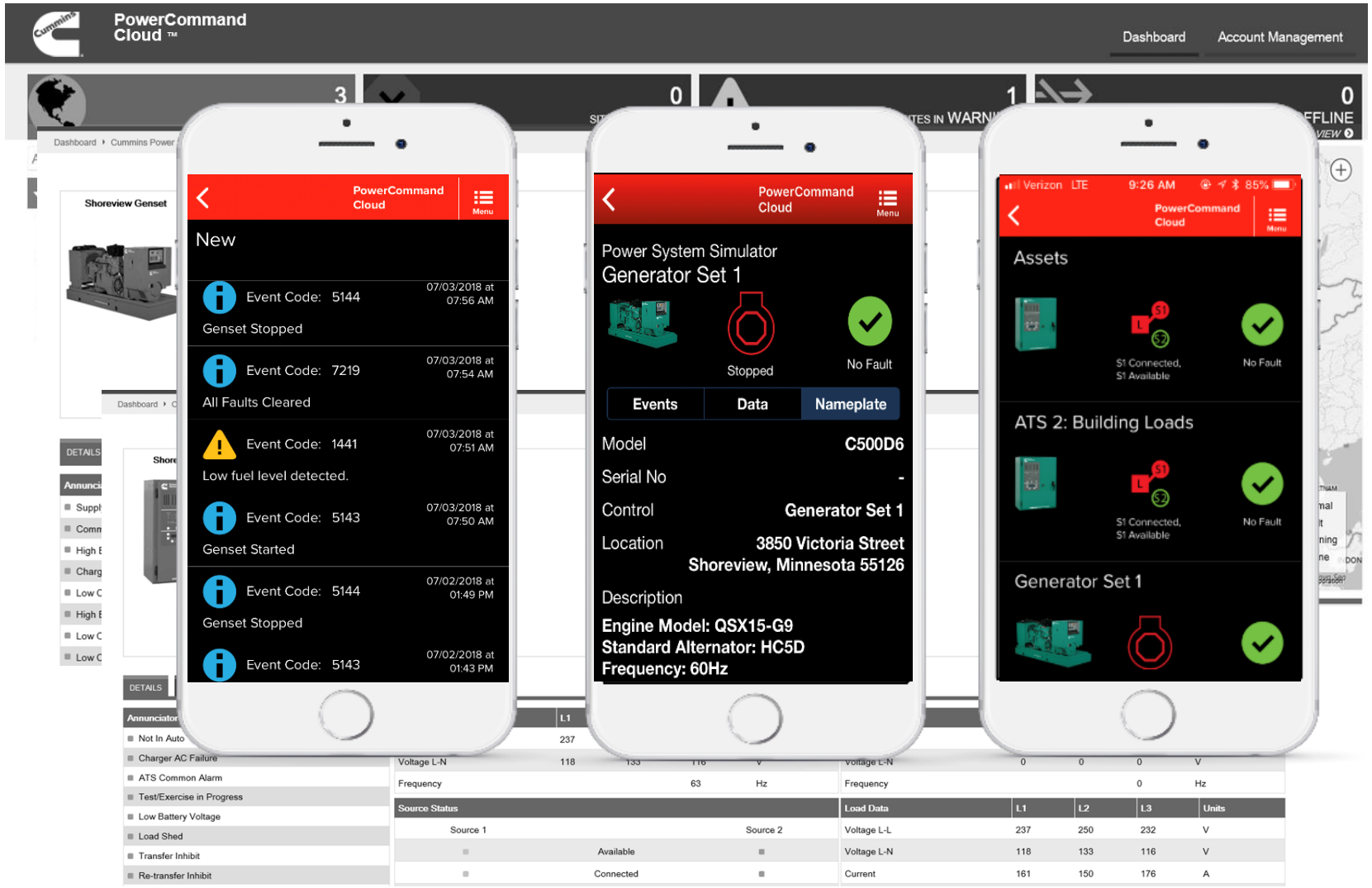


Equipment Remote Monitoring

Single point visibility to assets and site performance anytime anywhere.

Immediate notification of any critical or non-critical issues through automated emails and push notifications.

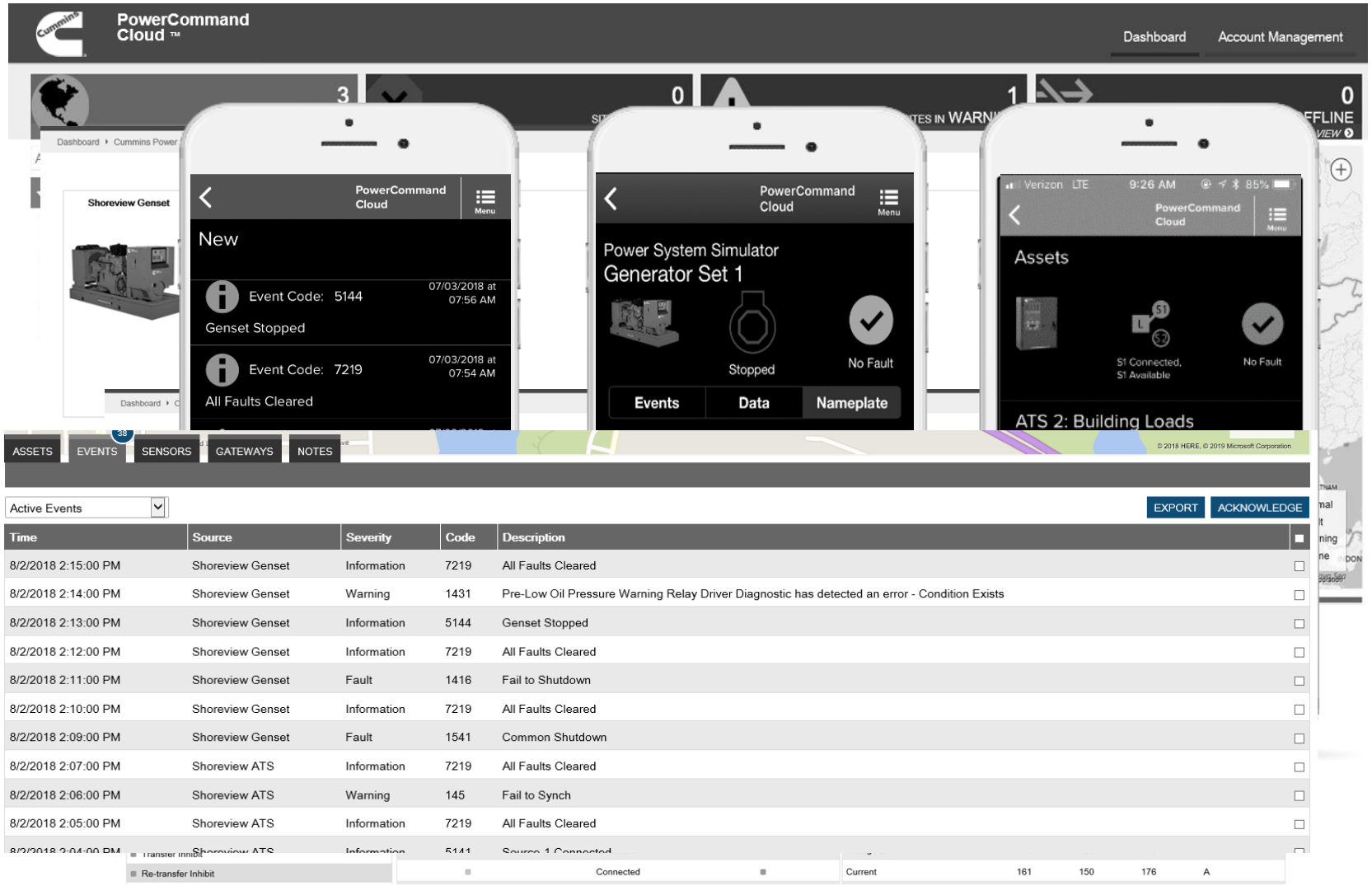


Equipment Remote Monitoring

Single point visibility to assets and site performance anytime anywhere.

Immediate notification of any critical or non-critical issues through automated emails and push notifications.

Access to historical performance data to any asset through reports and trending.



When evaluating standby system testing plans, ask yourself…

- What testing has been conducted on a prototype product that may not need to be replicated once the product has been installed?
- Is the manufacturer able to successfully demonstrate product performance through prototype and factory testing?
- What tests need to be conducted on site to verify product and system performance?
- What tests need to be incorporated into the power system maintenance program once the system has been commissioned?
- Are the code compliance requirements and manufacturer recommendations for all components understood and accounted for in the power system test plan?

Course Summary

NFPA 110 Testing and Service Requirements For Standby Power Systems

Standby power systems testing, and service is critical to the reliability of the system. This course will walk participants through site acceptance and in-service testing and will review best practices that will empower facility owners and managers to administer appropriate test strategies and service programs to maintain a reliable power system. This course will also look at common specification standards such as NFPA 110 that provide product testing and service guidelines while also addressing potential pitfalls.

After completing this course, participants will be able to:

- Describe generator set testing and service guidelines and best practices.
- Identify commonly adopted test standards such as NFPA 110 and their relevance to on-site testing best practices.
- Recognize the power system reliability benefits associated with a complete testing and service strategy.
- Describe advancements in technology that impact power system testing and service strategies.

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

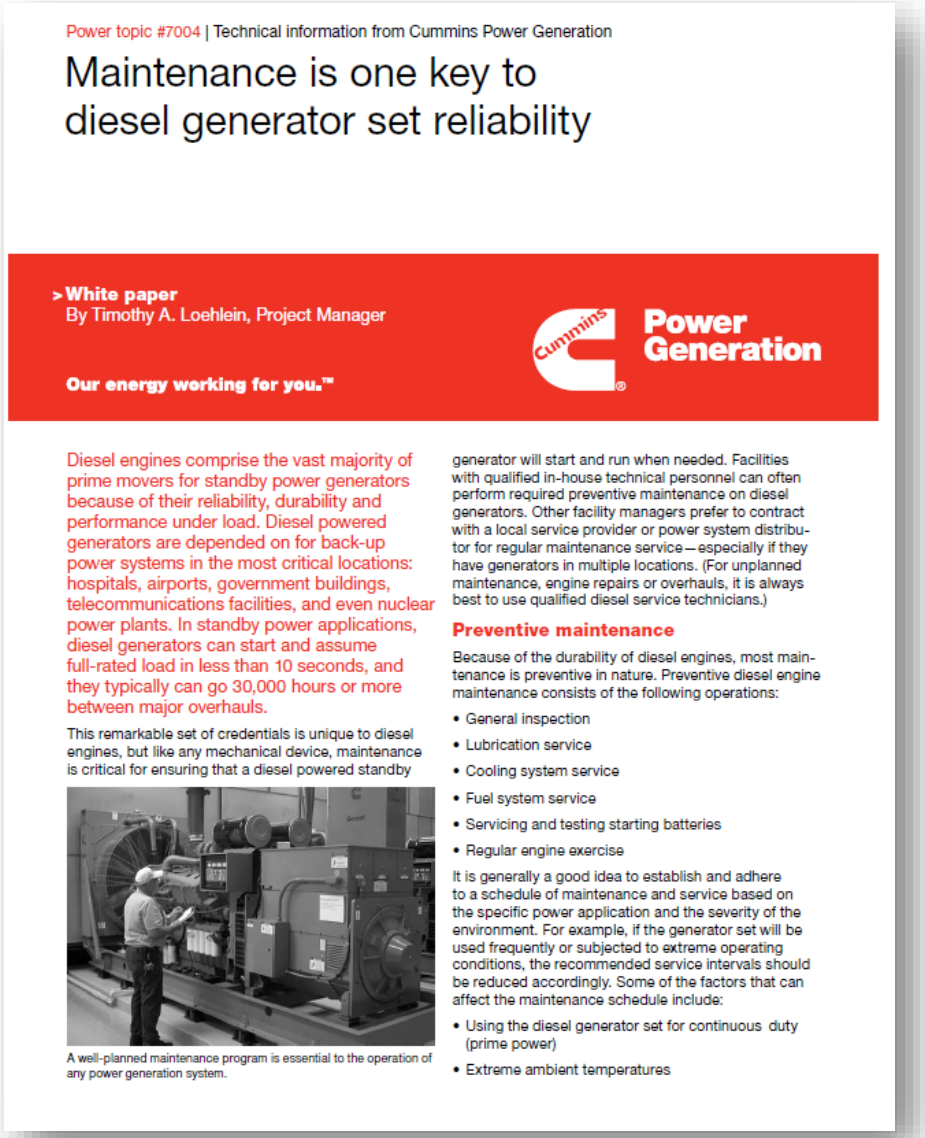
Design for safety and reliability-appropriate connection provisions for generator sets

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.

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Please complete the brief survey after exiting the webinar!

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Closing

Watch out for a follow-up email including:

- A link to the webinar recording and copy of the presentation
- A certificate issuing one professional development hour (1 PDH)

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Upcoming PowerHour Webinars:

January: Specifying Power System Equipment for Water and Water Facilities

February: Specifying Gaseous Generator Sets for Life Safety Applications

Please contact Michael Sanford if you have any questions related to the PowerHour webinar (michael.sanford@cummins.com)


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