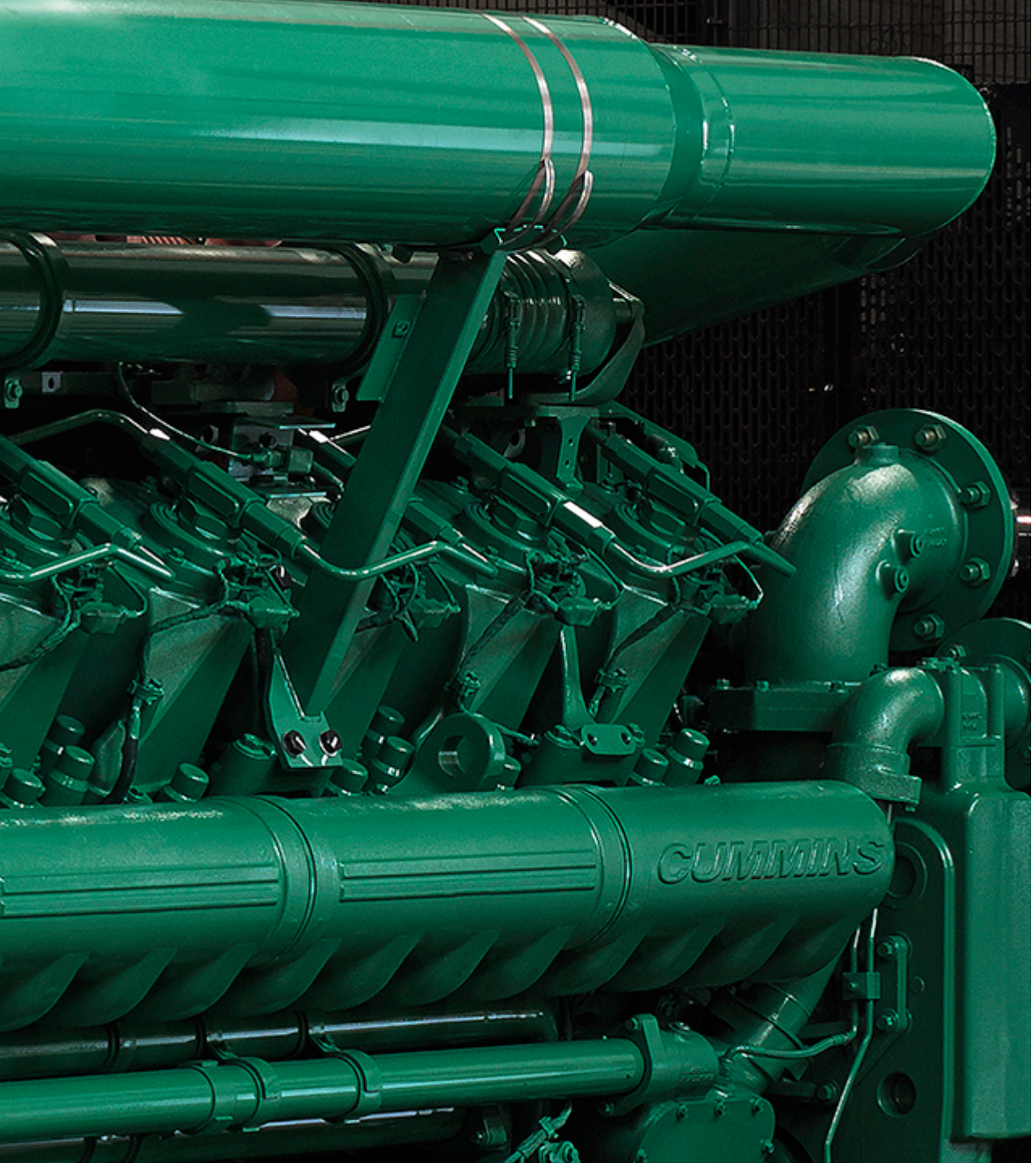

NFPA 110 Type 10 Requirements for Emergency Power Systems

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February 26, 2019 11:00 PDT / 13:00 CDT

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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 Type 10 Requirements for Emergency Power Systems

The 10-second start has been a point of pride for quality generator set manufacturers for many years. The capability of an emergency power system to deliver acceptable power within 10 seconds of an outage has made engine-based generator sets the standby power system of choice for healthcare and many other critical power facilities. However, there has been some confusion in the industry regarding those critical 10 seconds and methods of demonstrating compliance. This course will dive in to NFPA 110's Type 10 requirement and will examine the aspects that enable a power system to successfully meet the intent of the code and the impact this requirement may have on the way generator set and power systems are specified and designed.

After completing this course, participants will be able to:

- Recognize NFPA 110 classifications of emergency and standby power systems.
- Identify key aspects and intent of NFPA 110 that impact equipment selection and design of generator set emergency power systems.
- Describe various strategies for ensuring generator set and system performance as they relate to NFPA 110 Type 10 guidelines.

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.

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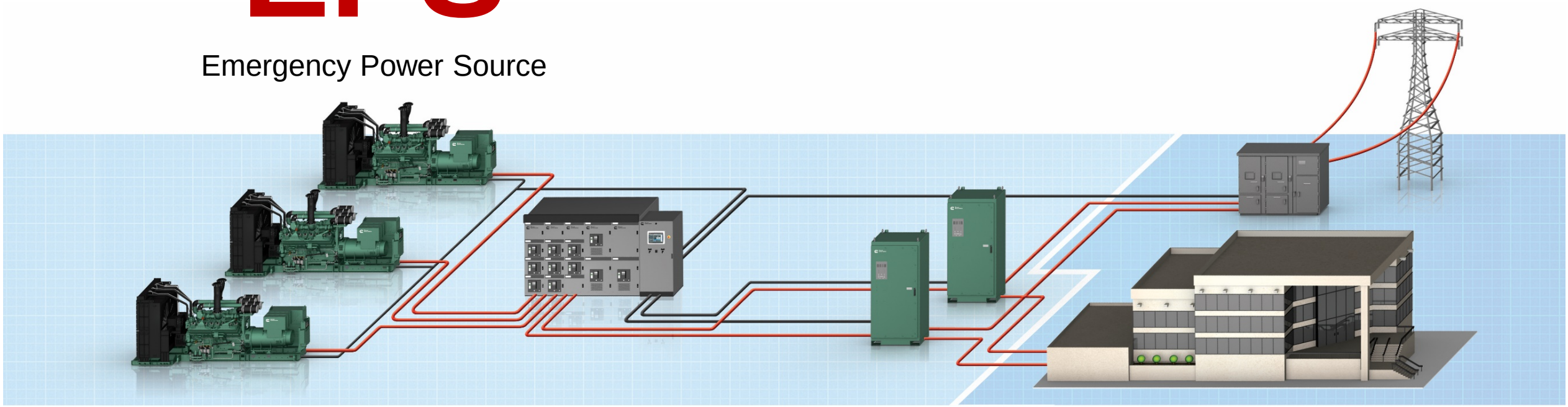
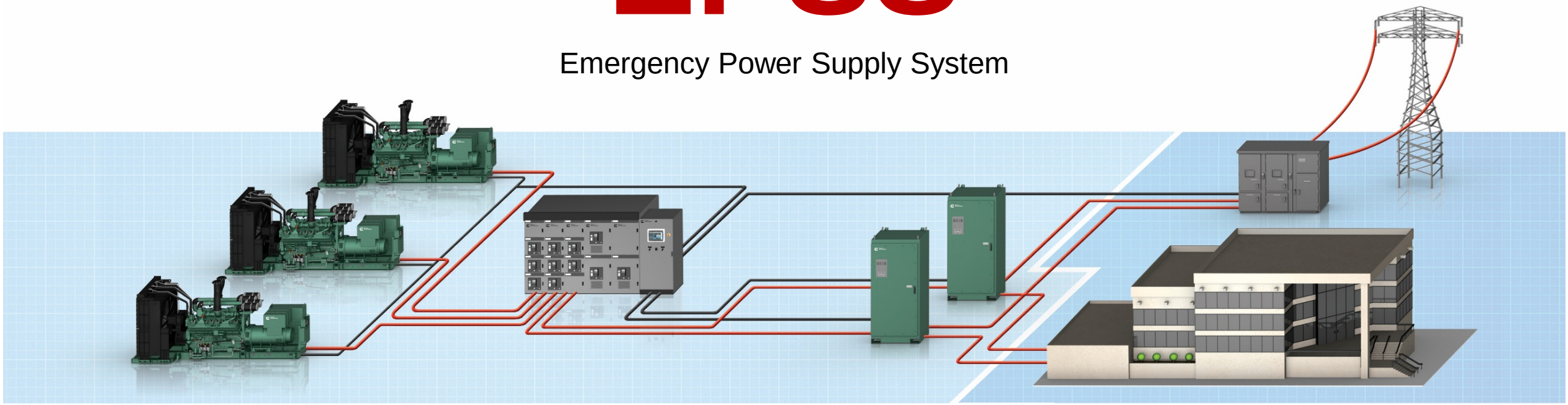
EPS

Emergency Power Source



EPSS

Emergency Power Supply System



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.

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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

NFPA 110 Overview

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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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Concept Check

NFPA 110 defines “Type” as …

a) Minimum time, in hours, for which the EPSS is designed to operate at its rated load without being refueled or recharged.

b) Maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable power.

c) Redundancy level, number of emergency power sources, that the EPSS will include.

d) Prototype testing requirements for emergency power source vendors.

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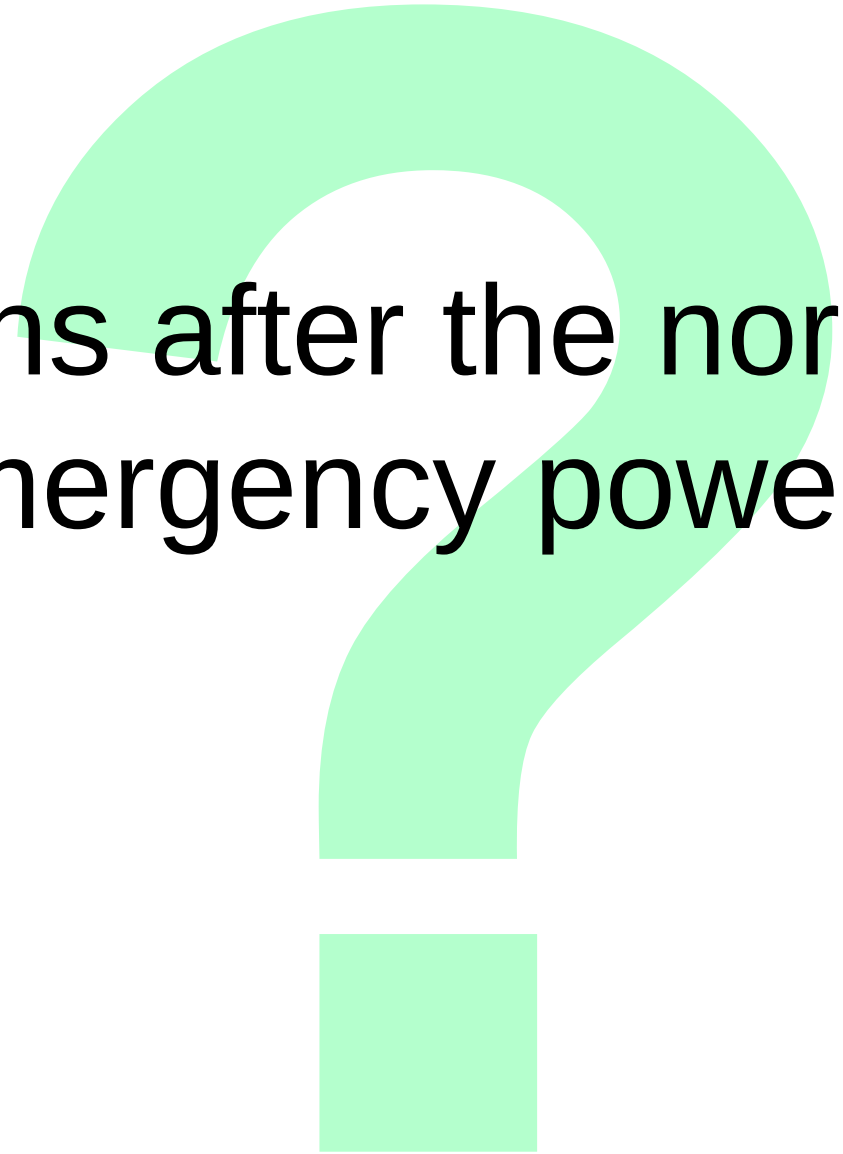
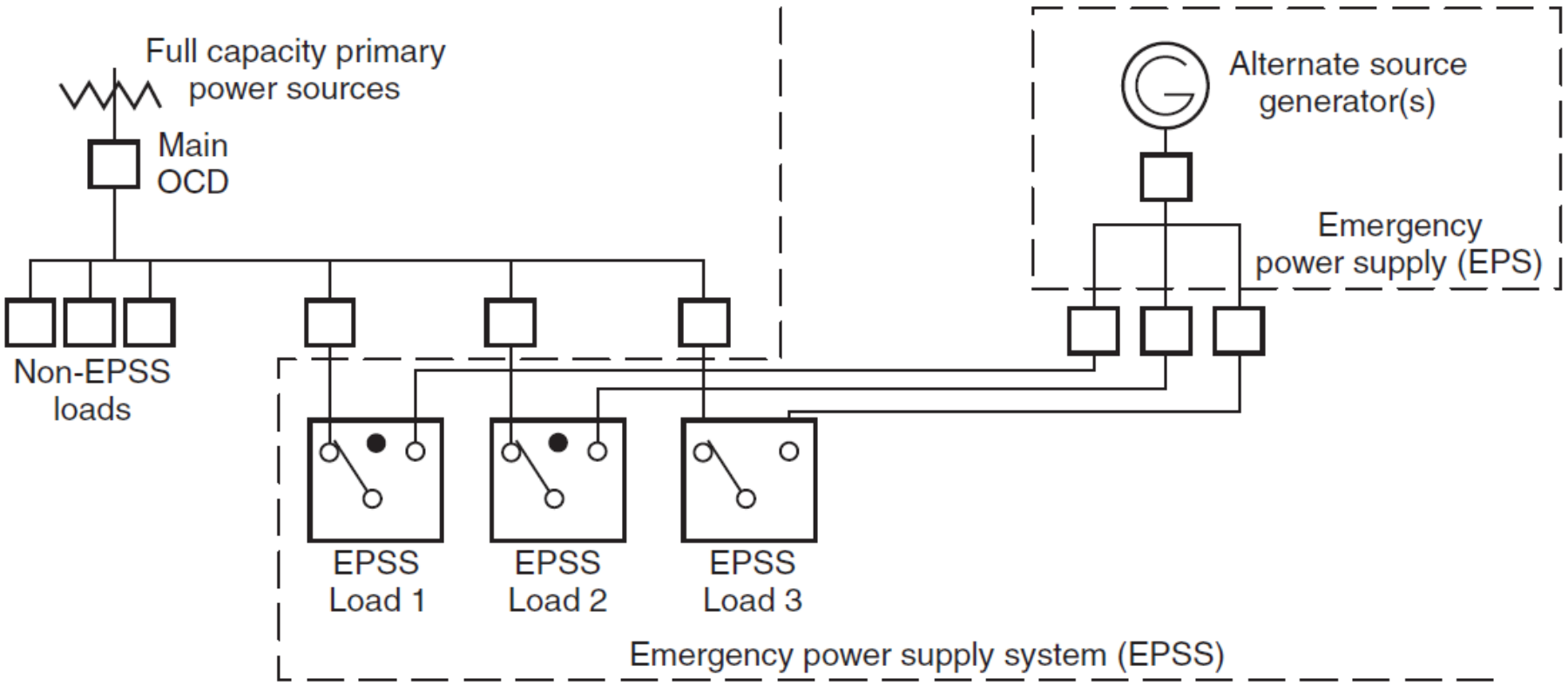
d) Prototype testing requirements for emergency power source vendors.

What happens after the normal source fails in an emergency power system?



Single Generator Set EPSS



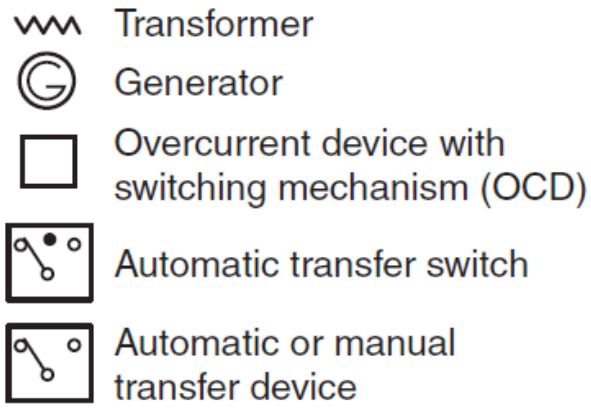


FIGURE B.1(a) Typical Rotating Emergency Power Supply System.

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

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Up to 1 second based on application

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Up to 8.5 seconds based on generator set configuration

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Up to 1 second based on application

Up to 8.5 seconds based on generator set configuration

Up to 0.5 seconds based on transfer switch and application

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10 Seconds

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10 Seconds

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.

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Spec Note Require vendors to include programmable delay options for both utility reclosers and motor starting (delayed transition).

NFPA 110 Overview

Generator Set Subsystems

Temperature Maintenance and Cooling Systems

Batteries, Starting and Charging Systems

Fuel Storage and Delivery Systems

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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	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.

NFPA 110 – Generator Set Subsystems

Prime Mover Starting Equipment

5.6.4.6 Automatic Battery Charger. In addition to the prime mover- (engine-) driven charger required in 5.6.3.6.1, a battery charger(s), as required in Table 5.6.4.2, shall be supplied for maintaining a charge on both the starting and control battery unit.

NFPA 110 – Generator Set Subsystems

Prime Mover Starting Equipment

5.6.4.7 All chargers shall include the following characteristics, which are to be accomplished without manual intervention (i.e., manual switch or manual tap changing):

(1) At its rated voltage, the charger shall be capable of delivering energy into a fully discharged battery unit without damaging the battery.

(2) The charger shall be capable of returning the fully discharged battery to 100 percent of its ampere-hour rating within the time specified in Table 5.6.4.2, item (f).

(3) As specified in Table 5.6.4.2, item (e), meters with an accuracy within 5 percent of range shall be furnished.

(4) The charger shall be permanently marked with the following:

- (a) Allowable range of battery unit capacity that can be recharged within the time requirements of Table 5.6.4.2
- (b) Nominal output current and voltage
- (c) Sufficient battery-type data to allow replacement batteries to be obtained

(5) The battery charger output and performance shall be compatible with the batteries furnished.

(6) Battery chargers used in Level 1 systems shall include temperature compensation for charge rate.

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

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 agreements that include fuel testing at least annually.

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 NOT 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.

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Spec Note Require vendors to indicate compliance with biodiesel blends up to B20 to ensure engine fuel system compatibility.

Concept Check

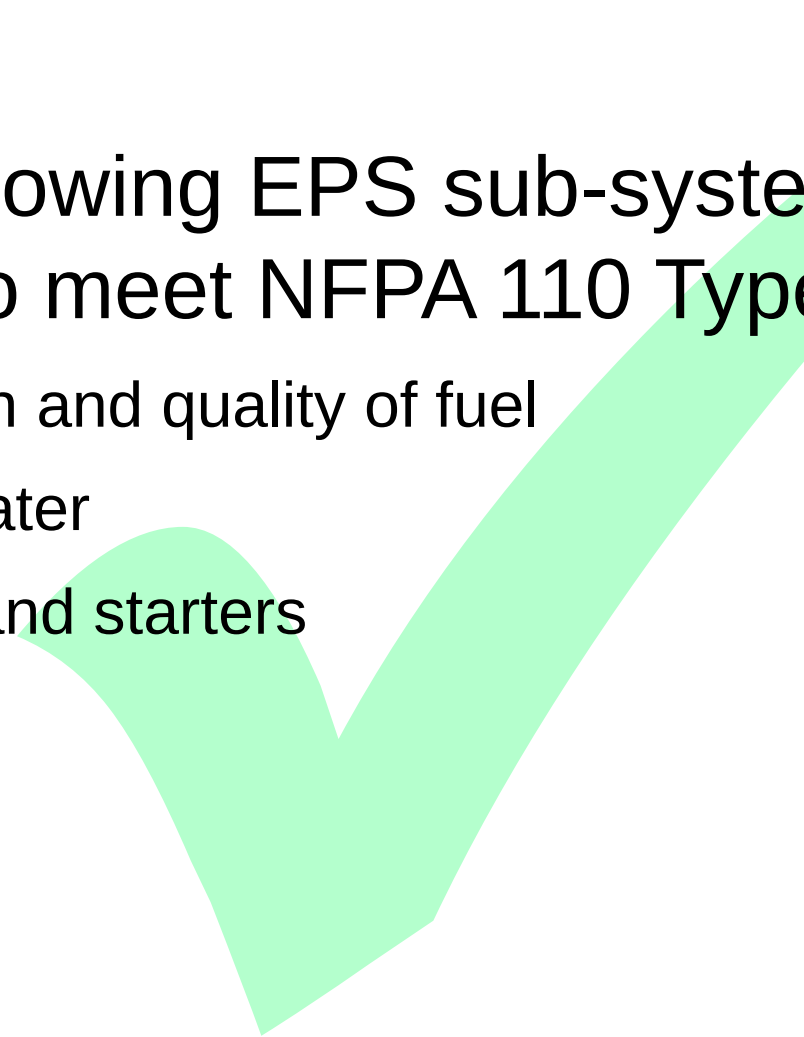
Which of the following EPS sub-systems may impact the EPSS's ability to meet NFPA 110 Type 10 requirements?

a) Fuel system design and quality of fuel

b) Engine coolant heater

c) Starting batteries and starters

d) All of the above



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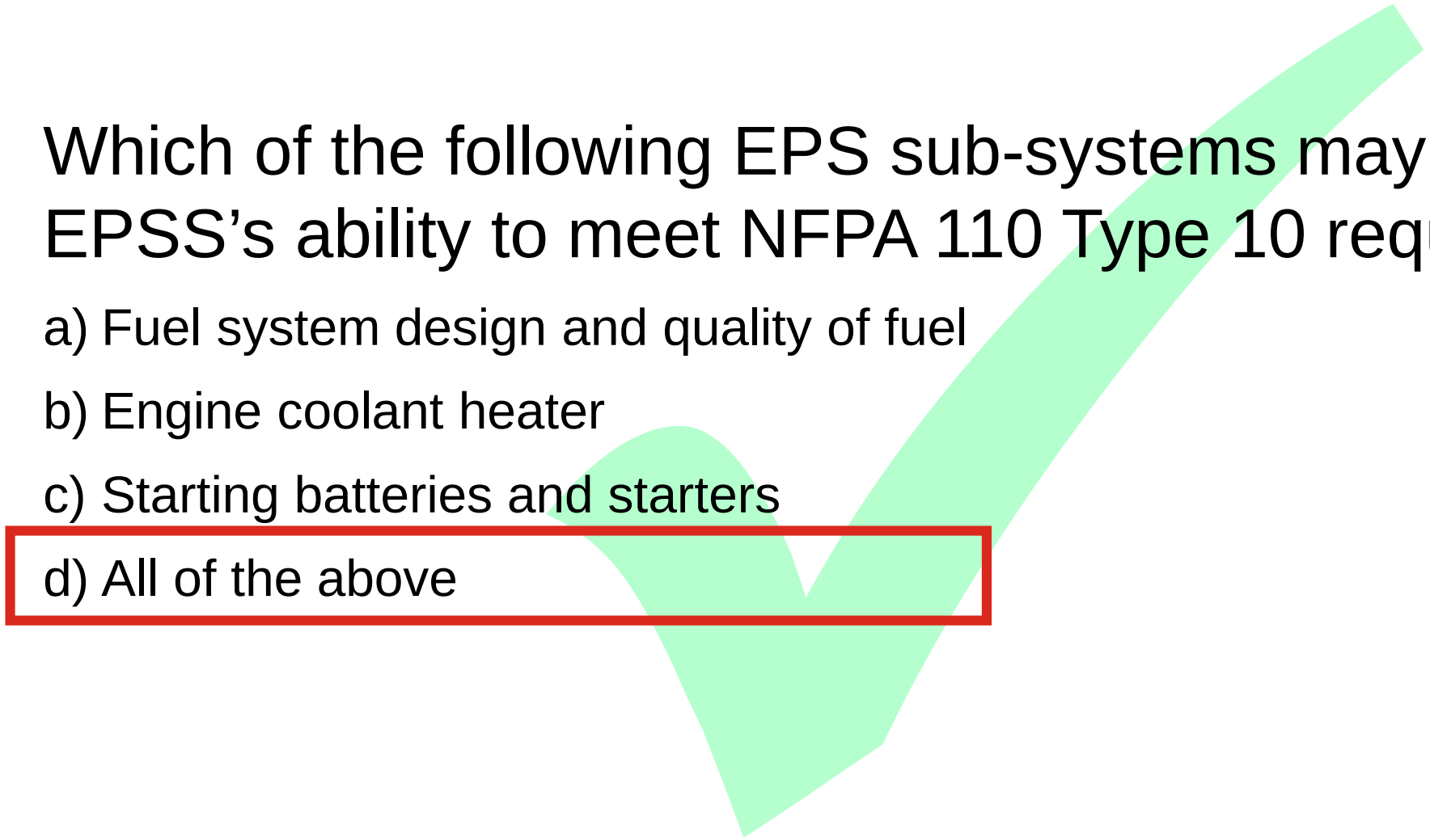
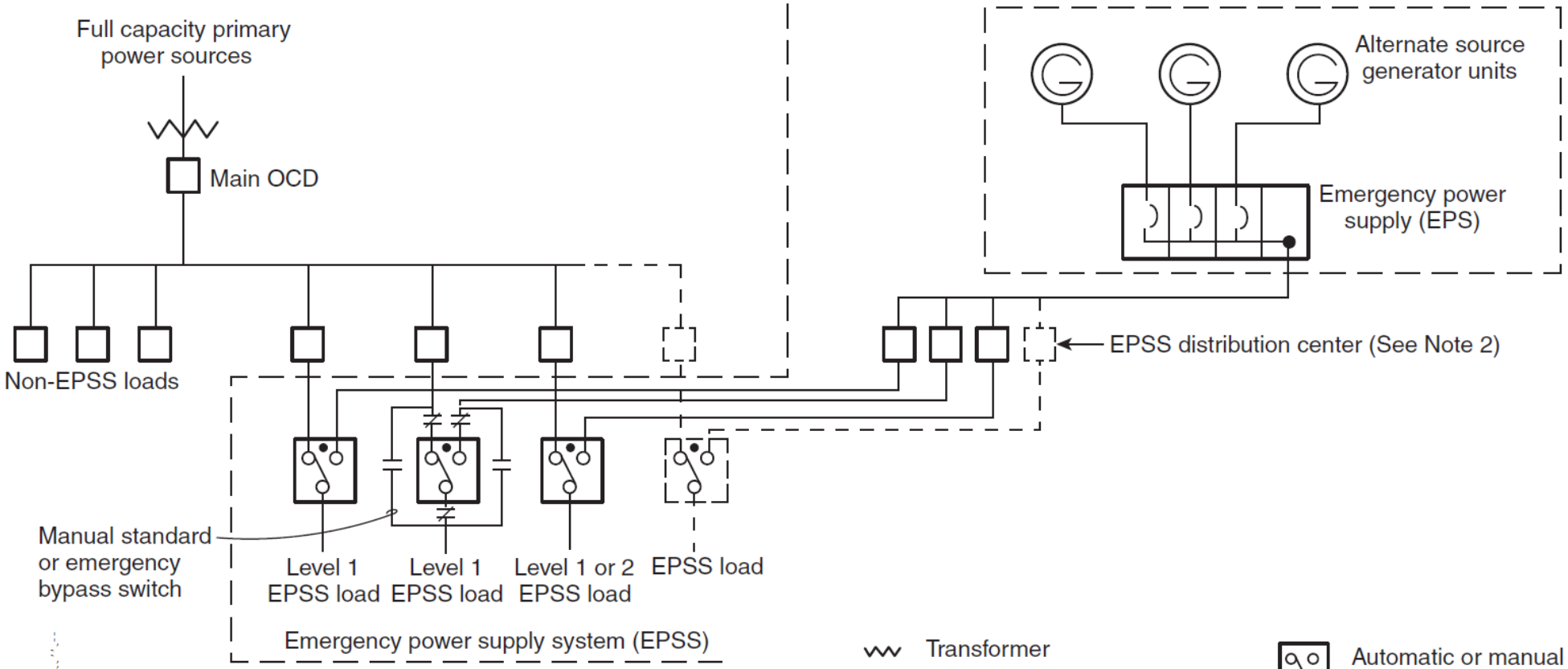


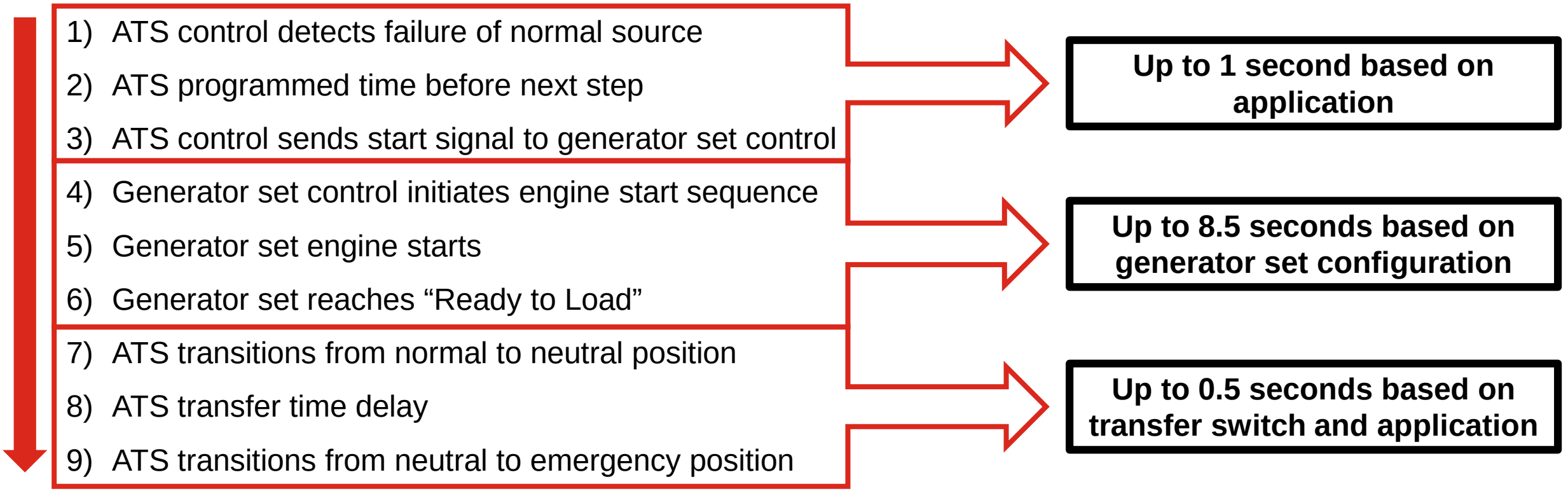
Paralleled Generator Set EPSS



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



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
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) 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

1) ATS control detects failure of normal source
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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

Up to 1 second based on 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
3) ATS control sends start signal to generator set control

Up to 1 second based on application

4) Generator set control initiates engine start sequence
5) Generator set engine starts
6) Generator set reaches “Ready to Load”

Up to 8.5 seconds based on generator set configuration

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

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

Up to 1 second based on application

4) Generator set control initiates engine start sequence
5) Generator set engine starts
6) Generator set reaches “Ready to Load”

Up to 8.5 seconds based on generator set configuration

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

Up to 1 second for first generator set
Up to 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
2) ATS programmed time before next step
3) ATS control sends start signal to generator set control

Up to 1 second based on application

4) Generator set control initiates engine start sequence
5) Generator set engine starts
6) Generator set reaches “Ready to Load”

Up to 8.5 seconds based on generator set configuration

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

Up to 1 second for first generator set
Up to 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

Up to 0.5 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
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) 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

10 Seconds

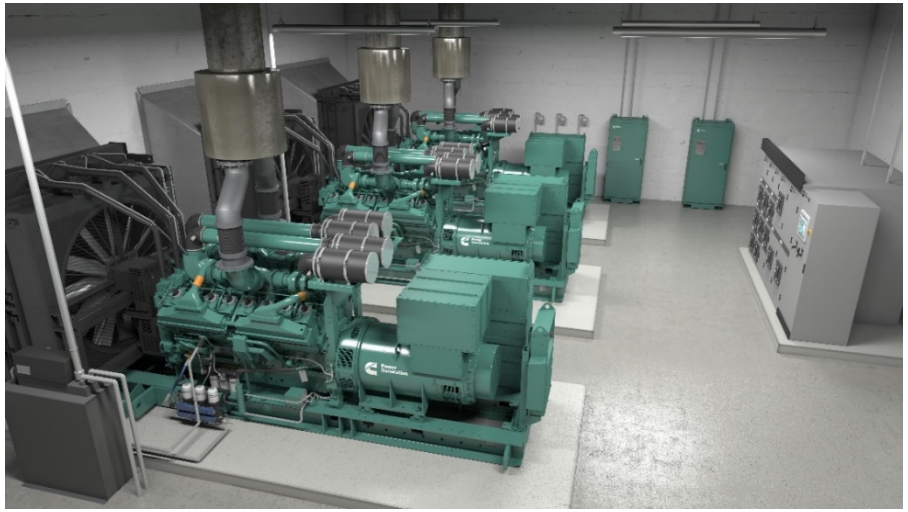
Spec Note The smallest generator set on the generator set paralleling bus shall have sufficient capacity to support all emergency loads.

EPSS Testing

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



8.4.6 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.

Considerations for NFPA 110 Level 1 Type Systems

- Is a single vendor providing all of the emergency power systems components or are components being provided by numerous vendors?
- Which vendors may need to be involved to validate NFPA 110 Level 1 Type 10 requirements are satisfied for the installation?
- How does sourcing the complete power system from a single vendor instead of multiple vendors impact EPSS performance accountability?
- Have the appropriate generator set and transfer switch sub-system requirements been included in the specification?

Additional Resources

Cummins White Papers

Maintenance is one key to diesel generator set reliability

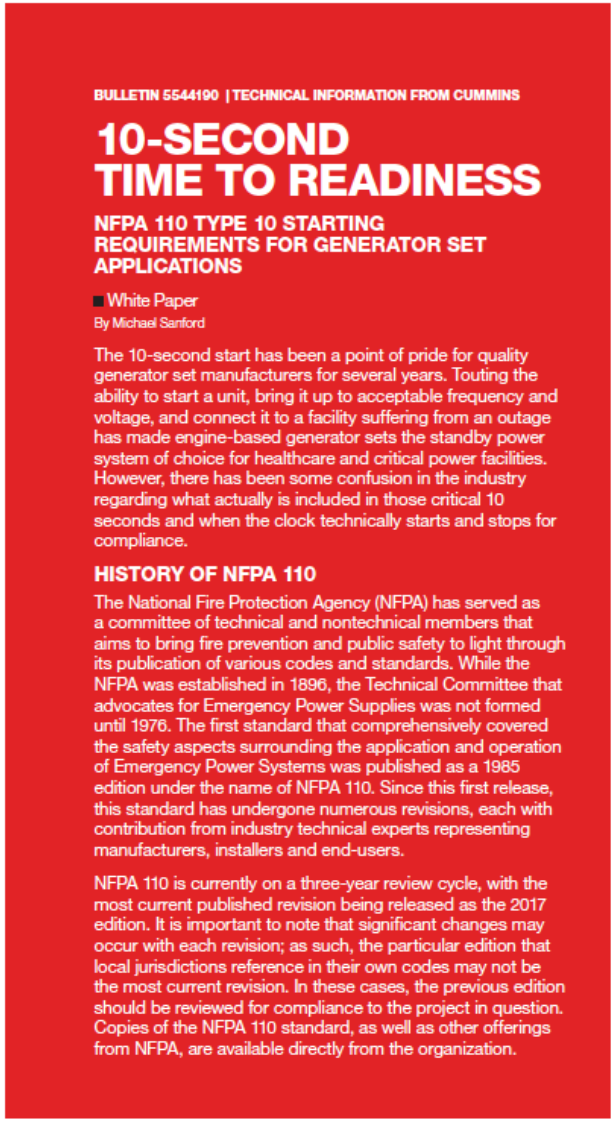
Rated power factor tests and installation acceptance of emergency and standby power systems

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

Cummins On-Demand Webinars

Testing Requirements of Emergency Power Supply Systems in Critical Healthcare Facility

Specifying Generator Set Testing for Reliable Power Systems



BULLETIN 5544190 | TECHNICAL INFORMATION FROM CUMMINS

10-SECOND TIME TO READINESS

NFPA 110 TYPE 10 STARTING REQUIREMENTS FOR GENERATOR SET APPLICATIONS

White Paper

By Michael Sanford

The 10-second start has been a point of pride for quality generator set manufacturers for several years. Touting the ability to start a unit, bring it up to acceptable frequency and voltage, and connect it to a facility suffering from an outage has made engine-based generator sets the standby power system of choice for healthcare and critical power facilities. However, there has been some confusion in the industry regarding what actually is included in those critical 10 seconds and when the clock technically starts and stops for compliance.

HISTORY OF NFPA 110

The National Fire Protection Agency (NFPA) has served as a committee of technical and nontechnical members that aims to bring fire prevention and public safety to light through its publication of various codes and standards. While the NFPA was established in 1896, the Technical Committee that advocates for Emergency Power Supplies was not formed until 1976. The first standard that comprehensively covered the safety aspects surrounding the application and operation of Emergency Power Systems was published as a 1985 edition under the name of NFPA 110. Since this first release, this standard has undergone numerous revisions, each with contribution from industry technical experts representing manufacturers, installers and end-users.

NFPA 110 is currently on a three-year review cycle, with the most current published revision being released as the 2017 edition. It is important to note that significant changes may occur with each revision; as such, the particular edition that local jurisdictions reference in their own codes may not be the most current revision. In these cases, the previous edition should be reviewed for compliance to the project in question. Copies of the NFPA 110 standard, as well as other offerings from NFPA, are available directly from the organization.

Course Summary

NFPA 110 Type 10 Requirements for Emergency Power Systems

- Recognize NFPA 110 classifications of emergency and standby power systems.
- Identify key aspects and intent of NFPA 110 that impact equipment selection and design of generator set emergency power systems.
- Describe various strategies for ensuring generator set and system performance as they relate to NFPA 110 Type 10 guidelines.

Specify:

- Type requirement as it pertains to the power system.
- The smallest generator set on the generator set paralleling bus shall have sufficient capacity to support all emergency loads.
- Site testing and maintenance practices that maintain system reliability such as fuel quality testing and battery check-ups.
- NFPA 110 prototype testing compliance and documentation of prototype testing.

Avoid specifying:

- NFPA 110 “certification” for generator sets or other components.

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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Upcoming PowerHour Webinars:

- March – NEC 2017 Updates (Generator Set Start Signal Integrity and Temporary Power Connection)
- April – Specifying Gaseous Generator Sets for Standby Applications


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