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NRC Acceptance Considerations for Ultrasonic Flow Measurement (UFM) of Feedwater Flow Rate in Nuclear Power Plants

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Discussion Topics

- Regulatory Background
- Acceptance Criteria
- Application Considerations

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Regulatory Background

- Appendix K of Part 50, Title 10, Code of Federal Regulations, originally required accident and transient analyses be conducted by assuming a thermal power of at least 1.02 x licensed power.
- Provided reasonable assurance that instrumentation uncertainties were adequately accounted for when operating at 100% of licensed power.

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Regulatory Background - Continued

- Regulation changed in 2000 to allow a lower assumed uncertainty on power level if justified by quantifying lower uncertainties in instrumentation used to determine thermal power.
- ~80 percent of the thermal power uncertainty is due to the uncertainty in measurement of feedwater flow rate.

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Regulatory Background - Continued

- Consequently, licensees began using ultrasonic flow meters (UFMs) to reduce uncertainty and allow operation at a higher power without exceeding design analysis limit.
- UFMs are used for (1) **power recovery** to account for venturi or flow nozzle fouling and (2) to obtain a **power uprate** that allows the licensed thermal power to be increased.

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Regulatory Background - Continued

- Venturis used to measure feedwater flow rate may indicate a flow rate higher than actual due to fouling that decreases the effective throat area.
- Therefore, with fouling the indicated thermal power is greater than actual thermal power.
- Consequently, plant thermal power must be reduced or the effect must be quantified so that indicated thermal power does not exceed licensed thermal power.

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Regulatory Background - Continued

- A UFM can be used to recalibrate a venturi to account for the effect of fouling.
  - Called “Power Recovery”
  - Can be accomplished without prior NRC approval in accordance with 10 CFR 50.59.

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Regulatory Background - Continued

- UFMs can also be used to reduce uncertainty associated with the licensed thermal power.
- For example, if thermal power uncertainty is 0.5% with installed UFMs rather than the 2% previously assumed, then licensed thermal power can be increased by 1.5%.

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Regulatory Background - Continued

- This measurement uncertainty recovery power uprate requires a license amendment and NRC approval since licensed thermal power is changed.
- Many licensing bases analyses were done for 1.02% thermal power and remain valid.

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Acceptance Criteria

- Traceability to a recognized national standard. This requires:
  - No breaks in chain of comparisons
  - All links in chain must be addressed
  - No unverified assumptions
- Calibration
- Uncertainty appropriately considered

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Typical UFM Application

- UFM design & characteristics
- Calibration testing
  - Test facility
  - At plant (eliminates test facility & transfer to plant)
- Transfer to plant
- In-plant operation

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UFM Design & Characteristics

- Is the UFM design acceptably described and understood?
- Is calibration sensitive to flow profile changes including swirl and, if applicable, to flow profile perturbations due to flow conditioners?
- Is flow profile determined?
- Is instrument sensitive to noise?

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Test Facility

- Traceability to national standard
- Facility uncertainty
- Facility operation
- Test fidelity
- Test range
- Data considerations

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Transfer from Test to Plant

- Calibration traceability
- Uncertainty due to transfer
- Fidelity between test & plant
- Calibration factor magnitude

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In-Plant Calibration

- Traceability to national standard
- Calibration uncertainty
- Calibration process & operation
- Status

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In-Plant Operation

- Calibration traceability
- Potential loss of calibration
- Cross-checks with other plant parameters

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Regulatory Insight of Measurement Uncertainty Recapture (MUR) Applications

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Discussion Topics

- Introduction
- Pre-Application Discussion
- MUR Application Guidelines
- Summary

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Expected MUR Applications

FISCAL YEAR	MEASUREMENT UNCERTAINTY RECAPTURE POWER UPRATES
2009	2
2010	6
2011	13
2012	3
2013	0
TOTALS	24

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Pre-Application Discussion

- Review LIC-109, “Acceptance Review Procedures”
- Any setpoint value change for Limiting Safety System Setpoint functions
- Review recently approved power uprates

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NRC Power Uprate Website

- http://www.nrc.gov/reactors/operating/licensing/power-uprates.html

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MUR Application Guidelines

- NRC Regulatory Issue Summary 2002-03: "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Applications"

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MUR Application Guidelines

- RIS 2002-03 Attachment 1
  - Section I. “Feedwater Flow Measurement Technique and Power Measurement Uncertainty”
- Lessons Learned
  - Deviations from RIS will result in staff spending significant additional time to review the uncertainty calculation and determine its acceptability.

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MUR Application Guidelines

- Section I of Attachment 1: Items A thru H
  - Item A: Approved Topical Reports
  - Item E: Calculation of the total power measurement uncertainty, explicitly identifying all parameters and their individual contribution to the power uncertainty
  - Item G: Proposed allowed outage time (AOT)
  - Item H: Proposed actions to reduce power level if exceed AOT

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Summary

- NRC expects many MUR power uprates for the next few years
- NRC's power uprate public website provides helpful information for power uprates
- RIS 2002-03 provides detail guidance for MUR power uprate applications

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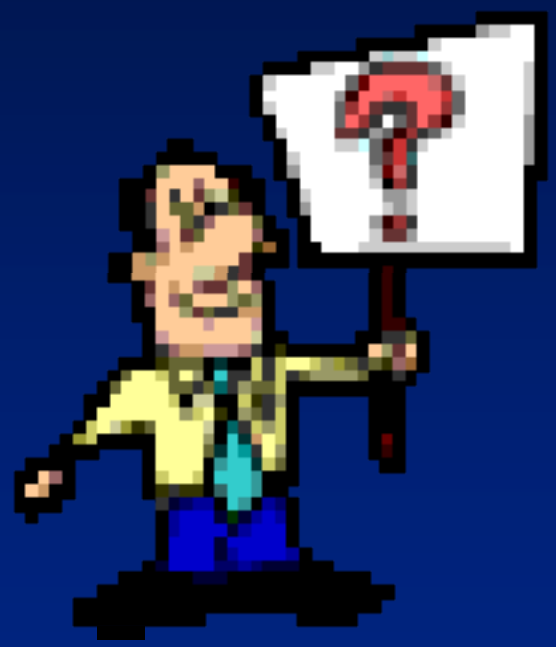
Questions?