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Project Number 694

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Subject: PWR Owners Group
Submittal of Request for Additional Information Response Regarding WCAP-17308-NP, Revision 0, " Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances," PA-LSC-0681

References:

1. Letter OG-12-162, "Submittal of WCAP-17308-NP, Revision 0, "Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances," PA-LSC-0681, May 1, 2012 (ML12234A250)

2. NRC Letter of Acceptance for Review of PWROG Topical Report WCAP-17308-NP, Revision 0, "Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances dated July 16, 2012 (TAC NO. ME8689)

3. NRC Letter for Request for Additional Information RE: PWROG Topical Report WCAP-17308-NP, Revision 0, "Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances", dated February 25, 2013 (TAC NO. ME8689)

4. Letter OG-13-126, Submittal of Request for Additional Information (RAI) Response Regarding WCAP-17308-NP, Revision 0, " Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances," PA-LSC-0681

5. NRC Letter for Request for Additional Information RE: Pressurized Water Reactor Owners Group Topical Report WCAP-17308-NP, Revision 0, "Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances", dated July 10, 2013 (TAC NO. ME8689) – ML13151A065

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Designated as original
05/05/15 by Jonathan Rowley

On May 1, 2012, the Pressurized Water Reactor Owners Group (PWROG) requested formal NRC review and approval of WCAP-17308-NP, Revision 0, in accordance with the Nuclear Regulatory Commission (NRC) Topical Report (TR) program for review and acceptance for referencing in regulatory actions (reference 1). Upon NRC review of the TR, the NRC staff has determined that additional information is needed (RAI) to complete the review per letter dated February 25, 2013 (reference 3). Responses to those questions were provided to the staff per PWROG letter OG-13-126 (reference 4). Subsequently, the PWROG received a second set of RAIs from the NRC staff on July 10, 2013 (reference 5).

Enclosed please find the PWROG response to the second set of NRC Request for Additional Information (RAI) Questions issued July 10, 2013.

Enclosed are:

1 copy of response to second set of NRC RAI Questions (Non-Proprietary)

If you have any questions, please do not hesitate to contact me at 205-992-7037 or Mr. W. Anthony Nowinowski of the PWR Owners Group Program Management Office at 412-374-6855 or Chad Holderbaum at 412-374-6230.

Sincerely yours,

Jack Stringfellow, Chairman
PWR Owners Group

cc: PWROG Management Committee
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REQUEST FOR ADDITIONAL INFORMATION (RAI) QUESTIONS

PRESSURIZED WATER REACTOR (PWR) OWNERS GROUP

WCAP-17308-NP, REVISION 0

"TREATMENT OF DIESEL GENERATOR (DG) TECHNICAL SPECIFICATION FREQUENCY AND VOLTAGE TOLERANCES"

BACKGROUND DOCUMENTS

1) PWR Owners Group Topical Report WCAP-17308-NP, "Treatment of Diesel Generator (DG) Technical Specification Frequency and Voltage Tolerances"

Section 1.1, "Background," has the following statements:

The minimum and maximum frequency values of 58.8 hertz (Hz) and 61.2 Hz and voltage values of 3740 volts (V) and 4580 V typically contained in plant-specific Technical Specification (TS) Surveillance Requirements (SR) are equal to plus or minus (±) 2 percent of the 60 Hz nominal frequency and ±10 percent of the 4160 V nominal voltage (i.e., the plant specific transient range specified in the Technical Specifications). However, the ±2 percent frequency tolerance and ±10 percent voltage tolerance is only applicable to DG starting and loading transients, and does not apply to steady-state operation as discussed in Regulatory Guide (RG) 1.9, Revision 3. The WCAP states further that the frequency and voltage criteria are specified in the context of the capability of the DG to recover from a transient such as DG load sequencing.

Section 1.2, "Issue," has the following statements:

To be consistent with the safety analyses and DG steady-state loading calculations, the ±2 percent criterion on frequency and the ±10 percent criterion on voltage should not have been incorporated into the TS as steady-state operating criteria. In these analyses and calculations, the motors were assumed to be operating at nominal frequency and voltage; therefore, operating the DG at the extremes of frequency and voltage could have a significant impact on the safety analyses.

Section 1.3, "Approach," has the following statements:

Some licensees have addressed the issue of DG frequency and voltage variation in their safety analyses by assuming that the motors are operating at the extremes of transient frequency and voltage limits, and calculating the impacts on pump flows, developed head, DG steady-state loading, and resulting core response.

The joint team decided that a project authorization should be developed that reflects the following items:

1. The TS and Bases need to be revised to clarify that the ±2 percent frequency and ±10 percent voltage tolerances are for DG loading transients, in accordance with RG 1.9 and not steady-state operation.

2. The development of a generic methodology that addresses DG frequency and voltage tolerances, as well as test measurement uncertainties, will be adopted in the pump inservice testing program, so that the emergency core cooling system flows and safety analyses will not be impacted. The DG frequency and voltage tolerances will be treated as uncertainties and statistically combined with the test measurement instrument uncertainties and setpoint tolerances.

2) NUREGs 1430, 1431 and 1432, "Technical Specifications"

The NUREGs have the following SR in Section 3.8.1.2:

Verify each DG starts from standby conditions and achieves steady state voltage > [3740] V and < [4580] V, and frequency > [58.8] Hz and < [61.2] Hz.

(It should be noted that the NUREGs provide typical range of values for steady state voltage and frequency of the Diesel Generators. The licensees are expected to use plant specific steady state voltage and frequency values based on the capability of the onsite power systems.)

3) Regulatory Guide 1.9, Revision 3, "Selection, Design, Qualification And Testing of Emergency Diesel Generator Units Used As Class 1E Onsite Power Systems At Nuclear Power Plants"

Section C 1.4 has the following recommendation:

The DG should be designed such that the frequency will not decrease, at any time during the *loading sequence*, to less than 95 percent of nominal and the voltage will not decrease to less than 75 percent of nominal. (A larger decrease in voltage and frequency may be justified for a diesel generator that carries only one large connected load.) Frequency should be restored to within 2 percent of nominal in less than 60 percent of each load-sequence interval for a steploaad increase, and less than 80 percent of each load-sequence interval for disconnection of the single largest load. Voltage should be restored to within 10 percent of nominal within 60 percent of each load-sequence interval. The acceptance value of the frequency and voltage should be based on plant-specific analysis (where conservative values of voltage and frequency are measured) to prevent load interruption.

ELECTRICAL ENGINEERING BRANCH (EEEB) RAIs

EEEB-RAI 1

The transient voltage and frequency drops delineated in RG 1.9 are significantly larger than the typical steady state tolerances referenced in NUREGs -1430, -1431 and -1432 and clearly identify the applicability during the loading sequence. Explain why the WCAP considers that the steady state ±2 percent frequency tolerance and ±10 percent voltage tolerance as only applicable to DG starting and loading transients, and does not apply to steady-state operation.

Response to EEEB RAI 1):

As discussed in the excerpt from Section C 1.4 above, the ±2% frequency tolerance and ±10% voltage tolerance are recovery criteria, associated with the design capability of the DG to

recover from loading transients, and not steady state operation criteria. After a DG is loaded, the frequency and voltage are maintained (controlled) around the nominal values of 60 Hz and [4160] V by the governor and voltage regulator, respectively. A properly functioning governor and voltage regulator will maintain frequency and voltage within tolerances significantly smaller than ±2% Hz and ±10% V, respectively.

EEEB-RAI 2

Provide confirmation that majority of plants participating in the PWR Owners Group will be able to demonstrate the capability of the DGs to maintain voltage and frequency in compliance with the proposed TS change in the WCAP during DG load sequencing transients.

Response to EEEB RAI 2):

The PWROG members will include their plant specific tolerances for frequency and voltage, based on the performance capability of their governor and voltage regulator, after the WCAP and TSTF Traveler are approved by the NRC, and plant specific LARs are submitted. Please see the bracketed voltage and frequency ranges in the Technical Specification markups of NUREG-1431, for SRs 3.8.1.7, 3.8.1.11, 3.8.1.12, 3.8.1.15, 3.8.1.19, and 3.8.1.20, in Appendix A of WCAP-17308-NP. The voltage and frequency ranges that are contained in brackets, would be replaced with ranges based on the plant specific performance capability of their governor and voltage regulator.

These plant specific ranges would be applicable after the DG is loaded, when frequency and voltage are being controlled by the governor and voltage regulator, not during load sequencing. During load sequencing, the ±2% frequency tolerance and ±10% voltage tolerance are applicable, as discussed in Regulatory Guide 1.9, Rev. 3.

EEEB-RAI 3

The DGs are designed to provide sufficient power for the electrical loads required for a safe shutdown of the plant. This includes the loads required to mitigate the effects of a design basis LOCA with a complete loss of off-site power. To validate the capability of the DGs to perform this function, the TS require a monthly surveillance run. In order to be considered operable, structures, systems and components (SSC) must be capable of performing the safety functions specified by its design, within the required range of design physical conditions, initiation times, and mission times. The staff recognizes that equipment may not be able to function at an absolute value and therefore specifies an acceptable range of parameters to demonstrate capability and operability of the equipment. The staff considers specified voltage and frequency parameters as one of the indicators that a DG will perform its intended function. Provide details on what parameters could be used to verify operability of a DG and hence the capability of the safety related equipment powered by the DG, if voltage and frequency range, as specified in current TSs, should not be required to demonstrate steady state operating capability.

Response to EEEB RAI 3):

SR 3.8.1.2 in NUREGs-1430, 1431, and 1432, is a functional test of the DG, that is performed every 31 days, to demonstrate that the DG starts from a standby condition, and maintains steady state voltage and frequency to nominal values of [4160] V and [60] Hz, respectively.

This 31 day test (SR 3.8.1.2) is performed more frequently than SR 3.8.1.7, which is performed every 184 days, and SRs 3.8.1.11, 3.8.1.12, 3.8.1.15, 3.8.1.19, and 3.8.1.20, which are performed every 18 months. The 31 day test is adequate to demonstrate DG operability on a more frequent basis, without demonstrating the capability of the DG to power the associated safety related equipment. This test is typically performed with the DG parallel to the grid, in which case voltage and frequency are dictated by the grid. This test can also be performed in the slow start mode, and is therefore not intended to be a design basis test, but rather a functionality test that verifies that the DG starts, and achieves nominal voltage and frequency.

Therefore, verifying that the DG starts from a standby condition and maintains steady state steady state voltage and frequency to nominal values of [4160] V and [60] Hz, respectively, is sufficient to demonstrate operability of the DG, since the less frequently performed SRs (SRs 3.8.1.7, 3.8.1.11, 3.8.1.12, 3.8.1.15, 3.8.1.19, and 3.8.1.20) demonstrate the capability of safety related equipment powered by the DG. It should be noted that SR 3.8.1.7, which is performed every 6 months, is a fast-start test, and does not power the safety related plant loads. These surveillances verify that the DG performs within the design basis.

EEEB-RAI 4

The WCAP recognizes that a DG operating at the extremes of frequency and voltage could have a significant impact on the safety analyses and that the original plant design assumed DGs operating at nominal voltage and frequency. The WCAP also states that licensees who have evaluated the issue of voltage and frequency variation in their safety analysis have used up significant analytical margin. Voltage and frequency are independently controlled by the exciter and the governor. A diesel generator operating at the lower end of the allowable steady state voltage and frequency will have an additive effect on the torque produced by a motor as depicted in Figures 2.4 and 2.5 of the WCAP report. The analytical methods used to calculate the available motor torque and pump speed at the extremes of the allowable range therefore provide a realistic value for performance capabilities of the diesel generators and the operating equipment. Explain why the method proposed in the WCAP will be conservative and provide assurance that the performance capabilities of the pumps and valves which may have little or no margin when operating at nominal design value will not adversely impact the safe shutdown capability of the plant.

Response to EEEB RAI 4):

The WCAP methodology treats pumps and valves using different approaches.

For pumps, the WCAP provides the licensee with a method to evaluate the effects of diesel generator frequency and voltage variations on pump developed hydraulic head. The intent of the WCAP is for licensees to conservatively modify the IST acceptance criteria for the pumps to incorporate the calculated impact on pump hydraulic head due to steady state variations in diesel generator frequency and speed. This will ensure the pumps perform their safety function accounting for the maximum expected variations in diesel generator steady state frequency and voltage.

For valves, the WCAP provides the licensee with a method to evaluate the effects of diesel generator frequency changes on valve stroke time and valve inertia and the effects on actuator thrust due to changes in valve differential pressure associated with changes in diesel generator frequency or voltage variations. The intent of the WCAP is for licensees to use this method to verify that MOVs have sufficient margin to accommodate expected variations in diesel generator

frequency and voltage. The WCAP methodology also requires the licensee to confirm the voltage variation of the diesel generator voltage regulator is within the allowable operating voltage range for the MOV motors to ensure that there would be no adverse impact on the MOV motors from the maximum expected voltage variation allowed by the voltage regulator. This approach will ensure that MOVs have sufficient margin to accommodate expected variations in diesel generator frequency and voltage.

This RAI is in reference to the DG operating at the lower end of the voltage and frequency. The methodology in WCAP-17308 verifies that the DG is operating within the capabilities of the voltage regulator and the governor, and therefore it is not necessary to evaluate the DG operating at lower end of the voltage and frequency. The methodology ensures that the impact of variations in voltage and frequency are within the design capabilities of the voltage regulator and governor. The issue is not whether the methodology is conservative, but whether it verifies that the DG is operating correctly, and accounts for normal variations within the correct operating bands.

EEEB-RAI 5

Explain why the safety analyses and available margins impacted by the capability of the DG operating in an allowable band should not be updated in view of reduced margins due to plant modifications associated with load growth, power uprates and component replacement.

Response to EEEB RAI 5):

The safety analyses are based on the ECCS flows, which are developed based on a nominal frequency of 60 Hz and a nominal voltage of 4160 V. ECCS pump performance is based on meeting the Inservice-Test (IST) pump curves during surveillance testing. Meeting the IST pump curves during surveillance testing, ensures that the ECCS pumps will deliver the ECCS flow that is assumed in the safety analyses. Adjusting the IST pump curves to include the control bands associated with the governor and voltage regulator, addresses the variations in frequency and voltage about the nominal frequency of 60 Hz and a nominal voltage of 4160 V, upon which the ECCS flows that are assumed in the safety analyses, were developed.

Unless the ECCS flows that are assumed in the safety analyses are revised, which results in a change to the ECCS pump IST curves, the impact of plant modifications associated with load growth, power uprates and component replacement would not impact the safety analyses.

If a plant modification associated with load growth, power uprates and component replacement impacts the ECCS flows that are assumed in the safety analyses, and the revised ECCS flows results in a change to the ECCS pump IST curves, then the revised ECCS pump IST curves would have to be adjusted to reflect the impact of the variation in frequency and voltage associated with the governor and voltage regulator. Adjusting the revised ECCS pump IST curves to reflect the impact of the variation in frequency and voltage associated with the governor and voltage regulator, ensures that the ECCS flows that are assumed in the safety analyses will be met.

EEEB-RAI 6

The WCAP proposes that the DG frequency and voltage tolerances be treated as random uncertainties. Typically, the uncertainty analysis associated with setpoint methodology for safety related components verifies that:

a) The analysis parameters and assumptions are consistent with the safety analysis, system design basis, TSs, plant design, and expected maintenance practices.

b) The relationships between the safety limit, analytical limit, the allowable value, the setpoint, the as-found limit and the as-left limit are clearly defined and provide assurance that controls and system variables maintain safety related systems within prescribed operating ranges.

If the DG voltage and frequency are considered random uncertainties, then provide details on methodology that the licensees should use to establish *the analytical limits* which ensure that the DGs are not overloaded, the load testing and fuel oil requirements in the technical specifications are bounding, and the equipment powered by the DGs will function satisfactorily at the extremes of allowable operating range.

Response to EEEB RAI 6):

There are no safety limits, analytical limts or allowable values associated with convoluting the uncertainties (control bands) associated with the governor and voltage regulator, using a Square-Root-Sum-of the Squares (SRSS) method. The safety analyses do not assume that the tolerance bands associated with the governor and voltage regulator actuate any instrumentation.

The SRSS methdolodogy is also used for the development of instrument uncertainties for the Reactor Trip System (RTS) and Engineered Safety Features Actuation System (ESFAS) Instrumentation setpoints.

The development of the RTS and ESFAS Instrumentation setpoint uncertainties, ensures that the Safety Analysis Limit (SAL), for the applicable RTS or ESFAS Instrument setpoint that is assumed in the safety analyses, is protected by the nominal trip setpoint, which includes uncertainties. The actuation of some RTS and ESFAS instrumentation, is credited, to ensure that the reactor core and reactor coolant system pressure safety limits, are not exceeded in the analysis of the postulated accidents that are assumed to occur. There are no safety analyses that are performed that assume that the tolerance bands associated with the governor and voltage regulator actuate any instrumentation.

The SRSS methodology that is discussed in WCAP-17308, just adds the tolerance bands associated with the governor and voltage regulator, to the measurement and test equipment (M&TE) uncertainties that are currently considered in the adjustment of the ECCS pump IST curves. This approach addresses the variations in frequency and voltage about the nominal frequency of 60 Hz and a nominal voltage of 4160 V, upon which the ECCS flows that are assumed in the safety analyses, were developed.

Fundamentally, the methodology in WCAP-17308 is based on the equipment operating *within its design basis, not at the extremes of the operating range.* That is the basis of the methodology. The methodology assumes that the DG is operating as it is designed to operate, i.e., that the DG is operating at a nominal 60 Hz and [4160] volts, within the capabilities of the controls. The methodology treats the variations of the controls *around the design basis parameters of voltage and frequency* as random in nature. The effects of these variations are then used to adjust equipment standards such as pump curves, so that when the equipment is determined by

Surveillance to be operating within these standards, the safety analyses assumptions are met. This is different from an actuation setpoint as discussed above.