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Regulatory Perspectives on the Use of High Density Polyethylene Pipe in Safety Related Applications

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Background

- Service Water (SW) systems are typically classified as safety-related ASME Class 3.
- Buried portions are typically exterior coated and lined carbon steel piping.
- Carbon steel piping is susceptible to corrosion and internal fouling.
- Potential degradation of system performance.

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Background (cont.)

- Initial through-wall leakage is virtually undetectable.
- Large through-wall leaks can impact plant operations.
- Some stainless steels and titanium alloys are used.
- High density polyethylene (HDPE) pipe has been used in nonsafety-related applications.
- Some US licensees have proposed to use HDPE in buried portions of the safety-related SW systems.

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Recent Applications by Licensees to Use HDPE

- Catawba - Buried portions of SW System – 12” diameter.
- Callaway – Buried portions of SW System – 36” and 4” diameter.
- Scope of NRC’s review was limited to issues related to buried service water application.

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Regulatory Issues

- NRC regulations incorporate by reference the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Sections III and XI.
- Current ASME Code does not address design, fabrication, inspection or testing of HDPE pipe.
- ASME Code case N-755 developed to address requirements of HDPE pipe (PE4710) for butt fused joints.

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Technical Issues

- NRC has not approved use of N-755. Issues exist related to:
  - Joint Integrity: Fusing qualifications and inspection of fused joints.
  - Structural design: service life beyond 10 years.
- Limited documented Operating Experience with this size and formulation of HDPE pipe.
- Use of alternate means of assuring joint integrity and structural design adequacy. Methodology based on N-755.

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Joint Integrity Issues

Fusion Procedure

- Absence of procedure qualification test records, procedure performance demonstrations
- Incomplete list of essential variables - not specific to material, fusing equipment model or pipe size/wall thickness.

Fused Joint Examinations

- Limited to visual examinations
- No volumetric examination requirements

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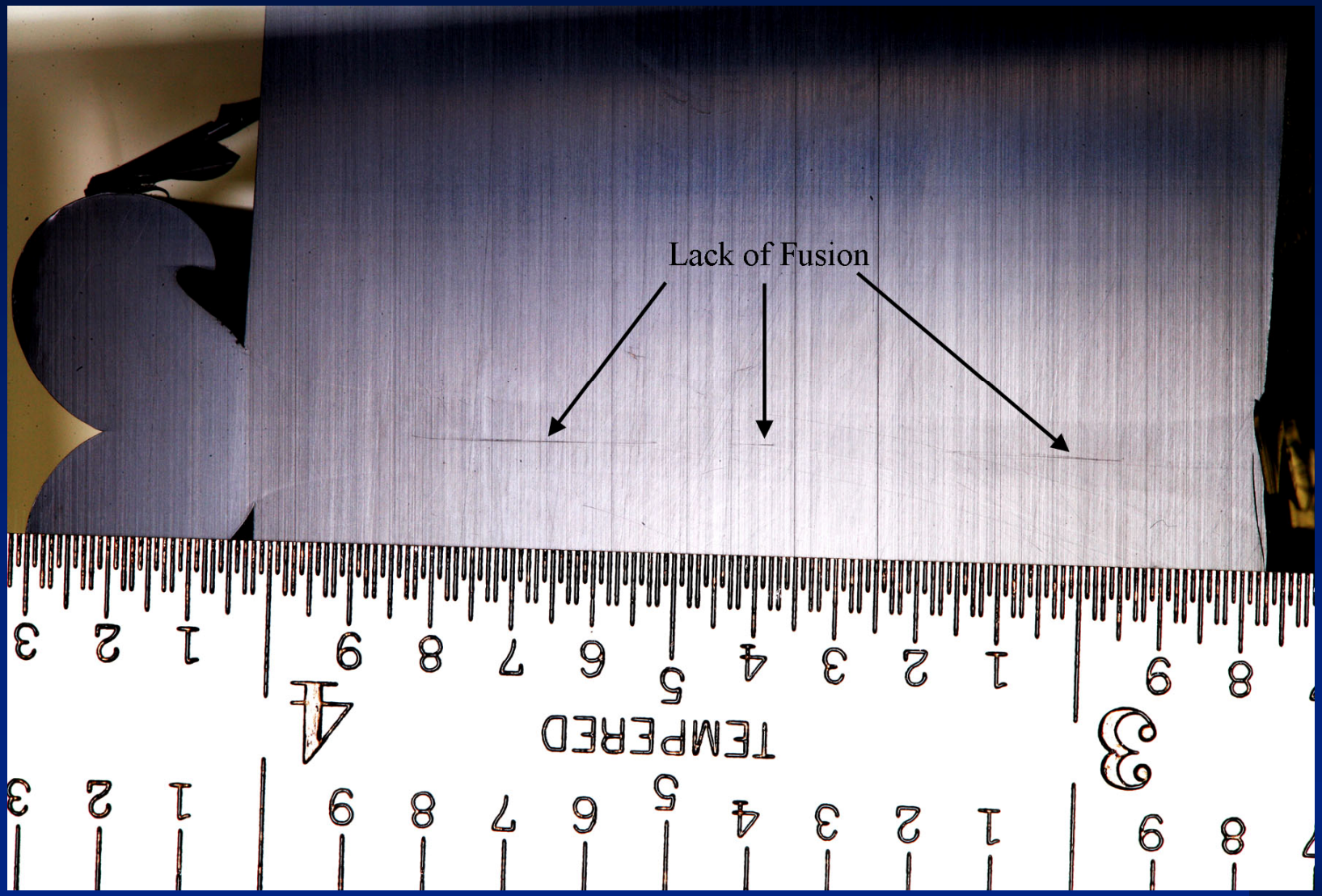

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Assurance of Joint Integrity

- For limited application – 12” diameter, 3400 feet of pipe, concerns easier to address due to relatively small pipe size and limited scope of equipment used.
  - performed sampling and in-process destructive testing
  - Tensile testing of joint sections taken at various radial positions around pipe.

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Assurance of Joint Integrity (cont.)

- For larger scale application – 36” diameter, 1200 feet of pipe, concerns more difficult to address due to larger size of pipe. Could not resolve in same manner as for smaller diameter and thickness pipe.
- Performed fusing qualifications, NDE following joining, and provided access points in the pipe for potential future inspection requirements.

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Design Considerations

- Verification of Service Life Beyond 10 years
  - mechanical properties
  - Fatigue properties
  - Slow Crack Growth resistance (SCG)
  - Acceptable flaw size relative to 10%t
- Use of thick wall formulas as D/t << 20

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Design Considerations (cont.)

- Side wall compression stress allowable
  - constant 1000 psi allowable not acceptable
  - Temperature dependent allowable
  - (S_h) for the duration is appropriate
- Consideration of thermal gradient stress required
  - thick wall pipes
  - poor thermal conductivity and large coefficient of thermal expansion

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Review and Approval Approach

Fusing and Fabrication Issues

- Future Submittals
  - Follow Catawba and Callaway as precedents.
  - Referencing of the ASME Code case is possible if those portions which don't apply or will not be used, are identified.
  - NRC will continue to require assurance of fused joint integrity either by qualification or destructive testing <u>and</u> examination until more experience or data is obtained.

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Review and Approval Approach

Design Considerations

- Future submittals
  - Complete documentation of all proposed systems
  - Staff not expecting as-built reconciliation in the submittal
  - Address all issues identified with Catawba, Callaway and ASME Code Case N-755
  - Design Factor (DF) > 0.5 not acceptable
  - Licensee's commitment to re-evaluate after the completion of testing program for possible impact on long term functionality

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Status of Current Approval

- Current operating plants. Certified designs for new reactors did not propose HDPE in ASME class systems.
- ASME Class 3 Service Water System piping. Buried applications only. Not above ground.
- Butt fused joints only. Electrofusion not reviewed and approved.
- Approved for 10-year design life. Additional approval needed beyond 10 years.

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Future Applications

- All will require separate NRC approval
- Above ground applications in Service Water Systems
  - Potentially different design considerations.
- Electrofusion
  - Fusing qualification and inspection issues
- Use in Certified Design applications
  - Will require NRC approval for both ASME (safety-related) and RTNSS (nonsafety-related) Class piping.