



**Harris Nuclear Plant Pre-Submittal Meeting    March 2, 2017**



# License Amendment Request for Emergency Diesel Generator Surveillance Changes

**NOTE:** Technical Specification mark-up pages for this license amendment request are provided on pages 20-25 of this document for reference with the presentation material.

## Duke Energy Participants

- Sarah McDaniel, Regulatory Affairs
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- Mark Grantham, Engineering Director
- Art Zarembo, Fleet Licensing Manager
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# Agenda

- I. Steady-State Voltage and Frequency Limit Changes
  - Description of Changes
  - Reason for Changes
  - Technical Evaluation - Overview
- II. Full Load Rejection Test Voltage Limit Change
  - Description of Change
  - Reason for Change
  - Technical Evaluation - Overview
- III. Regulatory Guidance
- IV. Precedents
- V. Industry Efforts

## Description of Changes: Steady-State Operation Parameters

TS SR 4.8.1.1.2.a.4, SR 4.8.1.1.2.e, SR 4.8.1.1.2.f.2, SR 4.8.1.1.2.f.4.b, SR 4.8.1.1.2.f.6.b, & SR 4.8.1.1.2.f.14:

- Current voltage limit is plus or minus **10%** of the nominal emergency diesel generator (EDG) voltage ( $6900 \pm 690$  volts) and the current frequency limit is plus or minus **2%** of the nominal frequency ( $60 \pm 1.2$  hertz)
- Proposed voltage limit is plus or minus **4%** of the nominal EDG voltage ( $6900 \pm 276$  volts) and the proposed frequency limit is plus or minus **0.8%** of the nominal frequency ( $60 \pm 0.48$  hertz)
- The new proposed limits are for EDG steady-state operation in the “isochronous mode” or with the emergency power system isolated from the normal, offsite source.

## Reason for Changes: Steady-State Operation Parameters

- While evaluating operational experience, Harris identified that surveillance requirement limits for EDG steady-state voltage and frequency testing are non-conservative.
  - The lower end of the range (6210 VAC) is below the dropout setting of the Degraded Grid Voltage Relay (6420 VAC nominal).
  - The upper end of the range (7590 VAC) is above the maximum allowed operating voltage for the 6.6kV motors supplied by the 6.9kV emergency buses (7260 VAC).
  - Use of a higher than 60 Hz frequency was not previously considered in the EDG loading analysis, thus fuel consumption, motor-operated valve (MOV) stroke times, pump speed/output or impact on fan operations were not previously evaluated.
- Administrative Controls: Surveillance procedures were revised to control voltage at a tighter band of 6500-7200 volts. Surveillance results are being monitored to verify that voltage and frequency are maintained in the tighter bands proposed.

## Technical Evaluation Overview: Steady-State Operation Parameters

- Impact on electrical loading characteristics of the EDGs
- Impact of voltage & frequency variation on EDG driven equipment (pumps, motor-operated valve (MOV) stroke time, air handlers, EDG fuel consumption)
  - Impact on the operating range of the powered equipment
  - Evaluation of Safe Shutdown Equipment & Impact to Accident Analyses
    - Impact on MOV Operation
    - Impact on Pump and Fan Operation
      - Effects of bus frequency variations on motor speed change, pump and fan flow, and differential pressure

## Description of Change: Full Load Rejection Test Voltage Limit

TS SR 4.8.1.1.2.f.11:

- Current voltage limit for the EDG full load rejection test is 110% of the EDG voltage at the start of the test
- Proposed limit is 8,280 volts, which is 120% of the EDG nominal voltage rating of 6900 volts



## **Reason for Change: Full Load Rejection Test Voltage Limit**

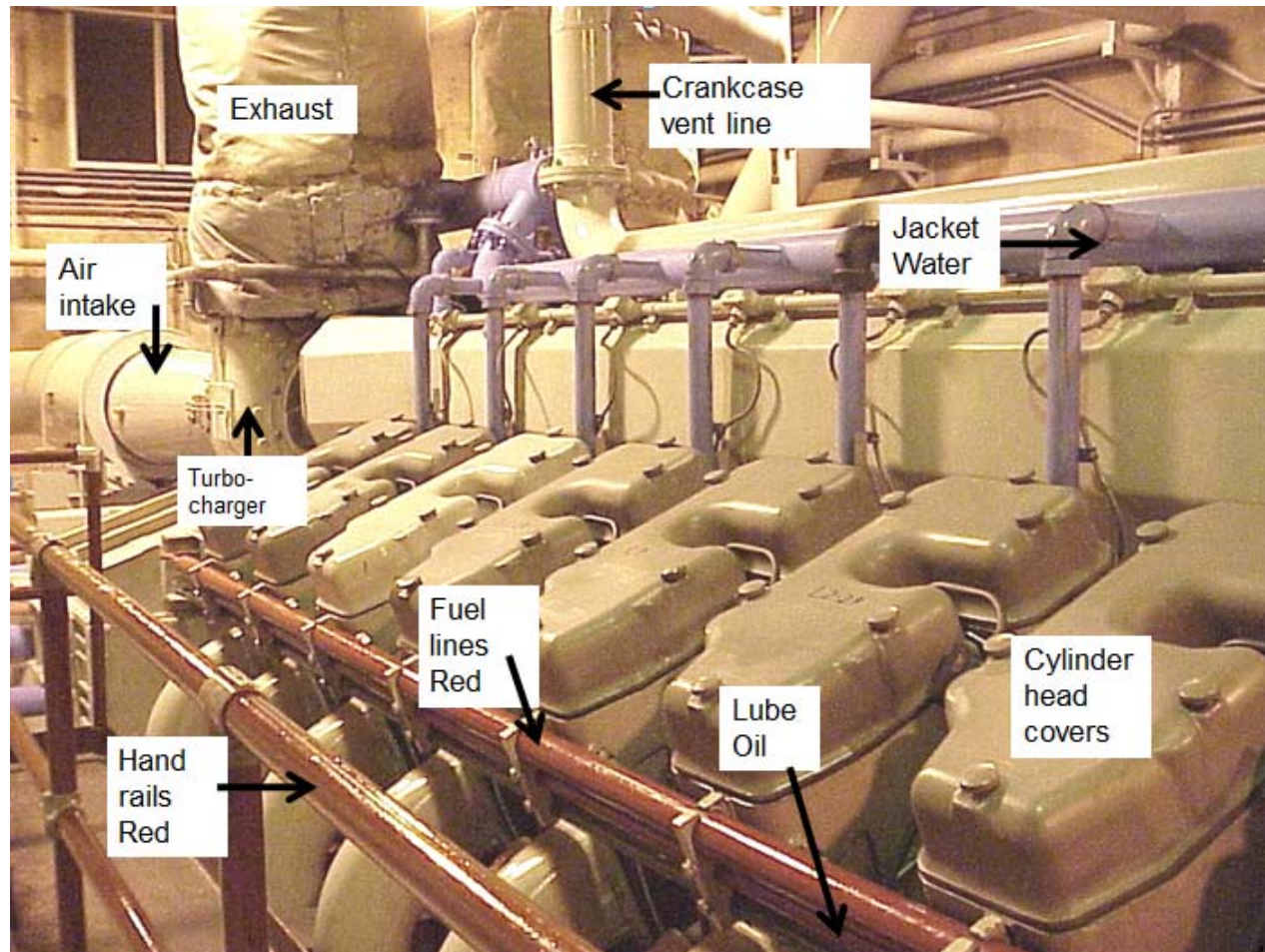
- Change to full load rejection test limit is necessary to gain margin. Previous results have shown that inadequate margin exists.
- The test requires that the EDG be paralleled to the grid just prior to load rejection. This reduces margin by approximately 2.5-3.0% due to the EDG being in the “droop” mode.

# Technical Evaluation Overview: Full Load Rejection Test Voltage Limit

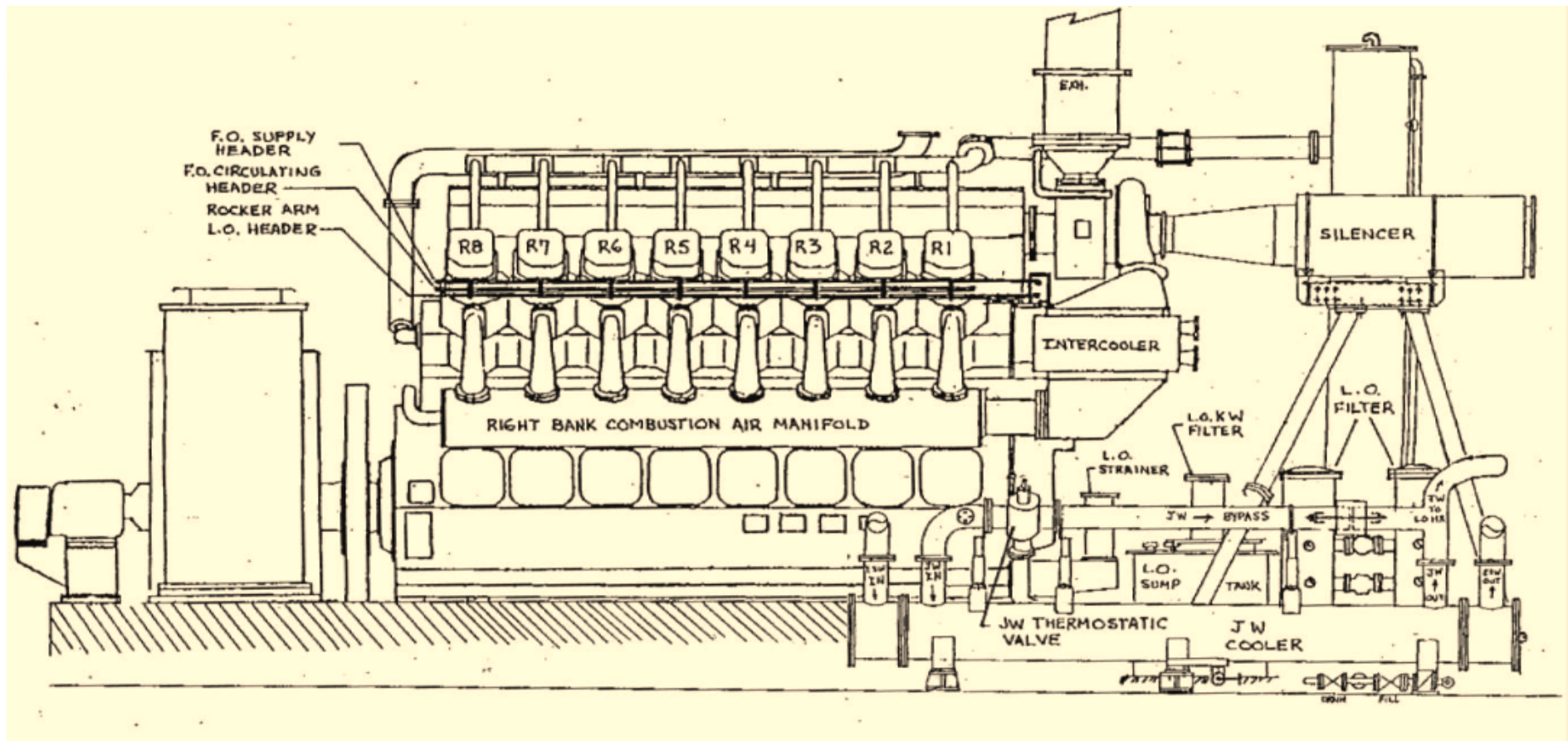
Load Rejection Test Voltage Limit of 8280 volts = 120% of nominal 6900 volts

- Standard industry value for peak voltage is 5000 volts (120% of nominal 4160 volts), which is identified in the Improved Standard Technical Specifications (NUREG-1431)
- Impact of increased voltage limit on
  - Emergency Diesel Generator, Cables, and Switchgear
  - Voltage Regulator & Control Circuits
  - Exciter Power Transformer
  - 3-Phase Potential Transformer
  - Voltage Regulator and Control Circuit
- Volt-Ampere Reactive Power (VAR) Loading

## Emergency Diesel Generator - Photo



## Emergency Diesel Generator - Drawing



## Regulatory Guidance

- General Design Criterion 17, "Electric Power Systems"
- General Design Criterion 18, "Inspection and testing of electric power systems"
- Regulatory Guide 1.9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," Revision 2
- Regulatory Guide 1.108, "Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants," Revision 1, as modified with the guidance of Information Notice 85-32, dated April 22, 1985

### Steady-State Operation Parameter Changes

- April 27, 2016: Davis Besse Nuclear Power Station, Unit 1 increased the EDG minimum steady-state voltage and frequency acceptance criterion for TS surveillance testing
- December 10, 2009: Crystal River, Unit 3 restricted the voltage and frequency TS surveillance limits for both slow and fast EDG starts
- April 30, 2009: DC Cook Nuclear Plant, Units 1 and 2 increased the EDG minimum steady-state voltage, increased the minimum steady-state frequency, and lowered the maximum steady-state frequency acceptance criterion for TS surveillance testing

### Full Load Rejection Test Voltage Limit

- December 17, 2015: Braidwood Station Units 1 and 2, and Byron Station, Units 1 and 2, increased the voltage limit for the EDG load rejection surveillance requirement
- April 24, 2015: Seabrook Station, Unit No.1 increased the voltage limit for the EDG load rejection surveillance requirement
- December 2, 2013: Wolf Creek Generating Station increased the EDG full load rejection test voltage limit



## Precedents: Steady-State Operation Parameters Davis Besse

Davis Besse Nuclear Power Station, Unit 1, requested changes to minimum voltage acceptance criterion in May 2012 and received a non-acceptance per email dated June 21, 2012 (ADAMS Accession No. ML14324A82), based upon the need for the items listed below. Harris has made changes to the LAR to address each item.

1. Excerpts from calculation(s) that establish the limiting voltage at various safety busses for equipment operability. Minimum starting voltage for large motors and the voltage drop at the remote safety buses associated with starting large motors. Confirm minimum voltage observed during load sequencing or large motor starts will not adversely impact equipment that was running with EDG nominal voltage.
2. Verify that EDG loading is within the capabilities of the EDG at the onset of an event when the pumps may be operating at run out conditions and during steady-state conditions with the EDG operating at the upper end of the allowable voltage and frequency.
3. Verify that the degraded voltage relays do not have to be reset (if actuated) during a loss off offsite power event when the EDG is required to supply plant loads.
4. Explain how the minimum frequency of  $\geq 58.8$  Hz and steady-state frequency values  $\geq 59.5$  Hz and  $\leq 60.5$  Hz are used to determine safeguards equipment operational requirements during design basis accident calculations.
5. Provide details on performance capabilities of accident mitigation equipment (pumps, motors, valves, etc.) when the EDG is operating at the lower end of the allowable voltage and frequency bands during design basis events.
6. Verify that motor operated valve performance is not adversely impacted (accident analyses) at the lower end of the TS allowable frequency coupled with the frequency/voltage variations allowed. The HNP LAR includes a summary of the evaluation of the proposed frequency range on MOVs.

Status of WCAP-17308-NP, Revision 0,  
"Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances"

- Pressurized Water Reactor Owners Group (PWROG) submitted WCAP-17308-NP to the NRC in September 2012.
- The NRC draft Safety Evaluation (DSE) for WCAP-17308-NP was issued for PWROG review in February 2016.
- Dialog regarding PWROG's comments on the WCAP-17308-NP DSE and NRC response to these comments is on-going.
- PWROG meeting provided licensees with the following update in December 2016:
  - There are two major issues remaining that need to be resolved for the PWROG to receive acceptance on WCAP-17308-NP, Revision 0, "Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances"
    - SR 3.8.1.2 (31-day Surveillance)
    - Consideration of manual connected loads
- WCAP-17308-NP will not be cited in the Harris LAR



### Westinghouse InfoGram 14-1 “Material Properties for Loss-of Coolant Accident Mass and Energy Release Analysis”

- The PWROG and Westinghouse are working to address the impact of InfoGram 14-1 for plants that are participating in the project. The details of the PWROG project were described during a meeting with NRC staff on June 1, 2016.
- The project is expected to result in a supplement to topical report WCAP-10325-P-A, “Westinghouse LOCA Mass and Energy Release Model for Containment Design,” that demonstrates sufficient methodology conservatism to address the issue.
- Harris is participating in the PWROG project and would implement the topical report supplement after NRC approval.

## Conclusion

- Change requested to TS SR 4.8.1.1.2.a.4, SR 4.8.1.1.2.e, SR 4.8.1.1.2.f.2, SR 4.8.1.1.2.f.4.b, SR 4.8.1.1.2.f.6.b, & SR 4.8.1.1.2.f.14 to restrict steady-state voltage and frequency test acceptance criterion
- Change requested to TS SR 4.8.1.1.2.f.11 to change the voltage limit for the EDG full load rejection test is 110% of the EDG voltage at the start of the test to 8,280 volts, which is 120% of the EDG nominal voltage rating of 6900 volts
- The proposed changes continue to provide adequate protection to public health and safety.



## ELECTRICAL POWER SYSTEMS

### A.C. SOURCES

#### OPERATING

#### LIMITING CONDITION FOR OPERATION

##### ACTION (Continued):

- h. With one automatic load sequencer inoperable:
  - 1. Restore the automatic load sequencer to OPERABLE status within 24 hours or be in at least HOT STANDBY within the next 6 hours and COLD SHUTDOWN within the following 30 hours.

#### SURVEILLANCE REQUIREMENTS

4.8.1.1.1 Each of the above required physically independent circuits between the offsite transmission network and the onsite Class 1E distribution system shall be:

- a. Determined OPERABLE at the frequency specified in the Surveillance Frequency Control Program by verifying correct breaker alignment and power availability, and
- b. Demonstrated OPERABLE at the frequency specified in the Surveillance Frequency Control Program by manually transferring the onsite Class 1E power supply from the unit auxiliary transformer to the startup auxiliary transformer.

4.8.1.1.2 Each diesel generator shall be demonstrated OPERABLE:

- a. At the frequency specified in the Surveillance Frequency Control Program by:
  - 1. Verifying the fuel level in the day tank,
  - 2. Verifying the fuel level in the main fuel oil storage tank,
  - 3. Verifying the fuel oil transfer pump can be started and transfers fuel from the storage system to the day tank,
  - 4. Verifying the diesel generator can start\*\* and accelerate## to synchronous speed (450 rpm) with generator voltage and frequency  $6900 \pm 690$  volts and  $60 \pm 1.2$  Hz,
  - 5. Verifying the diesel generator is synchronized, gradually loaded\*\* to an indicated 6200-6400 kW\*\*\* and operates for at least 60 minutes,
  - 6. Verifying the pressure in at least one air start receiver to be greater than or equal to 190 psig, and
  - 7. Verifying the diesel generator is aligned to provide standby power to the associated emergency buses.

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"276"

\*\* This test shall be conducted in accordance with the manufacturer's recommendations regarding engine prelube and warmup procedures, and as applicable, regarding loading recommendations.

\*\*\* This band is meant as guidance to avoid routine overloading of the engine. Loads in excess of this band for special testing or momentary variations due to changing bus loads shall not invalidate the test.

## The voltage and frequency conditions shall be met within 10 seconds or gradual acceleration to no-load conditions per vendor recommendations will be an acceptable alternative.

## ELECTRICAL POWER SYSTEMS

### A.C. SOURCES

#### OPERATING

#### SURVEILLANCE REQUIREMENTS (CONTINUED)

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##### 4.8.1.1.2 (Continued)

- b. Check for and remove accumulated water:
  - 1. From the day tank, at the frequency specified in the Surveillance Frequency Control Program and after each operation of the diesel where the period of operation was greater than 1 hour, and
  - 2. From the main fuel oil storage tank, at the frequency specified in the Surveillance Frequency Control Program .
- c. By sampling new fuel oil in accordance with ASTM-D4057-81 prior to addition to storage tanks and:
  - 1. By verifying, in accordance with the tests specified in ASTM-D975-81 prior to addition to the storage tanks, that the sample has:
    - a) An API Gravity of within 0.3 degrees at 60°F, or a specific gravity of within 0.0016 at 60°F, when compared to the supplier's certificate, or an absolute specific gravity at 60°F of greater than or equal to 0.83 but less than or equal to 0.89, or an API gravity of greater than or equal to 26 degrees but less than or equal to 38 degrees.
    - b) A kinematic viscosity at 40°C of greater than or equal to 1.9 centistokes, but less than or equal to 4.1 centistokes, if the gravity was not determined by comparison with the supplier's certification;
    - c) A flash point equal to or greater than 125°F; and
    - d) A clear and bright appearance with proper color when tested in accordance with ASTM-D4176-82.
  - 2. By verifying within 30 days of obtaining the sample that the other properties specified in Table 1 of ASTM-D975-81 are met when tested in accordance with ASTM-D975-81 except that the analysis for sulfur may be performed in accordance with ASTM-D1552-79 or ASTM-D2622-82.
- d. At the frequency specified in the Surveillance Frequency Control Program by obtaining a sample of fuel oil from the storage tank, in accordance with ASTM-D2276-78, and verifying that total particulate contamination is less than 10 mg/liter when checked in accordance with ASTM-D2276-78, Method A.
- e. At the frequency specified in the Surveillance Frequency Control Program, the diesel generators shall be started\*\* and accelerated to at least 450 rpm in less than or equal to 10 seconds. The generator voltage and frequency shall be 6900 ± 690 volts and 60 ± 1.2 Hz in less than or equal to 10 seconds after the start signal.

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"steady-state"

\*\* This test shall be conducted in accordance with the manufacturer's recommendations regarding engine prelube and warmup procedures, and as applicable regarding loading recommendations.



## ELECTRICAL POWER SYSTEMS

### A.C. SOURCES

#### OPERATING

#### SURVEILLANCE REQUIREMENTS (CONTINUED)

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##### 4.8.1.1.2 (Continued)

The generator shall be manually synchronized to its appropriate emergency bus, loaded to an indicated 6200-6400\*\*\*kW, and operate for at least 60 minutes. The diesel generator shall be started for this test by using one of the following signals on a rotating basis:

1. Simulated loss of offsite power by itself, and
2. A Safety Injection test signal by itself.

This test, if it is performed so that it coincides with the testing required by Surveillance Requirement 4.8.1.1.2.a.4, may also serve to concurrently meet those requirements as well.

- f. At the frequency specified in the Surveillance Frequency Control Program by:

1. DELETED
2. During shutdown, verifying that, on rejection of a load of greater than or equal to 1078 kW, the voltage and frequency are maintained with  $6900 \pm 690$  volts and  $60 \pm 6.75$  Hz, with frequency stabilizing to  $60 \pm 1.2$  Hz within 10 seconds without any safety-related load tripping out or operating in a degraded condition.
3. During shutdown, verifying that the load sequencing timer is OPERABLE with the interval between each load block within 10% of its design interval.
4. During shutdown, simulating a loss of offsite power by itself, and:

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"0.48"

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\*\*\* This band is meant as guidance to avoid routine overloading of the engine. Loads in excess of this band for special testing or momentary variations due to changing bus loads shall not invalidate the test.

# ELECTRICAL POWER SYSTEMS

## A.C. SOURCES

### OPERATING

#### SURVEILLANCE REQUIREMENTS (Continued)

##### 4.8.1.1.2 (Continued)

- a) Verifying de-energization of the emergency buses and load shedding from the emergency buses.
- b) Verifying the diesel starts\*\* on the auto-start signal, energizing the emergency buses with permanently connected loads in less than or equal to 10 seconds, energizing the auto-connected shutdown loads through the load sequencer, and operating for greater than or equal to 5 minutes while its generator is loaded with the emergency loads. After energization of these loads, the steady-state voltage and frequency shall be maintained at  $6900 \pm 690$  volts and  $60 \pm 1.2$  Hz.
5. During shutdown, verifying that on a safety injection test signal (without loss of power) the diesel generator starts on the auto-start signal and operates on standby for greater than or equal to 5 minutes.
6. During shutdown, simulating a loss of offsite power in conjunction with a safety injection test signal, and
  - a) Verifying de-energization of the emergency buses and load shedding from the emergency buses.
  - b) Verifying the diesel starts\*\* on the auto-start signal, energizing the emergency buses with permanently connected loads in less than or equal to 10 seconds, energizing the auto-connected emergency (accident) loads through the sequencing timers, and operating for greater than or equal to 5 minutes and maintaining the steady-state voltage and frequency at  $6900 \pm 690$  volts and  $60 \pm 1.2$  Hz.
  - c) DELETED

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\*\*This test shall be conducted in accordance with the manufacturer's recommendations regarding engine prelube and warmup procedures, and as applicable regarding loading recommendations.

# ELECTRICAL POWER SYSTEMS

## A.C. SOURCES

### OPERATING

#### SURVEILLANCE REQUIREMENTS (Continued)

##### 4.8.1.1.2 (Continued)

7. Verifying the diesel generator operates\*\* for at least 24 hours. During the first 2 hours of this test, the diesel generator shall be loaded to 6800-7000 kW\*\*\* and, during the remaining 22 hours of this test, the diesel generator shall be loaded to an indicated 6200-6400 kW\*\*\*.
8. DELETED
9. During shutdown, verifying the diesel generator's capability | to:
  - a) Synchronize with the offsite power source while the generator is loaded with its emergency loads upon a simulated restoration of offsite power.
  - b) Transfer its loads to the offsite power source, and
  - c) Proceed through its shutdown sequence.
10. DELETED
11. During shutdown, verifying the generator capability to reject a load of between 6200 and 6400 kW without tripping. |  
The generator voltage shall not exceed ~~110% of the generator voltage at the start of the test~~ during and following the load rejection;  

INSERT:  
"8280 volts"

 →
12. During shutdown, verifying that, with the diesel generator | operating in a test mode and connected to its bus, a simulated Safety Injection signal overrides the test mode by: (1) returning the diesel generator to standby operation and (2) automatically energizing the emergency loads with offsite power.

\*\*This test shall be conducted in accordance with the manufacturer's recommendations regarding engine prelube and warmup procedures, and as applicable regarding loading recommendations.

\*\*\*This band is meant as guidance to avoid routine overloading of the engine. Loads in excess of this band for special testing or momentary variations due to changing bus loads shall not invalidate the test.



## ELECTRICAL POWER SYSTEMS

### A.C. SOURCES

#### OPERATING

#### SURVEILLANCE REQUIREMENTS (CONTINUED)

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##### 4.8.1.1.2 (Continued)

13. During shutdown, verifying that all diesel generator trips, except engine overspeed, loss of generator potential transformer circuits, generator differential, and emergency bus differential are automatically bypassed on a simulated or actual loss of offsite power signal in conjunction with a safety injection signal.

14. During shutdown, verifying that within 5 minutes of shutting down the EDG, after the EDG has operated for at least 2 hours at an indicated load of 6200-6400 kw, the EDG starts and accelerates to  $6900 \pm 690$  volts and  $60 \pm 1.2$  hz in 10 seconds or less.

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"276"

g. At the frequency specified in the Surveillance Frequency Control Program or after any modifications which could affect diesel generator interdependence by starting\*\* both diesel generators simultaneously, during shutdown, and verifying that both diesel generators accelerate to at least 450 rpm in less than or equal to 10 seconds.

h. At the frequency specified in the Surveillance Frequency Control Program by:

- 1) Draining each main fuel oil storage tank, removing the accumulated sediment, and cleaning the tank using a sodium hypochlorite solution or other appropriate cleaning solution, and
- 2) Performing a pressure test, of those isolable portions of the diesel fuel oil piping system designed to Section III, subsection ND of the ASME Code, at a test pressure equal to 110% of the system design pressure.

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"steady-state"

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\*\* This test shall be conducted in accordance with the manufacturer's recommendations regarding engine prelube and warmup procedures, and as applicable regarding loading recommendations.