

# 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

- Background
- Methodology to Adjust Pump IST Curves
- Results of a Plant-Specific Application of the Methodology
- Topical Report Content
- TSTF Traveler
- Schedule
- NRC Letter Acknowledging PWROG Program
- 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)

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### 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.

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### Methodology to Adjust Pump IST Curves

- Consider 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).
- Account for the capability of the control systems, i.e., governor and voltage regulator to control around those nominal values.
- Treat the tolerance as an uncertainty, similar to an instrument setpoint, and perform an uncertainty calculation which considers the specified tolerance, measurement and test instrument uncertainties, and setting tolerances.

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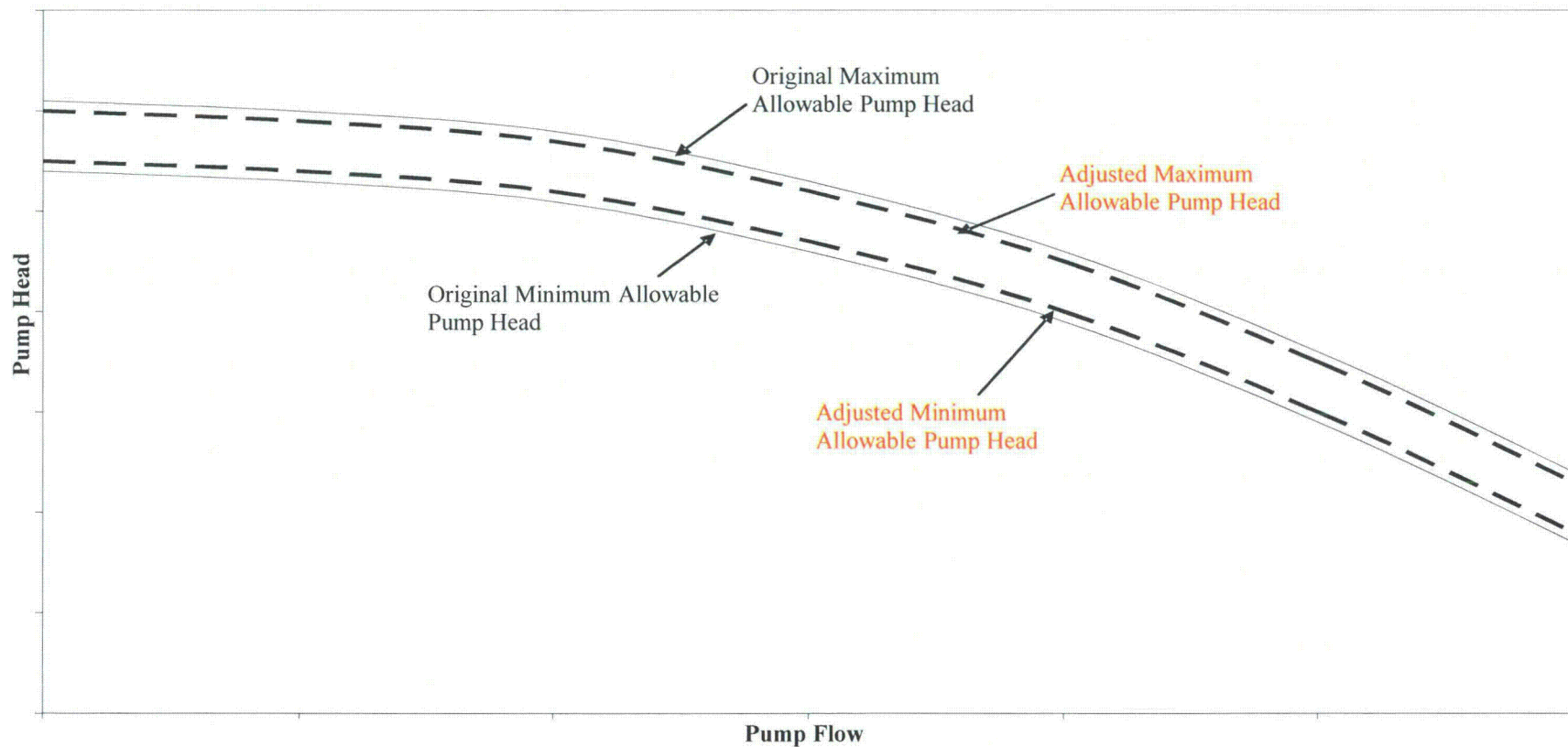
### Methodology to Adjust Pump IST Curves (cont.)

- The methodology for performing the uncertainty calculation 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 the 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.

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## Methodology to Adjust Pump IST Curves (cont.)

### Changes to IST Requirements to Address DG Voltage/Frequency Variations



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### Results of a Plant-Specific Application of the Methodology

- Pump/Motor Nominal Operating Speed – 3552 RPM
- Motor Synchronous Speed – 3600 RPM
- Diesel Generator Nominal Data
  - $f_N = 60$  Hz
  - $V_N = 4000$  V
- Diesel Generator Uncertainty Band
  - $U_f = 0.4$  Hz
  - $U_v = 210$  V

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### Method of Adjusting the Pump Curve

- Determine the total change in pump develop head
  - Must be evaluated at each point on curve
    - Uncertainty in head due to head measurement
    - Uncertainty in head due to flow measurement
    - Uncertainty in head due to uncertainty in speed

$$U_{\Delta H, Total} = \sqrt{U_{\Delta H}^2 + U_{\Delta H-Q}^2 + U_{\Delta H-S}^2}$$

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### Method of Adjusting the Pump Curve

- Determine change in pump/motor speed

$$U_s = \left( 1 - \left( \frac{V_{Nom}}{V_{Nom} + U_v} \frac{f_{Nom} + U_f}{f_{Nom}} \right)^2 \right) (S_{Synchronous} - S_{Nom}) + \left( \frac{U_f}{f_{Nom}} \right) S_{Nom}$$

$$U_s = \left( 1 - \left( \frac{4000V}{4210V} \frac{60.4Hz}{60Hz} \right)^2 \right) (3600 - 3552) + \left( \frac{0.4Hz}{60Hz} \right) 3552 = 28RPM$$

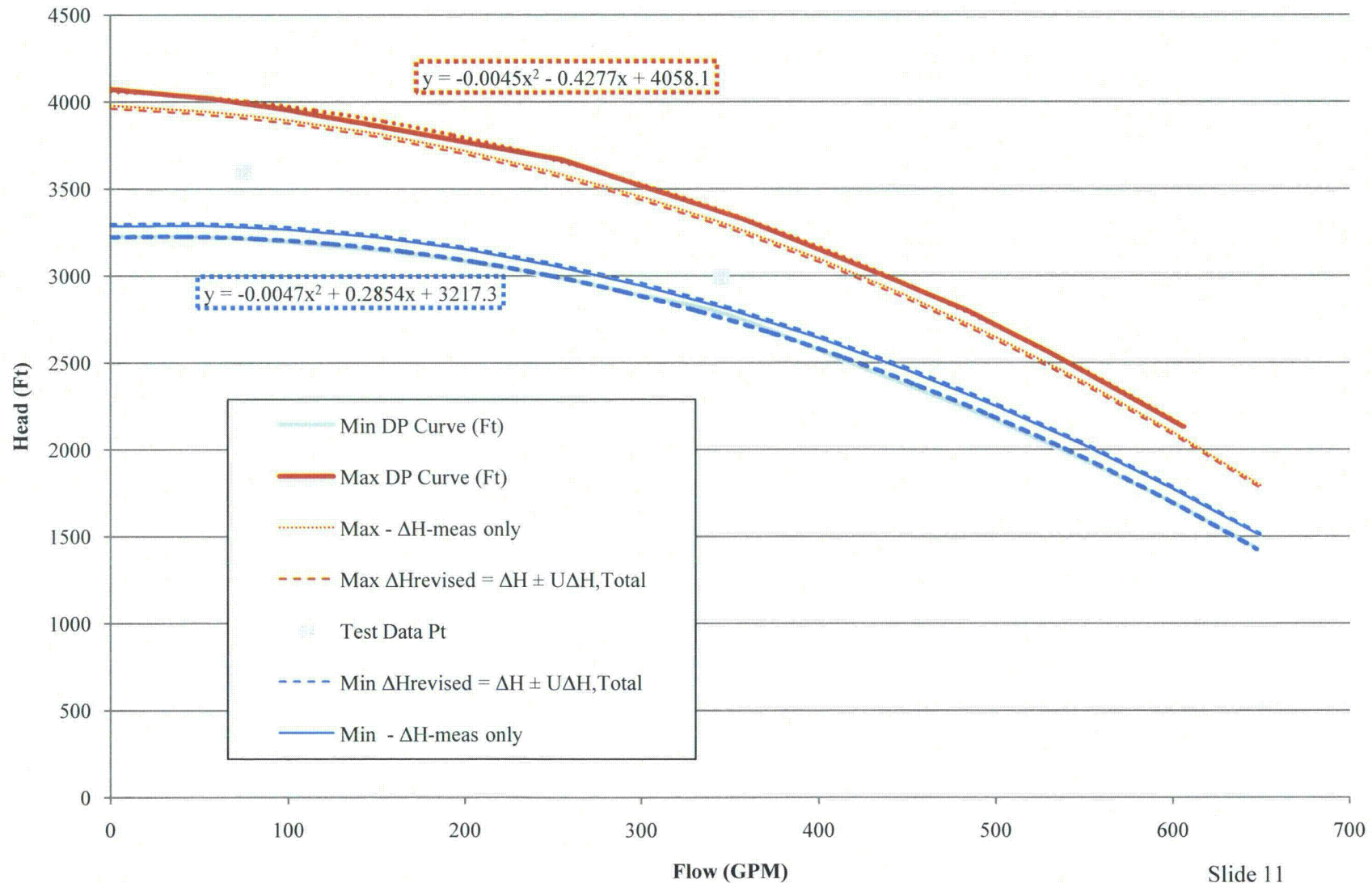
- Determine associated change in pump develop head
  - Must be evaluated at each point on curve

$$U_{\Delta H-s} = \Delta H \left[ \left( \frac{S_{Nom} + U_s}{S_{Nom}} \right)^2 - 1 \right] + \left| \frac{d(\Delta H)}{dQ} \right| \left( \frac{U_s}{S_{Nom}} \right) Q$$

$$U_{\Delta H-s} = \Delta H [0.016] + \left| \frac{d(\Delta H)}{dQ} \right| (0.008) Q$$

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## Min/Max Pump Performance Curves



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### Topical Report Content

- Methodology to Adjust Pump IST Curves
- Impact on DG Loading Calculations
- Impact on DG Fuel Consumption Calculations
- Impact on MOV Performance
- Impact on Ventilation Fans Credited in the Dose Analyses

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### TSTF Traveler

- The 2% criterion on frequency and the 10% criterion on voltage are recovery criteria (e.g., load sequencing for machined design) in accordance with RG 1.9, Rev 3.
- STS will be revised as follows
  - Steady state voltage **at a nominal value of [4160] V and frequency at a nominal value of [60] Hz within limits.**  
 ~~$\geq [3744] \text{ V}$  and  $\leq [4576] \text{ V}$ , and frequency  $\geq [58.8] \text{ Hz}$  and  $\leq [61.2] \text{ Hz}$ .~~
- During steady state operation, the DG should be verified to be controlling frequency and voltage to their respective nominal values.

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### TSTF Traveler (cont.)

- STS Bases Changes
  - The SR also demonstrates that the DG can maintain voltage and frequency within a band around the nominal values of [4160] V and [60] Hz. The band placed around these nominal values is based on the capability of the voltage regulator and governor. These limits are determined in accordance with WCAP-17308-P (Ref. 11). WCAP-17308-P provides the methodology to evaluate the impact of variations in voltage and frequency, due to the voltage regulator and governor, on pump flow and developed head, DG loading and fuel consumption calculations, MOVs, and filtration fans.

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### Schedule

- The Topical Report (WCAP), will be submitted to the NRC for review and approval in the 4<sup>th</sup> Quarter of 2011.
- The PWROG will request a one year review by the NRC.
- Include Tech Spec and Bases markups in the Topical Report.
- Submit Traveler for NRC review after the Staff issues the DSE for the TR.

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### NRC Letter Acknowledging the PWROG

- The NRC issued a letter on January 21, 2011 regarding a non-conservative Tech Spec and the timely submittal of a LAR.
- The PWROG will submit a letter stating that interim actions (procedure changes) have been implemented to ensure that DG frequency and voltage are being controlled properly, such that there is reasonable assurance that the DG performance assumed in the licensing basis analyses will be maintained while a generic solution to correct the deficiency is completed.
- The PWROG requests the Staff to issue a similar letter for this issue.

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## Summary and Conclusions

- The issue continues to be raised by NRC 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 a specified tolerance after loading.
- 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 generic approach to address the issue.