PWR Owners Group-NRC Meeting

PWROG Program to Address Technical Specification Diesel Generator (DG) Frequency and Voltage Tolerances

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PWR Owners Group-NRC Meeting

Agenda

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- Schedule
- Summary and Conclusions
- Open Discussion

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Background

- The Standard Technical Specifications (TS) contain Surveillance Requirements (SRs) that verify diesel generator (DG) voltage and frequency.
  - Frequency is allowed to vary $\pm$ 2%
    - 58.8 Hz – 61.2 Hz
  - Voltage is allowed to vary up to $\pm$ 10% (rounded to the nearest 10 volts)
    - 3740 V – 4580 V (for a 4160 V system)

Background (cont.)

- The wording of the TS SRs on DG voltage and frequency would allow steady state DG operation within those limits.
- Over the last several years, NRC Component Design Basis Inspection (CDBI) inspectors have asked licensees if their design basis considers steady state DG operation at the extremes of these voltage and frequency limits.
- Steady state DG operation at the extremes of the voltage and frequency limits has a broad design basis impact. To name a few:
  - Emergency Core Cooling System (ECCS) performance.
  - Auxiliary Feedwater System (AFW) performance.
  - DG loading capacity.

Background (cont.)

- Licensee approaches to address the issue have varied:
  - Some have done extensive reanalysis (core response, DG loading, etc.) at the expense of significant analytical margin.
  - Some have changed TS SR limits to significantly tighten the operating bands on DG voltage and frequency.
  - Some have been able to demonstrate that the TS allowance is not a safety issue.

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Issue

- Current TS limits on DG voltage and frequency are derived from Regulatory Guide (RG) 1.9, "Selection, Design, Qualification, and Testing of Emergency Diesel Generator Units used as Class 1E Onsite Electric Power Systems at Nuclear Power Plants," Revision 3
- Section 1.4 under Design Considerations of the RG states, in part, the following:
  - "Frequency should be restored to within 2 percent of nominal in less than 60 percent of each load-sequence interval for step-load increase and in less than 80 percent of each load sequence interval for disconnection of the single largest load, and voltage should be restored to within 10 percent of nominal within 60 percent of each load-sequence time interval."

Issue (cont.)

- Section 2 of RG 1.9, Revision 3 describes DG testing. With regard to DG voltage and frequency during testing, the RG states:
  - "Verify that the emergency diesel generator reaches required voltage and frequency within acceptable limits and time as defined in the plant technical specifications. "
- The 2% criterion on frequency and the 10% criterion on voltage are not specified in Section 2 of RG 1.9, Revision 3.
- It is important to note that the 2% criterion on frequency and the 10% criterion on voltage are starting and accelerating design criteria for the DG.
- The 2% criterion on frequency and the 10% criterion on voltage are specified in the context of the capability of the DG to recover from a transient such as DG load sequencing.

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Issue (cont.)

- The 2% criterion on frequency and the 10% criterion on voltage are recovery criteria.
- To be consistent with the safety analyses and DG steady state loading calculations, the 2% criterion on frequency and the 10% criterion should not have been incorporated into the TS as steady state operating criteria.
- The issue is generic to the entire PWR fleet.
- The pump flows used in the safety analyses are based on the driving motors operating at nominal motor nameplate ratings (allowing for some pump degradation).
  - This means that the motors driving the pumps are operating at nominal frequency and voltage.
- DG steady state loading calculations are typically based, in part, on the motors operating at nominal frequency and voltage.

Issue (cont.)

- Some licensees have addressed this issue in the safety analyses.
  - Assume the motors are operating at the extremes and calculate the impacts on pump flows, developed head, and resulting core response. Calculate impact on DG steady state loading.
  - Uses significant analytical margin, e.g., peak clad temperatures, DG margins, etc.
  - Many safety analyses may not have sufficient margin, therefore the TS DG operating limits have to be reduced.
  - Rather than assuming that the DG is operating at the extremes of the frequency and voltage limits after loading, i.e., treating the limits as a bias, assume that the DG is set up to control to a nominal 60 Hz and the correct nominal voltage for the design (e.g., 4160 V).
  - The issue then becomes how to account for the ability of the control system to control around those nominal values.

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Approach

- A properly operating governor and voltage regulator will be able to control around a nominal value within the manufacturer's specified tolerance.
- This is validated on a monthly basis when the DG is synchronized to the grid. Synchronization requires precise control.
- If the tolerance is treated as an uncertainty, similar to an instrument setpoint, an uncertainty calculation can be performed, which considers the manufacturer's specified tolerance, instrument uncertainties, and setting tolerances.
- The results of the statistical uncertainty calculation for governor and voltage regulator performance will be translated into an impact on pump flow and developed head.
- This impact will then be factored into the In-Service Testing (IST) acceptance criteria for the affected pumps.

Approach (cont.)

- The program will develop a methodology for performing the uncertainty calculation that will allow the licensees to input their plant specific uncertainties and tolerances for DG frequency control, DG voltage control, and instrument uncertainties associated pump performance monitoring.
- The results of the statistical uncertainty calculation for governor and voltage regulator performance will be translated into an impact on pump flow and developed head.
- This impact will then be factored into In-Service Testing (IST) acceptance criteria for the affected pumps.

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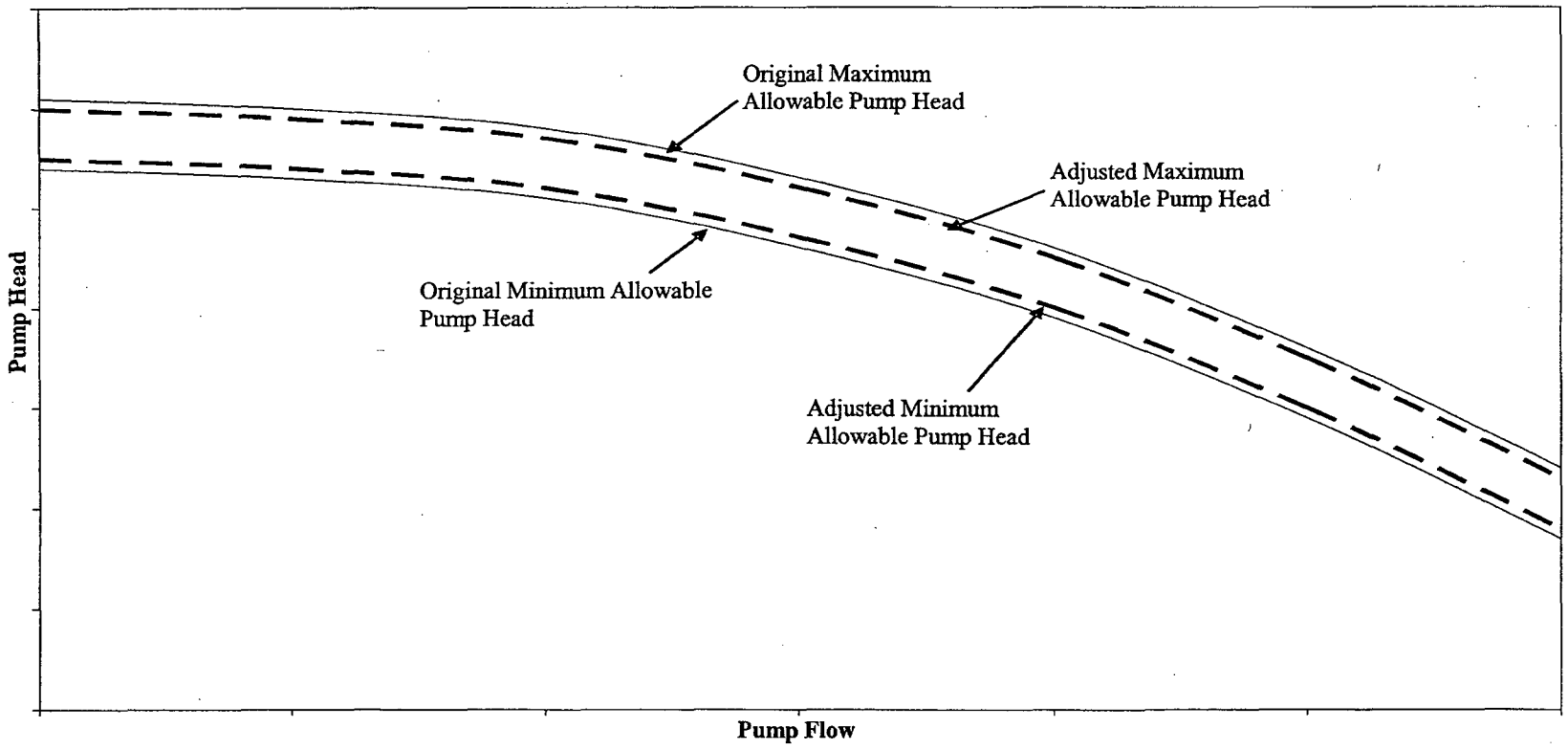
Approach (cont.)

Changes to IST Requirements to Address DG Voltage/Frequency Variations



TSTF Traveler

- The STS will need to be revised to capture the concept that the 2% criterion on frequency and the 10% criterion on voltage are recovery criteria (e.g., load sequencing).
- The STS Bases will be revised discuss the methodology used to consider the capability of the governor and voltage regulator to control around their nominal values.
- This is similar to the treatment of Reactor Protection System (RPS) and the Engineered Safety Feature Actuation System (ESFAS) setpoints.
- During steady state operation, the DG should be verified to be controlling frequency and voltage to their respective nominal values.

Schedule

- The methodology, which will be documented in a Topical Report (WCAP), will be submitted to the NRC for review and approval by December 31, 2010.
- The TSTF Traveler (containing the TS and Bases changes) will also be submitted for NRC review and approval by December 31, 2010.
- The PWROG will request a one year review by NRC.

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Summary and Conclusions

- The issue continues to be raised by NRC CDBI inspectors.
- The current STS and plant specific TS allow steady state DG operation within the limits in the TS SRs.
- A properly operating DG governor and voltage regulator will control the DG to within the manufacturer's specified tolerance after loading.
- The TS will be revised to be consistent with RG 1.9, Revision 3.
- The issue has been addressed by some licensees on a plant specific basis.
- The approach used to address the issue has varied.
- The PWROG program will ensure a consistent approach to address the issue.

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Open Discussion