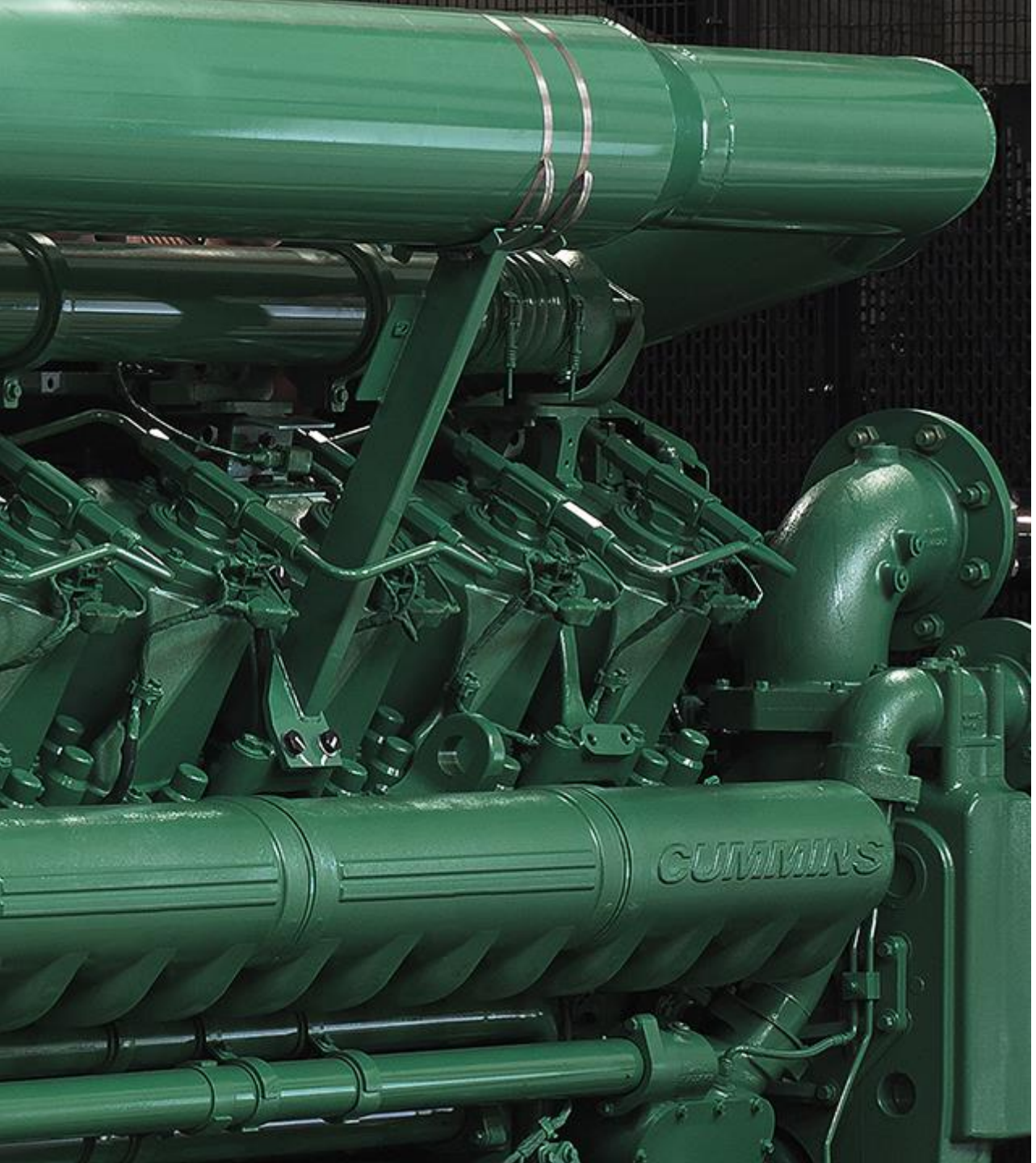

NEC 2017 Code Changes for Emergency Power Systems

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April 2nd 2019 11:00 PDT / 13:00 CDT

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Cummins presenter:

Rumman Kabir
Technical Marketing Specialist
Cummins Inc.

Cummins facilitator:

Tom Bakritzes,
Global Sales Training Manager
Cummins Inc.

Your local Cummins contacts:

- Western Canada: Ian Lindquist (ian.Lindquist@cummins.com), Western Canada Region
- Eastern Canada: Gianluca Ianiro (gianluca.ianiro@cummins.com), Eastern Canada Region
- AZ, ID, NM, NV: Carl Knapp (carl.knapp@cummins.com), Rocky Mountain Region
- CO, MT, ND, UT, WY: Chris Scott (chris.scott@cummins.com), Rocky Mountain Region
- Northern IL, IA: John Kilinskis (john.a.kilinskis@cummins.com), Central Region
- UP of MI, MN, East ND, WI: Michael Munson (michael.s.munson@cummins.com), Central Region
- NE, SD, West MO, KS: Earnest Glaser (earnest.a.glaser@cummins.com), Central Region
- South IL, East MO: Jeff Yates (jeffrey.yates@cummins.com), Central Region
- TX, OK, AR, LA, MS, AL, Western TN: Scott Thomas (m.scott.thomas@cummins.com), Gulf Region
- FL, GA, NC, SC, Eastern TN: Robert Kelly (robert.kelly@cummins.com), South Region
- NY, NJ, CT, PA, MD: Charles Attisani (charles.attisani@cummins.com), East Region
- CA, HI: Brian E Pumphrey (brian.pumphrey@cummins.com), Pacific Region
- WA, OR, AK: Tom Tomlinson (tom.tomlinson@cummins.com), Pacific Region
- For other states and territories, email powergenchannel@cummins.com or visit http://power.cummins.com/sales-service-locator

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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.

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Course Objectives

NEC 2017 ® Code Changes for Emergency Power Systems

The 2017 National Electric Code (NEC ®) introduced provisions that impact emergency power system design. The first provision impacts start signal requirements between the power transfer equipment (such as a transfer switch) and the emergency generator set controller; the provision requires fail safe operation of the generator set if the start signal wiring is compromised. The second provision address temporary power source connection requirements during the maintenance or repair of the emergency generator set. This course will take a deep dive into these two requirements including review of exceptions, NEC ® amendments, and solutions.

After completing this course, participants will be able to:

- Identify key NEC ® 2017 code changes and related Tentative Interim Amendment (TIA).
- Describe start signal integrity and temporary generator set connection requirements.
- Recognize compliant solutions for start signal integrity and temporary generator set connection provisions.

NFPA 70, National Electric Code (NEC)

History and Development of the *National Electrical Code* ®

The National Fire Protection Association has acted as sponsor of the *National Electrical Code* since 1911. The original Code document was developed in 1897 as a result of the united efforts of various insurance, electrical, architectural, and allied interests.

90.1 Purpose.

(A) Practical Safeguarding. The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.

(B) Adequacy. This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

NEC® in Effect

3/1/2019

2017 NEC® - 28
2014 NEC® - 15
2011 NEC® - 1
2008 NEC® - 3
County/Municipality NEC® regulation only - 3

- *The 2016 California Electrical Code, California Code of Regulations Title 24, Part 3 is based on the 2014 edition of NFPA 70®, National Electrical Code®.*
- *The 2011 New York City Electrical Code is based on the 2008 edition of NFPA 70®, National Electrical Code®.*

2017 NEC Updates

Generator Control Wiring
700.10(D)(3)

- Generator set must start on loss of integrity from Emergency and Fire Pump start circuits.

(3) **Generator Control Wiring.** Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator control wiring shall be continuously monitored. Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and start the generator(s).

Temporary Source of Power
700.3(F)

- Emergency system shall include a permanent means to connect to a temporary source of power

N (F) **Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power.** If the emergency system relies on a single alternate source of power, which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power shall comply with the following:

Concept Check

National Electric Code (NEC) requirements are considered necessary for which of the following

a) Maximizing efficiency of electrical systems

b) Convenience of implementation of electrical systems

c) Safeguarding of persons and property from electrical hazards

d) Ease of future expansion of electrical systems

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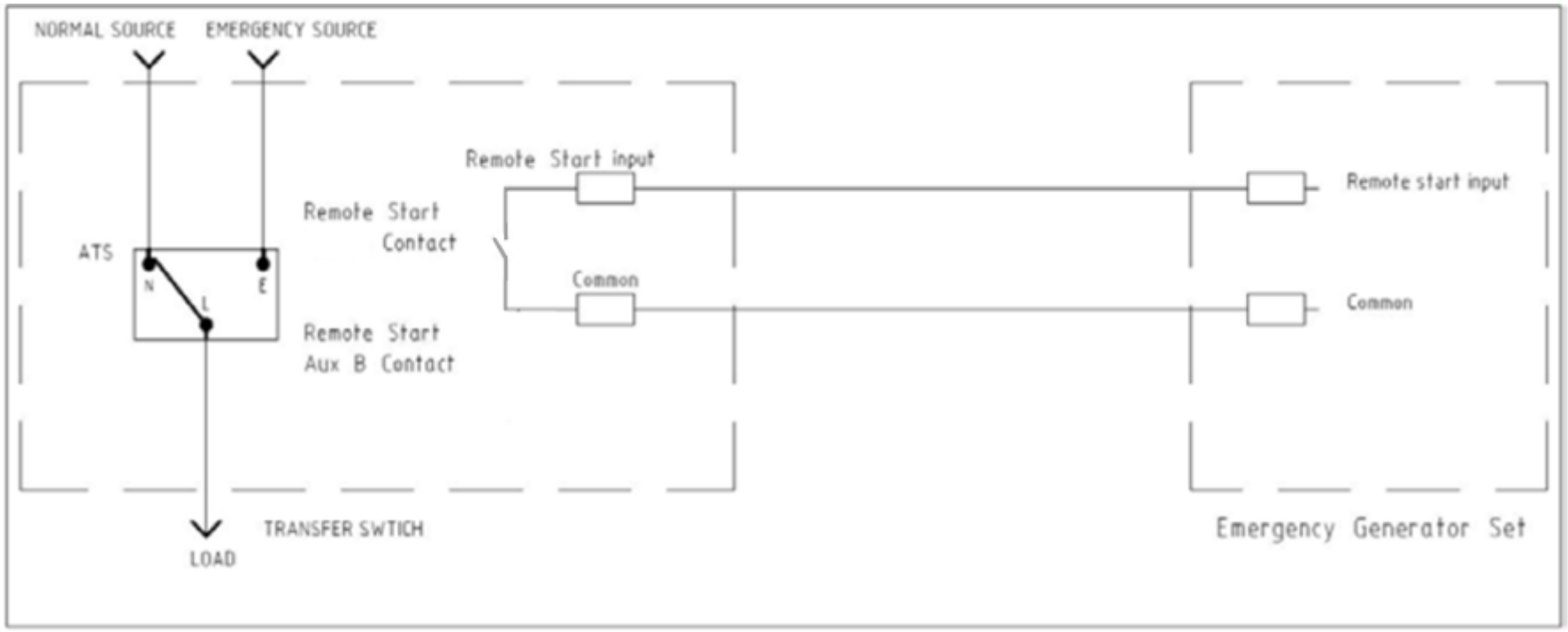
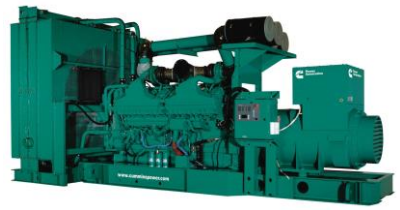
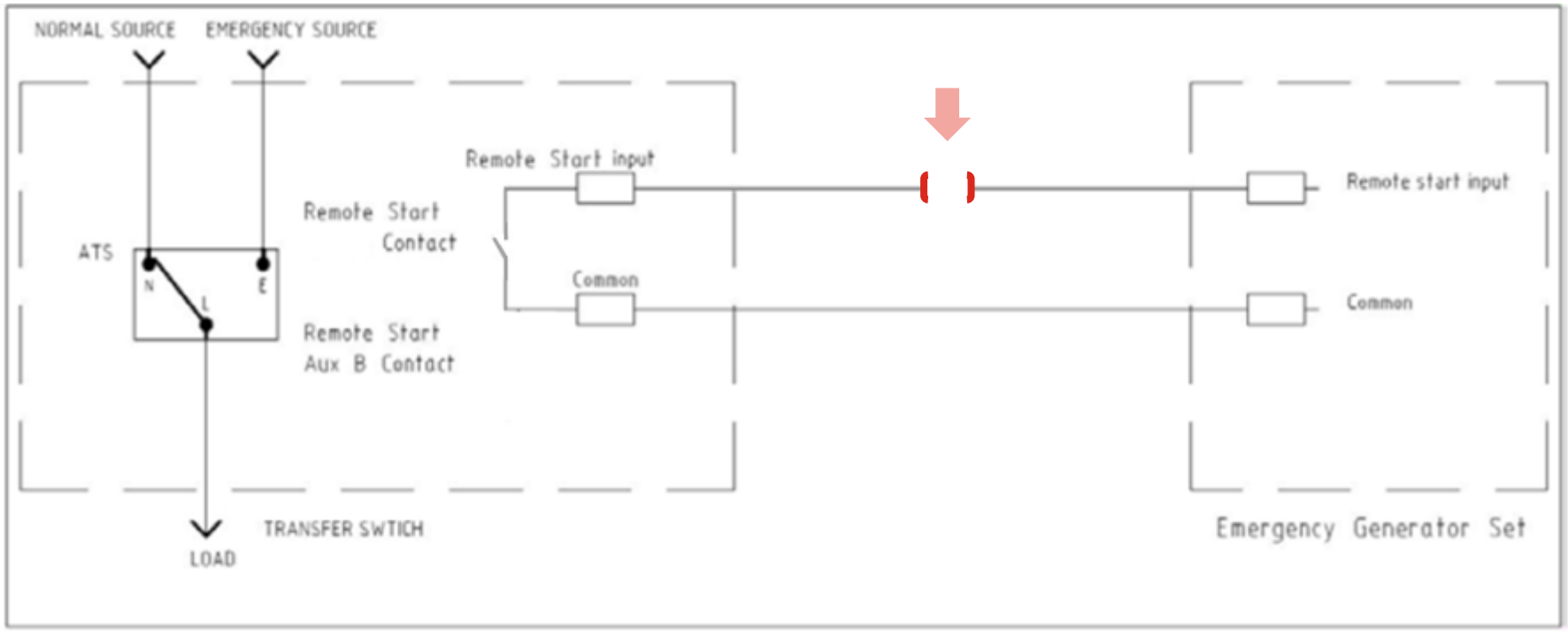
Traditional Generator Start Circuit (Normally Closed)

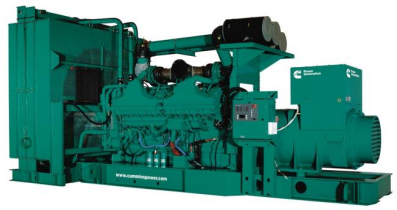




Normally closed contact, held open when utility is available. Closes when utility fails, starting the Generator set.

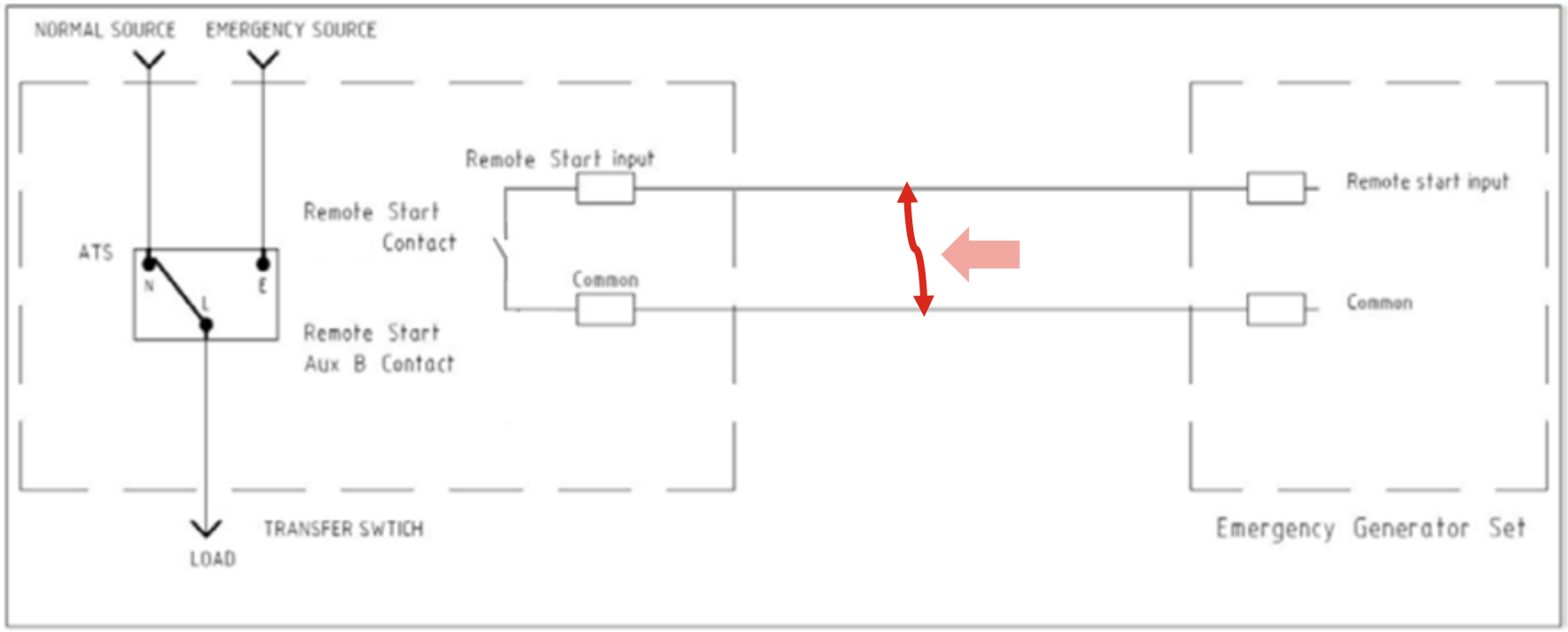
Traditional Generator Start Circuit (Normally Closed) Fault: Line Break

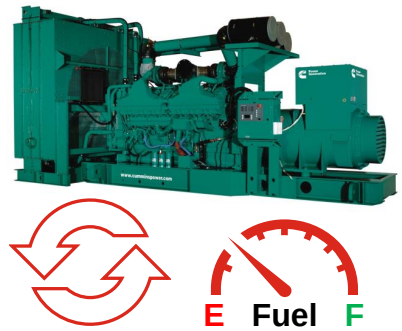




Generator will never start, even during an emergency due to the start circuit always being open as a result of the line break.

Traditional Generator Start Circuit (Normally Closed) Fault: Line Short





Generator set Starts. Without Monitoring and Alarm, facility might run out of fuel without an actual emergency being there.

Generator Control Wiring 700.10(D)(3)

Generator Control Wiring. Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator control wiring shall be continuously monitored. Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and start the generator(s).

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Concerns raised:

- "Integrity" is not defined
- Does loss of integrity mean a shorted start circuit or a loose connection?
- Does control wiring also mean Remote start circuit?

Generator Control Wiring 700.10(D)(3)

Tentative Interim Amendment (TIA)

Generator Control Wiring. Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator ~~control wiring~~ remote start circuit shall be ~~continuously~~ monitored for broken, disconnected, or shorted wires. Loss of integrity ~~of the remote start circuit(s)~~ shall ~~initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and~~ start the generator(s).

Generator Control Wiring 700.10(D)(3)

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TIA Recommendations:

- Defines "integrity" as "… broken, disconnected, or shorted…"
- Eliminates control wiring and focuses on remote start circuit
- Eliminates annunciation requirements
- Eliminates "continuously monitoring" requirement

Generator Control Wiring 700.10(D)(3)

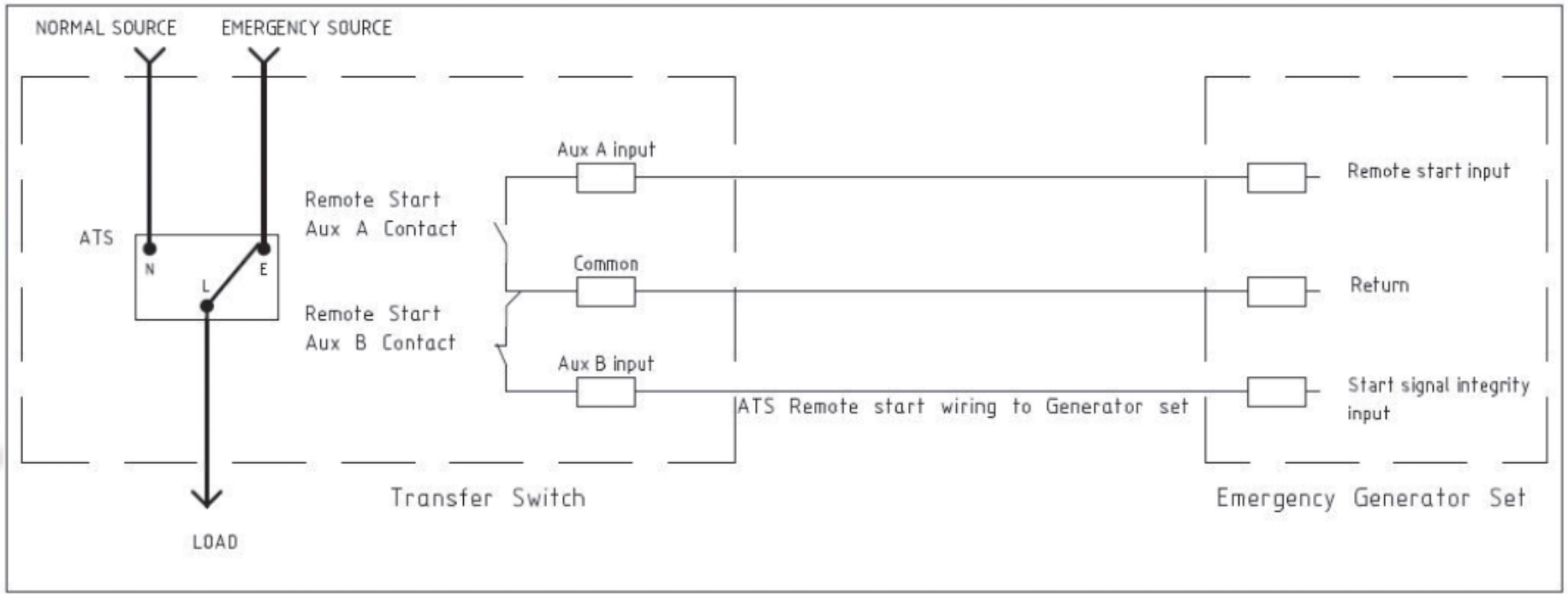
Final Language

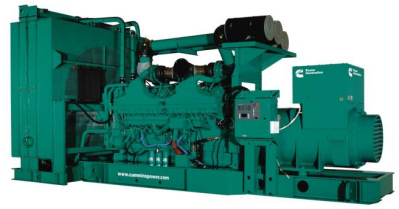
Generator Control Wiring. Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator remote start circuit shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall start the generator(s).

Timeline

- TIA 17-17 published in the April 2018 Issue of *NFPA News*
- TIA issued date: August 14, 2018
- TIA effective date: September 3, 2018

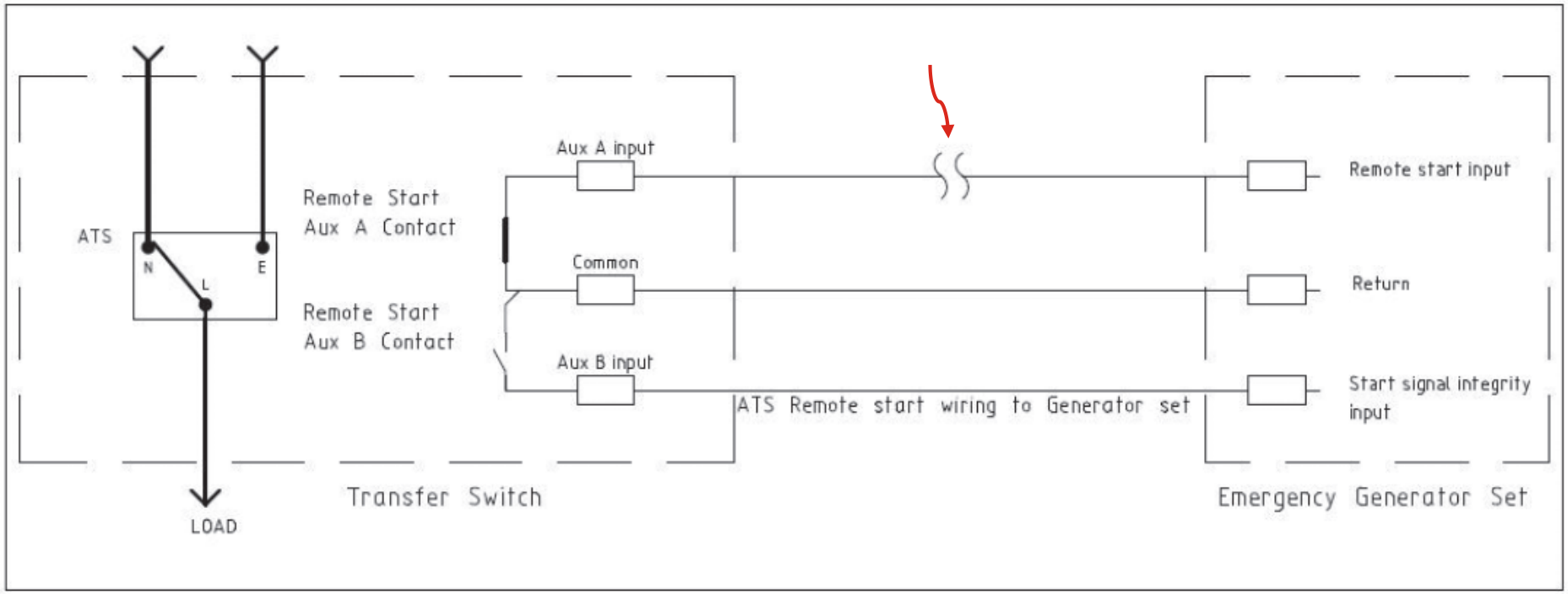
Compliant Start Signal Connection.

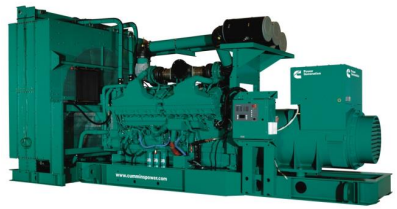




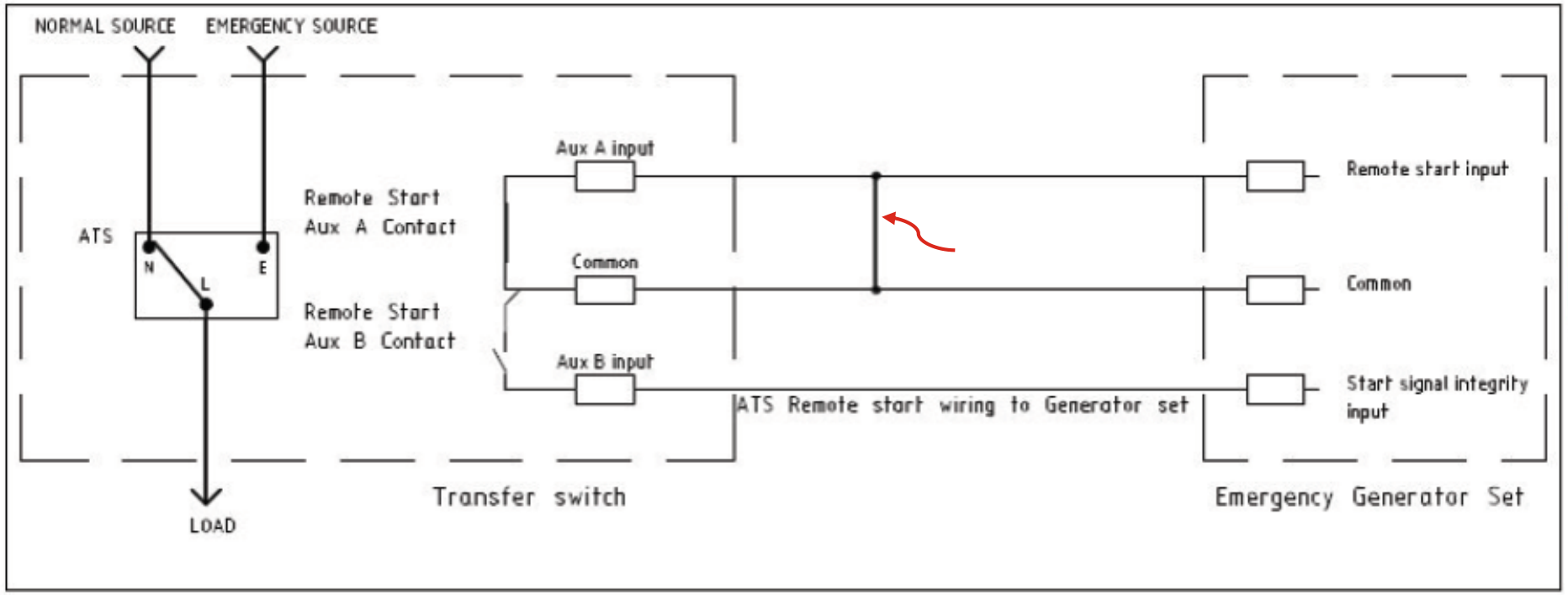
Input position 'A' at Remote Monitoring Unit	Input position 'B' at Remote Monitoring Unit	Results
Closed	Open	Normal (No fault)
Open	Closed	Normal (No fault)
Open	Open	Abnormal (Fault)
Closed	Closed	Abnormal (Fault)

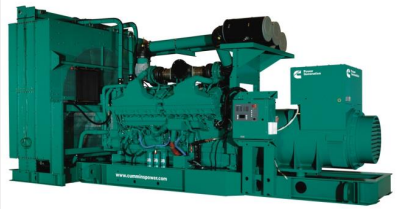
Fault: Line Break



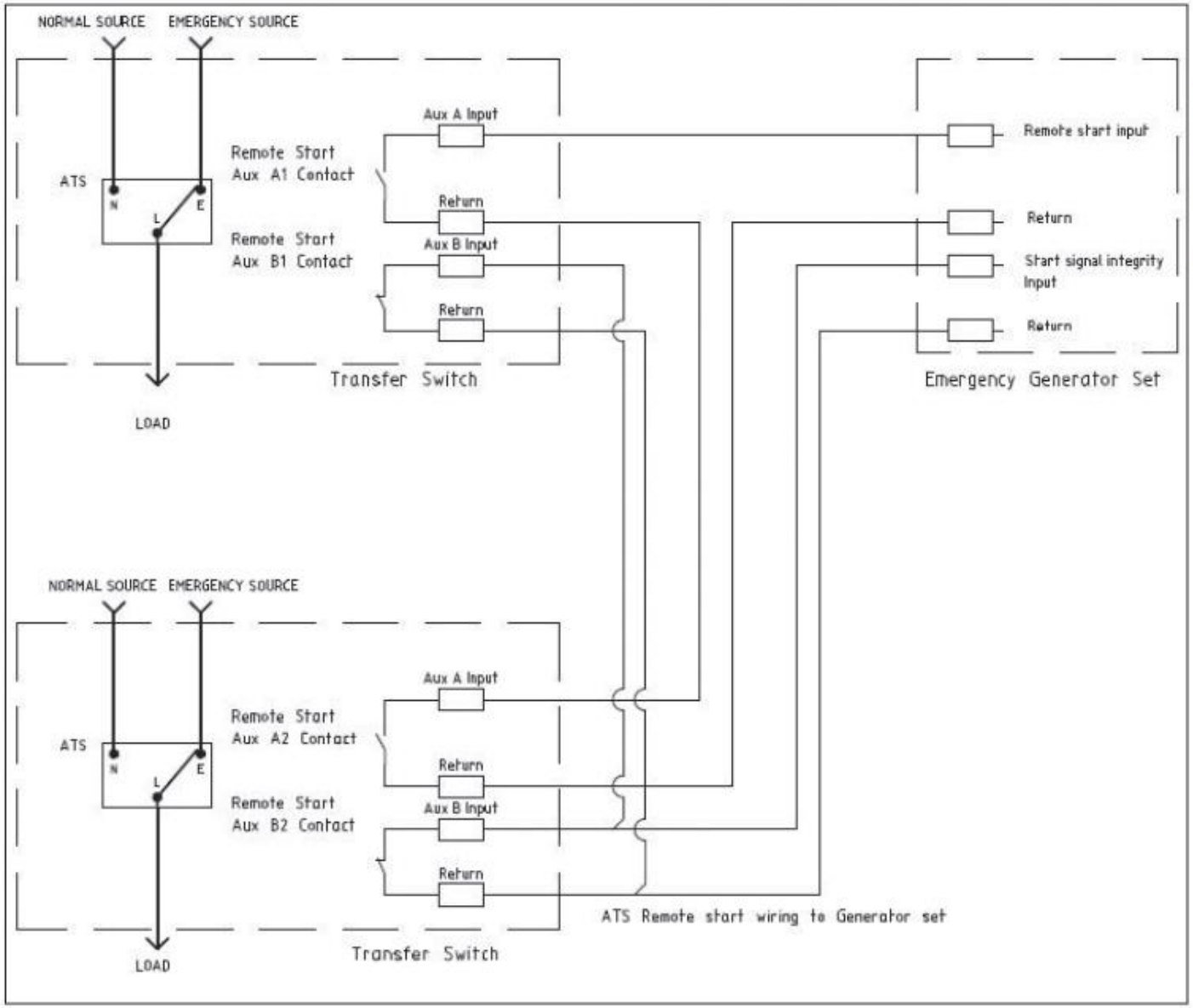


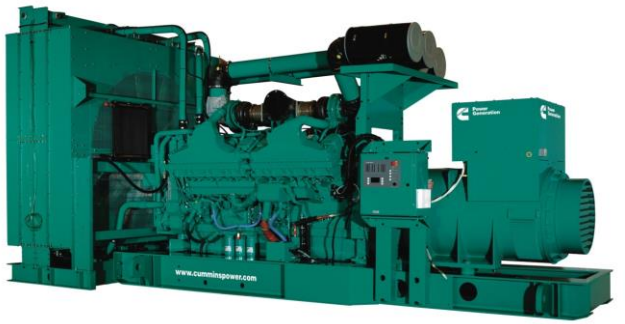
Fault: Line Short



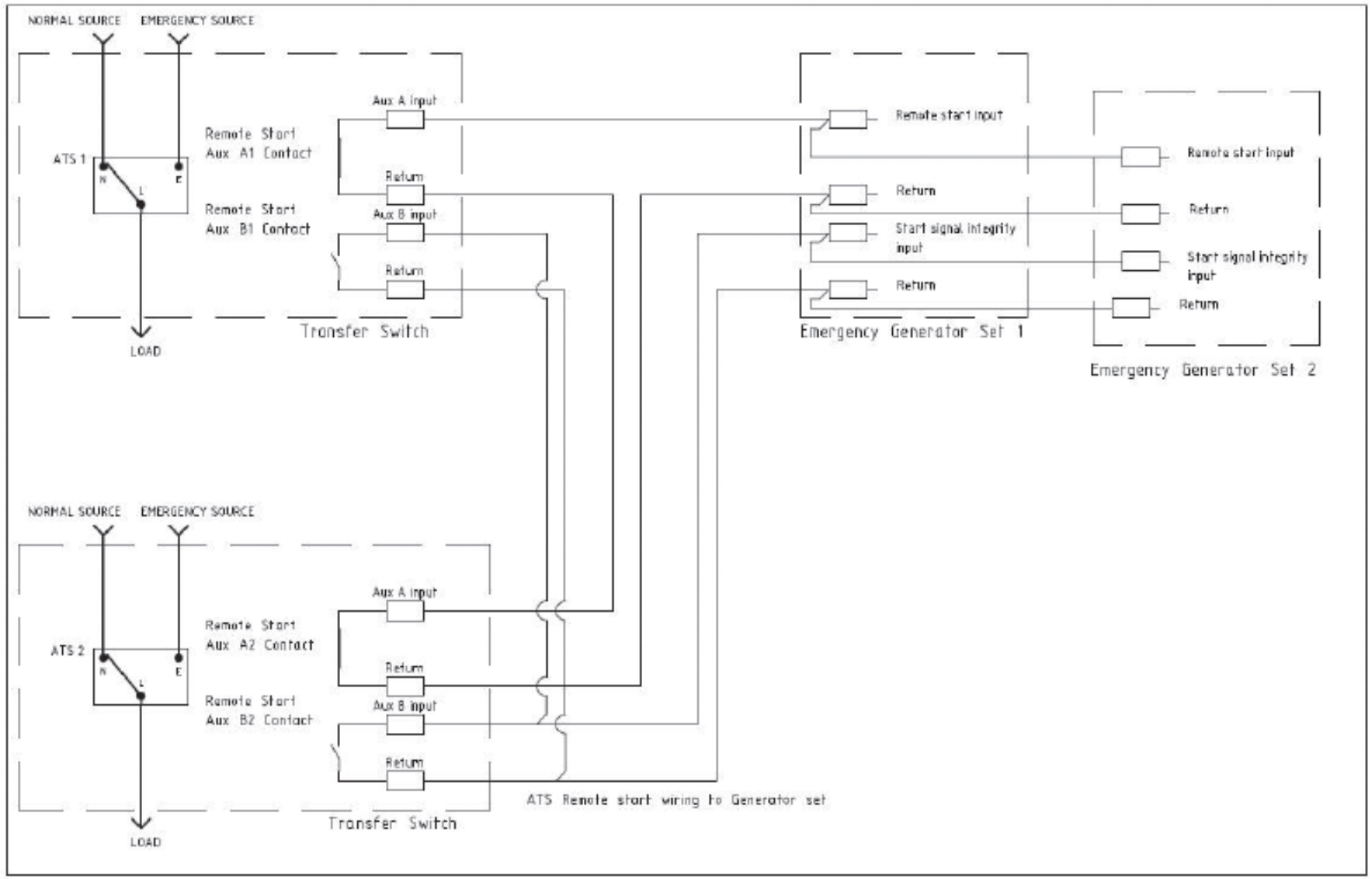


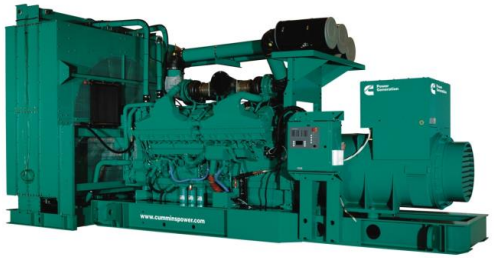
Multiple ATS and Single Genset

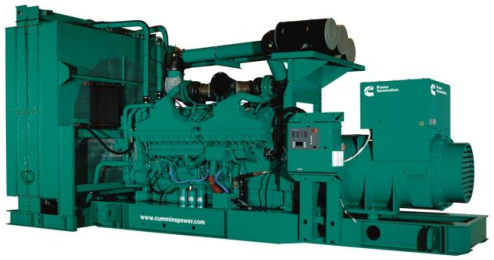




Multiple ATS, Multiple Genset







Concept Check

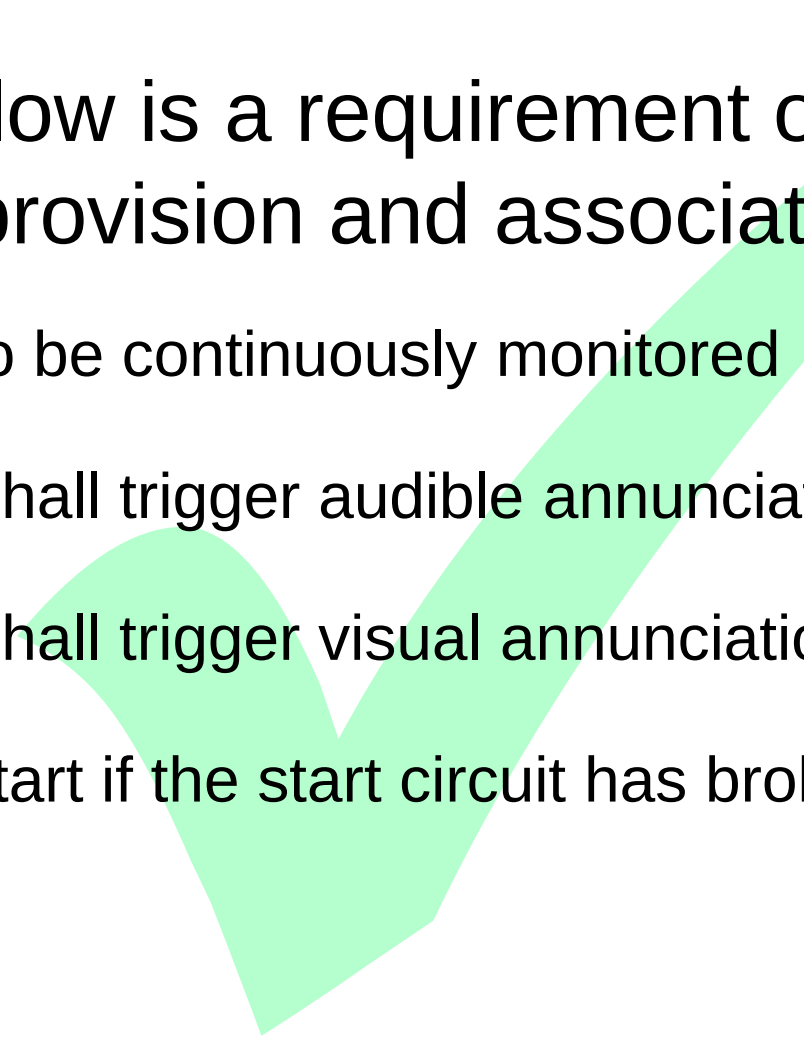
Which of the below is a requirement of NEC 2017 start circuit integrity provision and associated TIA

a) Start circuit has to be continuously monitored

b) Loss of integrity shall trigger audible annunciation

c) Loss of integrity shall trigger visual annunciation

d) Generator shall start if the start circuit has broken/disconnected wiring



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c) Loss of integrity shall trigger visual annunciation

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Generator Control Wiring 700.10(D)(3)

Key Takeaways

- Must Ensure that generator start circuit is not a single point of failure that will make power unavailable to emergency loads during a Utility Failure.
- The requirement does not apply to Legally Required, Optional or COPS ATS (NEC 701, 702 and 708).
- Generator set and transfer switch manufacturers may provide varying options to meet the intent of the code.

Spec Note: Specify that Generator and Transfer switch manufacturers provide documentation that demonstrate start signal compatibility between the specific models of Generator and ATS per code requirements of NEC 2017 and TIA 17-17.

Temporary Source of Power 700.3(F)

Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power. If the emergency system relies on a single alternate source of power which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power shall comply with the following:

(1) Connection to the portable or temporary alternator source of power shall not require modification to the permanent system wiring.

(2) Transfer of power between the normal power source and the emergency power source shall be in accordance with 700.12.

(3) The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.

(4) Mechanical or electrical interlocking shall prevent inadvertent interconnection of power sources.

(5) The switching means shall include a contact point which shall annunciate at a location remote from the generator or at another facility monitoring system to indicate that the permanent emergency source is disconnected from the emergency system.

It shall be permissible to utilize manual switching to switch from the permanent source of power to the portable or temporary alternate source of power and to utilize the switching means for connection of a load bank.

Informational Note: There are many possible methods to achieve the requirements of 700.3(F). See figure 700.3(F) for one example.

Exception: The permanent switching means to connect a portable or temporary alternate source of power, for the duration of the maintenance or repair, shall not be required where any of the following conditions exists:

(1) All processes that rely on the emergency system source are capable of being disabled during maintenance or repair of the emergency power source.

(2) The building or structure is unoccupied and fire suppression systems are fully functional and do not require an alternate power source.

(3) Other temporary means can be substituted for the emergency system.

(4) A permanent alternate emergency source, such as, but not limited to, a second on-site standby generator or separate electric utility service connection, capable of supporting the emergency system, exists.

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Concept Check

Which of the below is not a requirement of 700.3(F) provision for temporary source of power switching means.

a) Connection point has to be marked with Phase rotation

b) Shall meet applicable portions of NEC 700.12

c) Shall require modification of the permanent system wiring

d) Interlock shall be required for preventing inadvertent interconnection of sources.

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b) Shall meet applicable portions of NEC 700.12

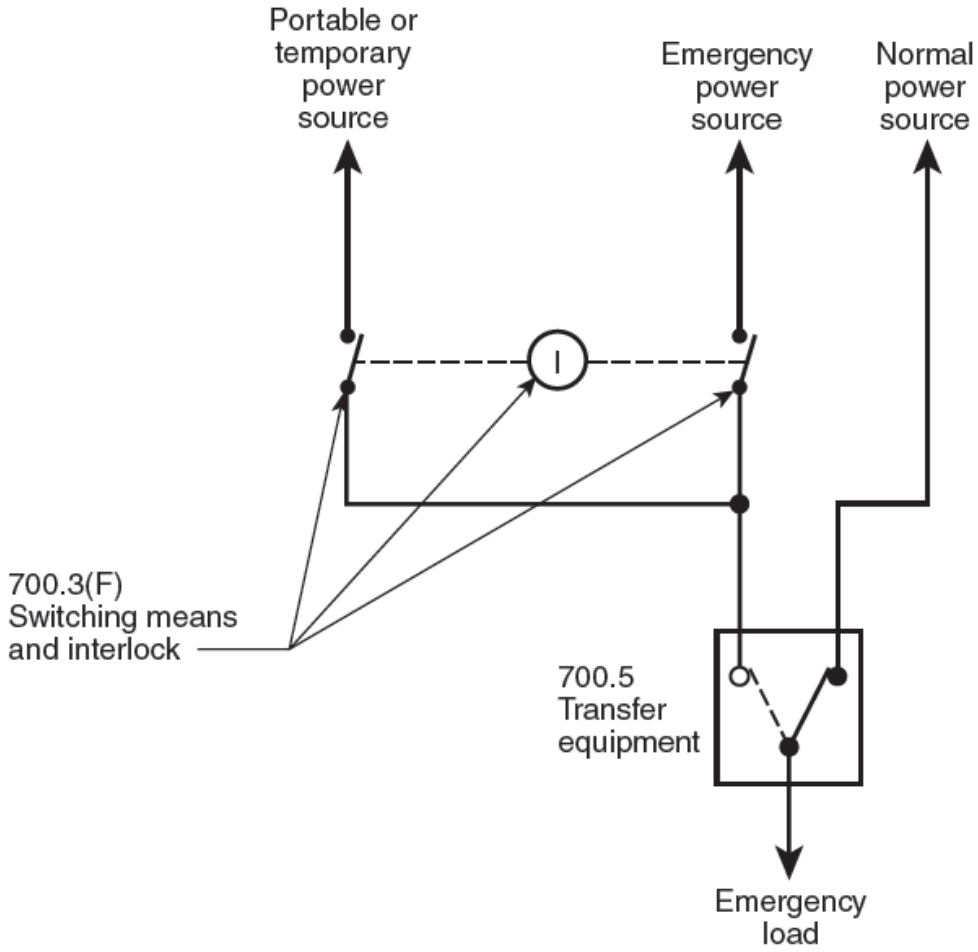
c) Shall require modification of the permanent system wiring

d) Interlock shall be required for preventing inadvertent interconnection of sources.

Temporary Source of Power 700.3(F)

Solution Requirements Summary

- Permanent connection point should be located near the power lead entrance to building
- Phase rotation and system bonding requirements shall be marked at portable connection point
- Terminal block should be provided for ATS start signal from NEC 700 ATS (including start signal integrity)
- Annunciator with “permanent generator offline” shall be provided
- Annunciator with “interlock engaged” alarm shall be provided
- Overcurrent protection devices (circuit breakers) should be part of the coordination study



Temporary Source of Power 700.3(F)

Exceptions

Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power. If the emergency system relies on a single alternate source of power which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power shall comply with the following:

(1) Connection to the portable or temporary alternate source of power shall not require modification to the permanent system wiring.

(2) Transfer of power between the normal power source and the emergency power source shall be in accordance with 700.12.

(3) The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.

(4) Mechanical or electrical interlocking shall prevent inadvertent interconnection of power sources.

(5) The switching means shall include a contact point which shall annunciate at a location remote from the generator or at another facility monitoring system to indicate that the permanent emergency source is disconnected from the emergency system.

It shall be permissible to utilize manual switching to switch from the permanent source of power to the portable or temporary alternate source of power and to utilize the switching means for connection of a load bank.

Informational Note: There are many possible methods to achieve the requirements of 700.3(F). See figure 700.3(F) for one example.

Exception: The permanent switching means to connect a portable or temporary alternate source of power, for the duration of the maintenance or repair, shall not be required where any of the following conditions exists:

(1) All processes that rely on the emergency system source are capable of being disabled during maintenance or repair of the emergency power source.

(2) The building or structure is unoccupied and fire suppression systems are fully functional and do not require an alternate power source.

(3) Other temporary means can be substituted for the emergency system.

(4) A permanent alternate emergency source, such as, but not limited to, a second on-site standby generator or separate electric utility service connection, capable of supporting the emergency system, exists.

Temporary Source of Power 700.3(F)

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Temporary Source of Power 700.3(F)

Solution Recommendations

Means of switching power sources

- Interlocked circuit breakers
- Transfer switch

Optional functions

- Load Bank Connection
- Means to connect entire facility to temporary source

Spec Note: Specify that the temporary source connection point shall be clearly marked with phase rotation and system bonding requirements. It shall also prevent inadvertent interconnection between the two sources and provide annunciation when the permanent generator is disconnected

Temporary Source of Power 700.3(F)

Interlocked Circuit Breakers

PART NUMBER
17-400

REVISIONS				
ZONE	REV	DESCRIPTION	DWN	DATE
	01	ADDITIONAL NOTES ADDED	MDS	1/2/2018

EMERGENCY POWER SOURCE

NORMAL POWER SOURCE (UTILITY)

G

G

U

PORTABLE OR TEMPORARY POWER SOURCE (MALE CAMLOC)

SEE NOTES 1 2 3 4

K KIRK-KEY INTERLOCK

K KIRK-KEY INTERLOCK

NEC 700.5 AUTOMATIC TRANSFER SWITCH

NEC 700.3(F) SWITCHING MEANS AND INTERLOCK. CIRCUIT BREAKERS MUST BE INCLUDED IN THE COORDINATION STUDY AND LOCATED NEAR BUILDING ENTRANCE

EMERGENCY LOAD

NOTE:

1. MARKED W/ PHASE ROTATION.
2. TERMINAL BLOCK W/ START LEADS FROM ATS.
3. ALARM FROM SWITCHING MEANS TO REMOTE ANNUNCIATOR.
4. REMOTE ANNUNCIATOR MUST BE LABELED: PERMANENT GENERATOR IS OFFLINE.

DO NOT SCALE DRAWING

SCALE: N.T.S. MASS: N/A

MATERIAL: N/A

FINISH: N/A

DIMENSIONAL TOLERANCES: (UNLESS OTHERWISE SPECIFIED)
X = ±0.125
.X = ±0.100
XX = ±0.050
.XXX = ±0.015
.XXXX = ±0.005
ANGLES = ±1°

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DRAWN: M. SEYMOUR
DATE: 11/6/2017

CUMMINS INC.

PART NO. 17-400

DESCRIPTION: 2017 NEC 700.3(F) BASIC

REV 01

SIZE C

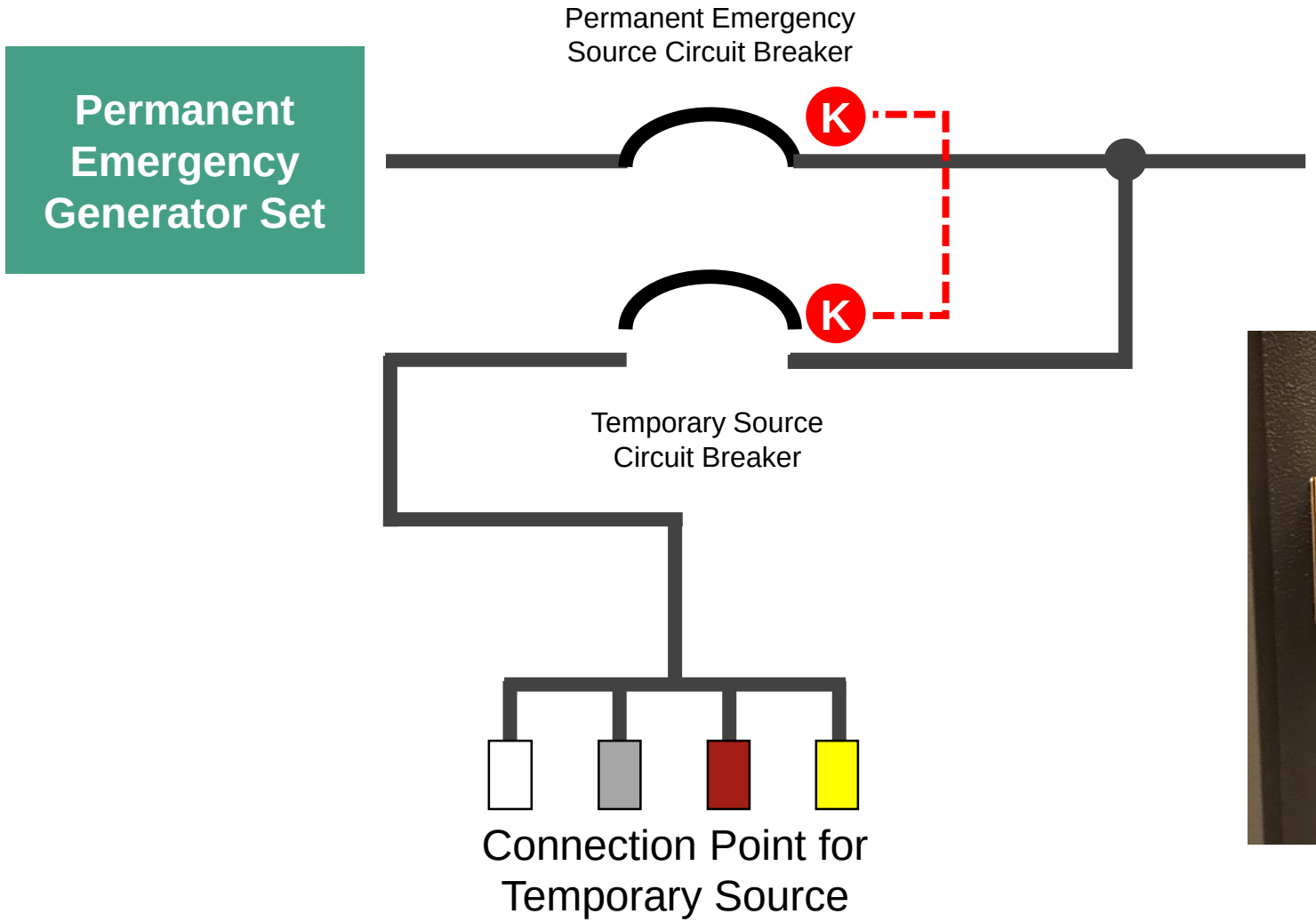
APPROVED: DATE:

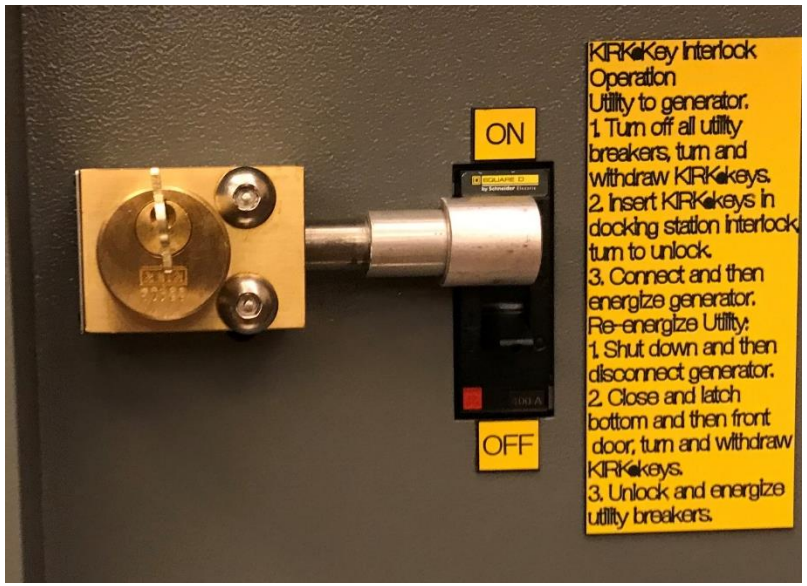
FSCM NO.

SHEET 1 OF 1

Temporary Source of Power 700.3(F)

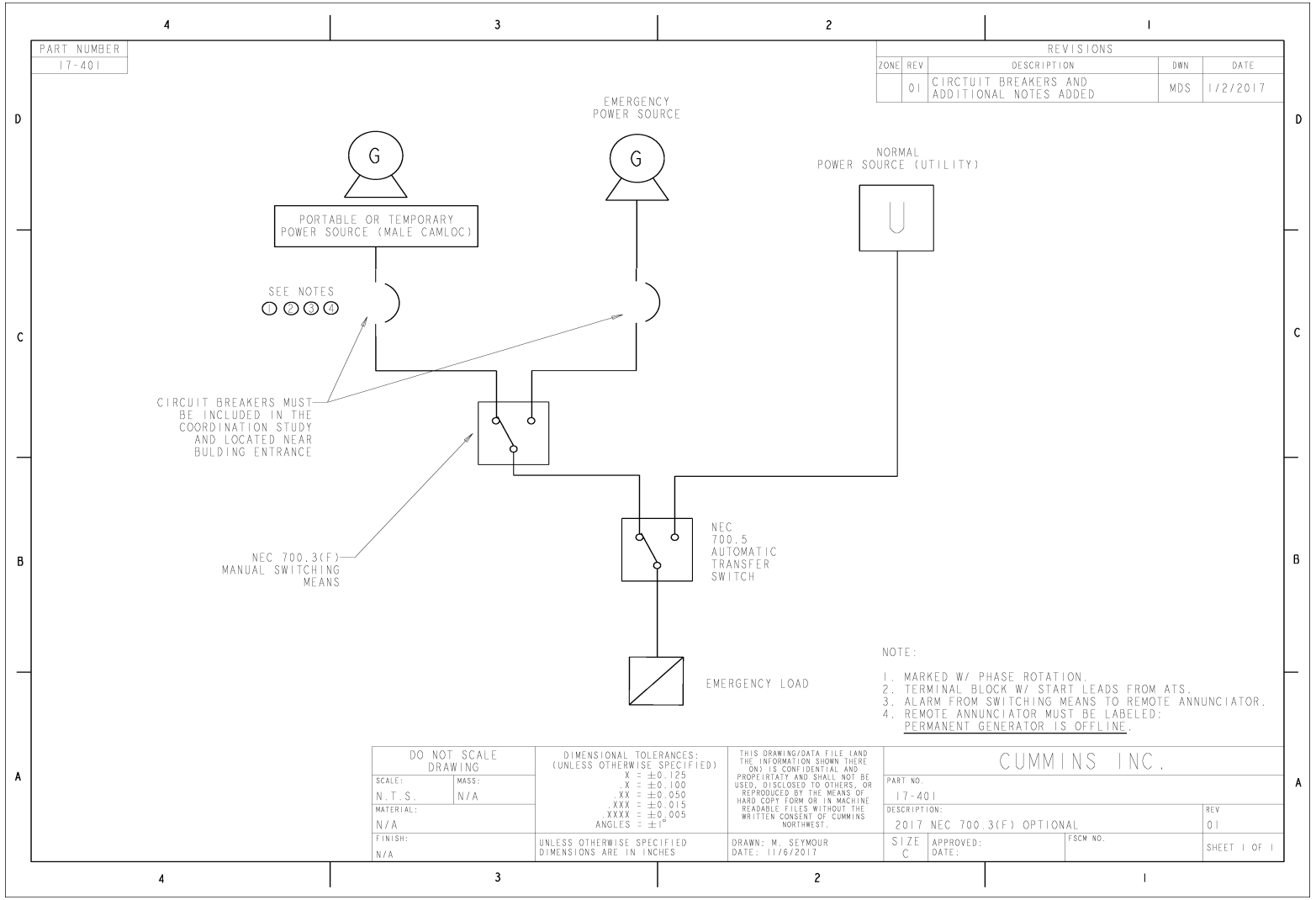
Interlocked Circuit Breakers





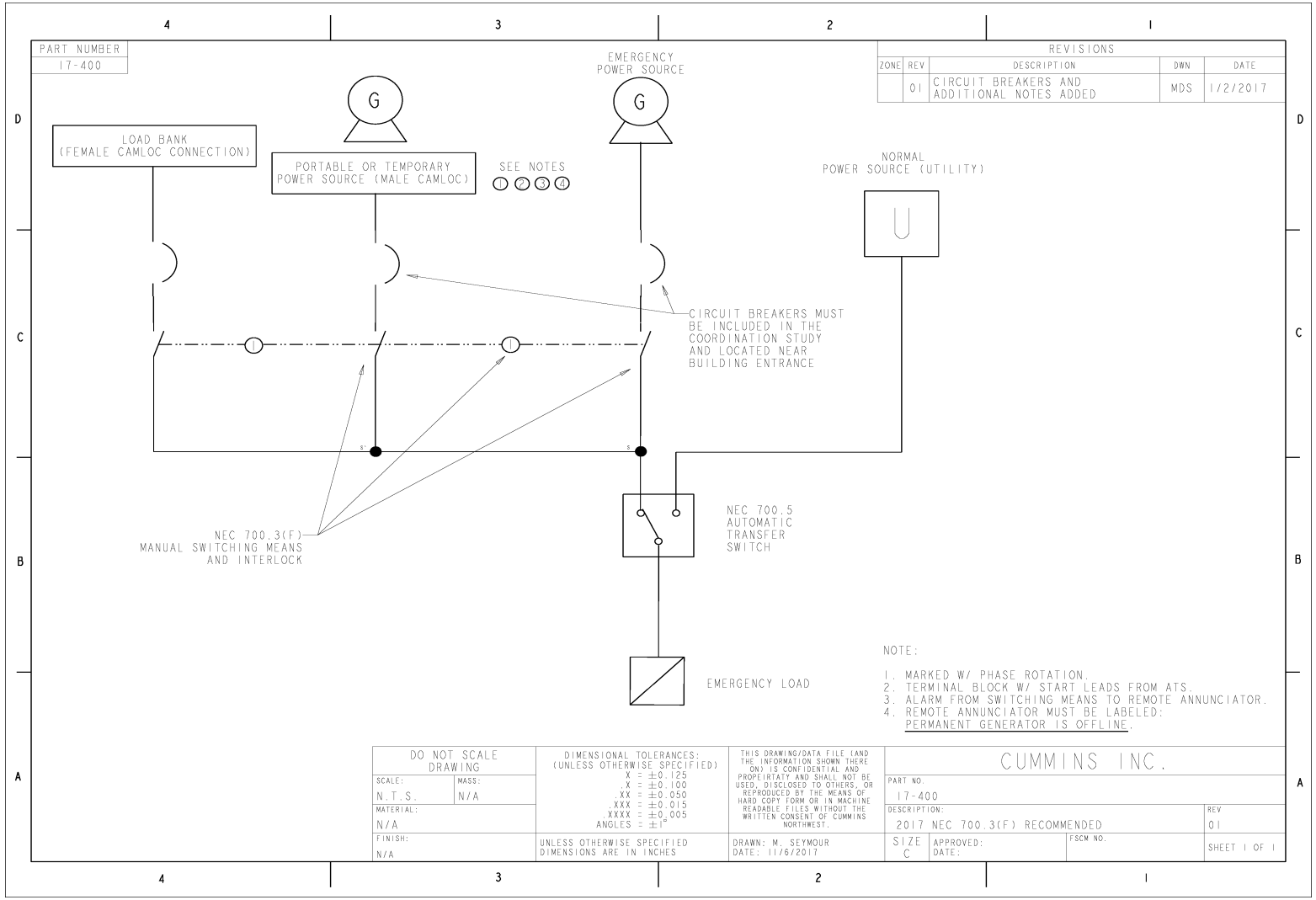
Temporary Source of Power 700.3(F)

Transfer Switch



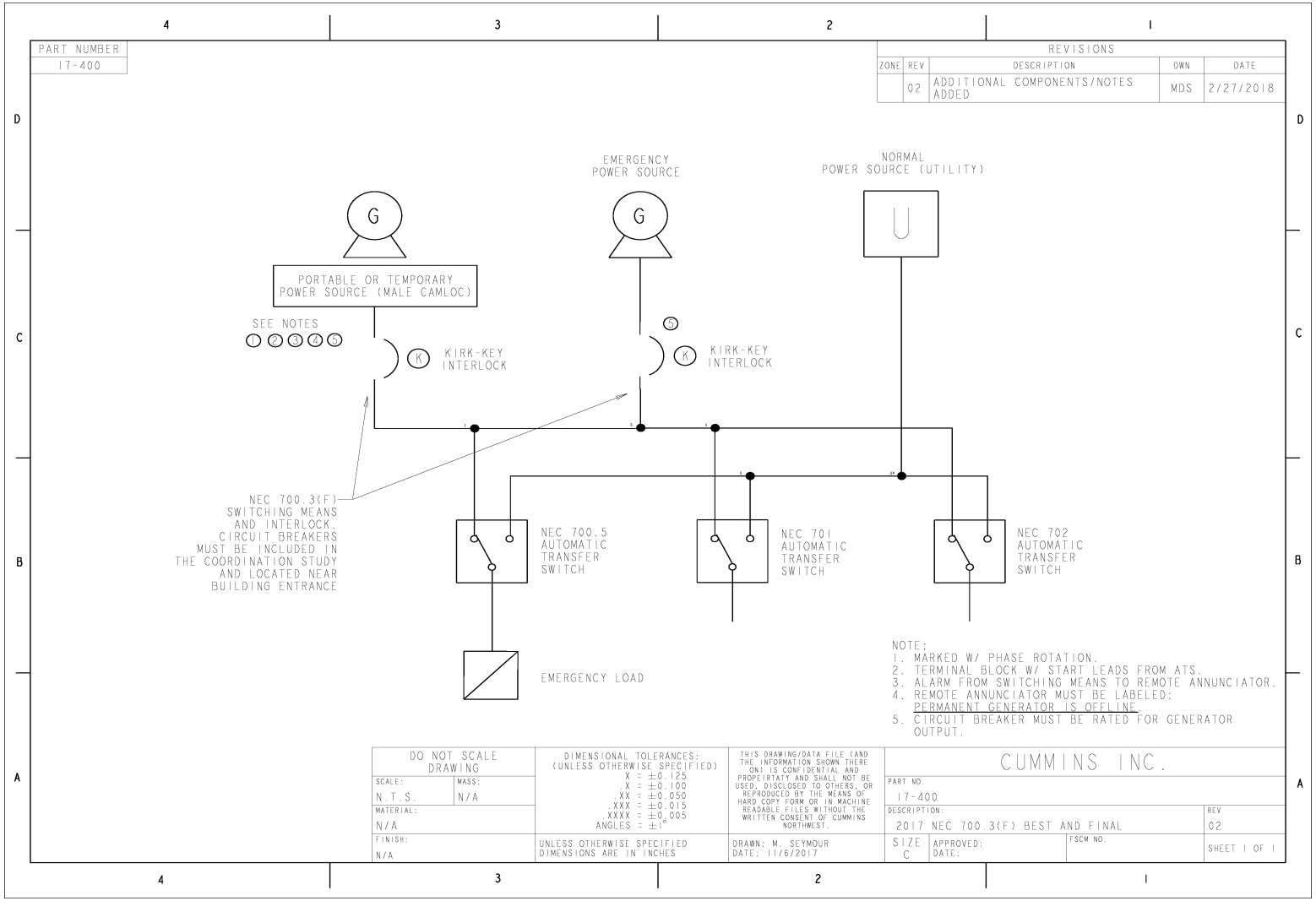
Temporary Source of Power 700.3(F)

Optional Functions – Load Bank Connection



Temporary Source of Power 700.3(F)

Optional Functions – Whole Building Load



Concept Check

Which of the below is not an exception of 700.3(F) provision for temporary source of power switching means.

a) Emergency system can be disabled during maintenance

b) The structure is unoccupied and fire suppression system is disconnected

c) Fire suppression system is fully functional and don’t depend on backup power

d) When you have a second onsite generator capable of supporting full emergency load.

Concept Check

Which of the below is not an exception of 700.3(F) provision for temporary source of power switching means.

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Additional Resources

Cummins White Papers:

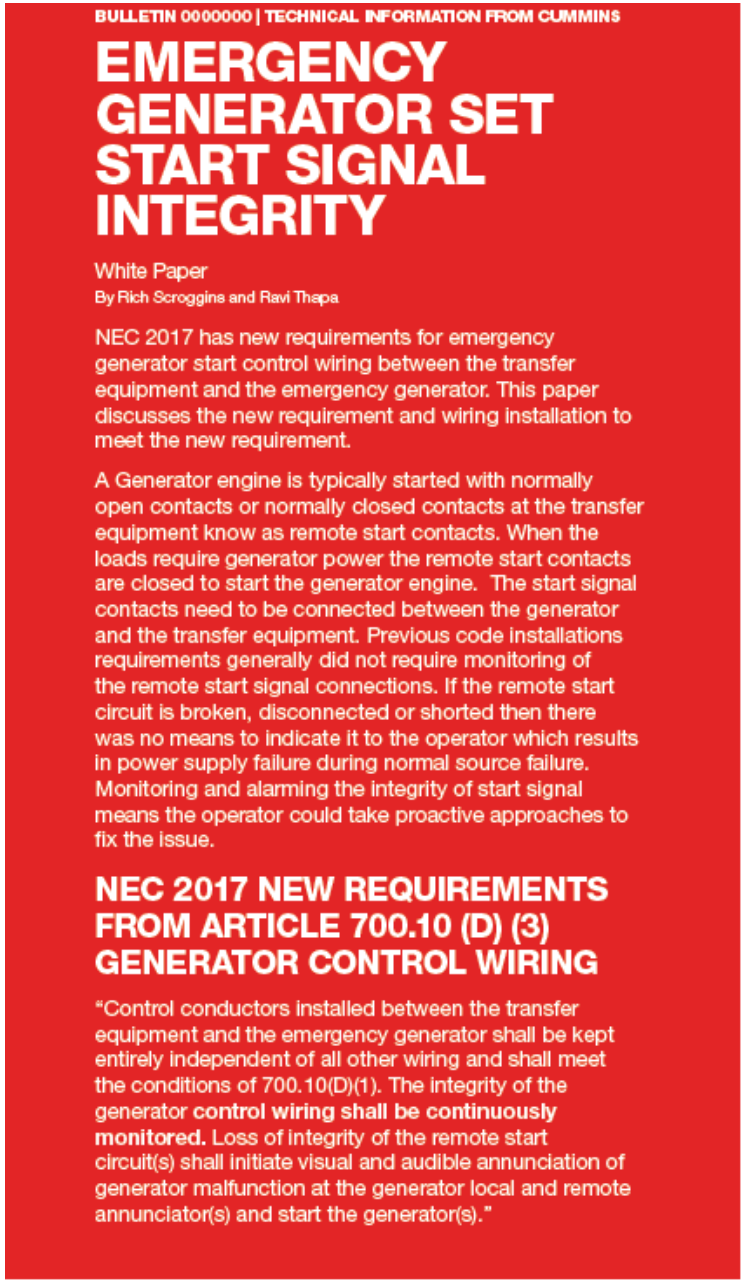
- Emergency Generator Set Start Signal Integrity
- Understanding 100% rated breaker assemblies and their application
- Design for safety and reliability-appropriate connection provisions for generator sets

NFPA 70/NEC resources:

- NEC 2017 700.10(D)(3) Start Signal Integrity final language. Click HERE or Search for TIA 17-17 in your web browser.

Cummins On-Demand Recorded Webinars:

- NFPA 110 Type 10 Requirements for Emergency Power Systems
- Testing Requirements of Emergency Power Supply Systems in Critical Healthcare Facility



BULLETIN 0000000 | TECHNICAL INFORMATION FROM CUMMINS

EMERGENCY GENERATOR SET START SIGNAL INTEGRITY

White Paper

By Rich Scroggins and Ravi Thapa

NEC 2017 has new requirements for emergency generator start control wiring between the transfer equipment and the emergency generator. This paper discusses the new requirement and wiring installation to meet the new requirement.

A Generator engine is typically started with normally open contacts or normally closed contacts at the transfer equipment know as remote start contacts. When the loads require generator power the remote start contacts are closed to start the generator engine. The start signal contacts need to be connected between the generator and the transfer equipment. Previous code installations requirements generally did not require monitoring of the remote start signal connections. If the remote start circuit is broken, disconnected or shorted then there was no means to indicate it to the operator which results in power supply failure during normal source failure. Monitoring and alarming the integrity of start signal means the operator could take proactive approaches to fix the issue.

NEC 2017 NEW REQUIREMENTS FROM ARTICLE 700.10 (D) (3) GENERATOR CONTROL WIRING

"Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator **control wiring shall be continuously monitored.** Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and start the generator(s)."

Course Summary: NEC 2017 changes

700.10 (D)(3): Start Signal Integrity:

- Engine-Generator Start Signal Integrity shall be monitored for Broken, Disconnected and Shorted wires. Loss of Integrity should not affect power availability for Emergency loads.
- TIA 17-17 updates the language and removes requirement for continuous monitoring and annunciation.

700.3 (F) Temporary Source of Power:

- Have to have a temporary source connection point if primary generators would be taken offline for service
- Shall be marked with phase rotation and system bonding requirements.
- Annunciation for “interlock engaged” and “permanent generator offline” alarm shall be provided

Specify:

- Engine-Generator Set and ATS manufactures shall show compatibility of Start Signal Integrity as required by NEC 2017 section 700.10(D)(3) and TIA 17-17.
- Specify that the temporary source connection point shall be clearly marked with phase rotation and system bonding requirements. It shall also prevent inadvertent interconnection between the two sources and provide annunciation when the permanent generator is disconnected

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

Your local Cummins contacts:

- AZ, ID, NM, NV: Carl Knapp (carl.knapp@cummins.com), Rocky Mountain Region
- CO, MT, ND, UT, WY: Chris Scott (chris.scott@cummins.com), Rocky Mountain Region
- Northern IL, IA: John Kilinskis (john.a.kilinskis@cummins.com), Central Region
- UP of MI, MN, East ND, WI: Michael Munson (michael.s.munson@cummins.com), Central Region
- NB, SD, West MO, KS: Earnest Glaser (earnest.a.glaser@cummins.com), Central Region
- South IL, East MO: Jeff Yates (Jeffery.yates@cummins.com), Central Region
- TX: Scott Thomas (m.scott.thomas@cummins.com), Gulf Region
- FL, GA, SC, NC and Eastern TN: Robert Kelly (robert.kelly@cummins.com), South Region
- NY, NJ, CT, PA, MD: Charles Attisani (charles.attisani@cummins.com): East Region
- CA, HI: Brian E Pumphrey (brian.Pumphrey@cummins.com)
- WA, OR, AK: Tom Tomlinson (tom.tomlinson@cummins.com)
- For other states and territories, email powergenchannel@cummins.com or visit http://power.cummins.com/sales-service-locator

Closing

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- A PDH Certificate

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- PowerHour webinar recording, presentation and FAQ archive
- Other Cummins Continuing Education programs
- Sizing and spec development tool

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

Upcoming PowerHour Webinars:

- April – Specifying Gaseous Generator Sets for Standby Applications
- May – Introduction to Generator Set Sizing Software


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