

ASME Code Case N-838 *Thoughts*

David Rudland
U.S. NRC RES/DE/CIB
June 5, 2014

NRC/EPRI Materials Issue Program
Technical Information Exchange
June 3-5, 2014

Code Case N-838

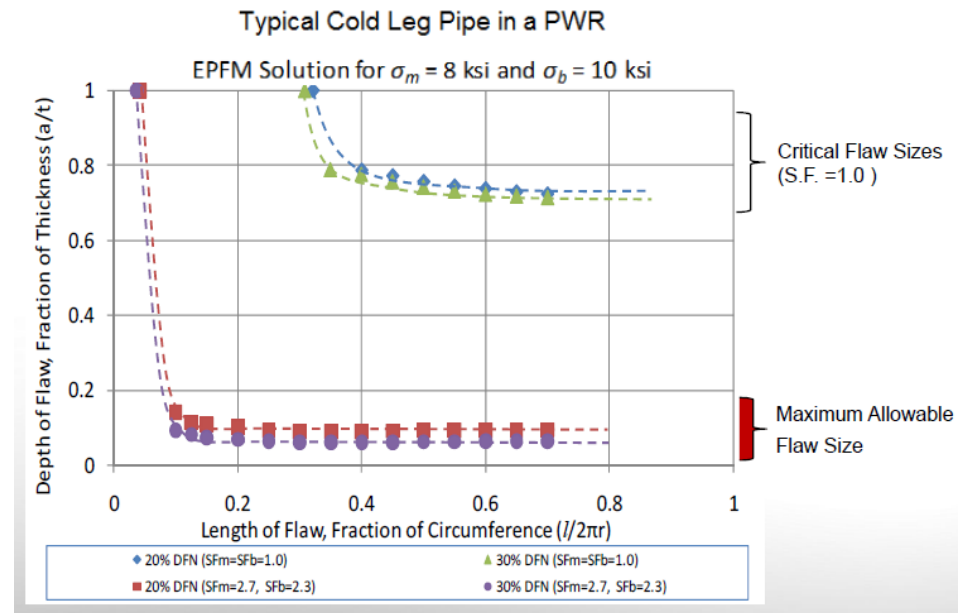
- Since Cast Austenitic Stainless Steel (CASS) piping may thermally age, an aging management program is required for those materials that are susceptible per the GALL report screening criteria
 - May use enhanced volumetric examination to detect and size cracks and a component-specific flaw tolerance evaluation
- Code Case N-838 - Flaw Tolerance Analyses for Acceptance of CASS Components Section XI, Division 1
- ASME Working Group on Pipe Flaw Evaluation (WGPFE) developed Code Case N-838 to support the development of N-824

Code Case N-838

- Defines allowable flaw sizes for CASS with ferrite number (FN) between 20 and 25% in support of NDE development for CASS
- Higher FN leads to higher susceptibility to thermal aging - %Ni may be a factor
- Currently ASME Code allows limit load for CASS where $FN < 20\%$ - Item under discussion

Code Case N-838

- Deterministic flaw tolerance analyses using ASME Section XI Appendix C with structural factor produces very small allowable flaws – below UT capability



- Under EPRI funding, Structural Integrity Associates (SIA) developed probabilistic methodology to predict allowable flaw size
 - Best estimate models with uncertainty treatment
 - **First time PFM used in development of allowable flaw sizes**
- NRC has issues with models and uncertainty distribution choices

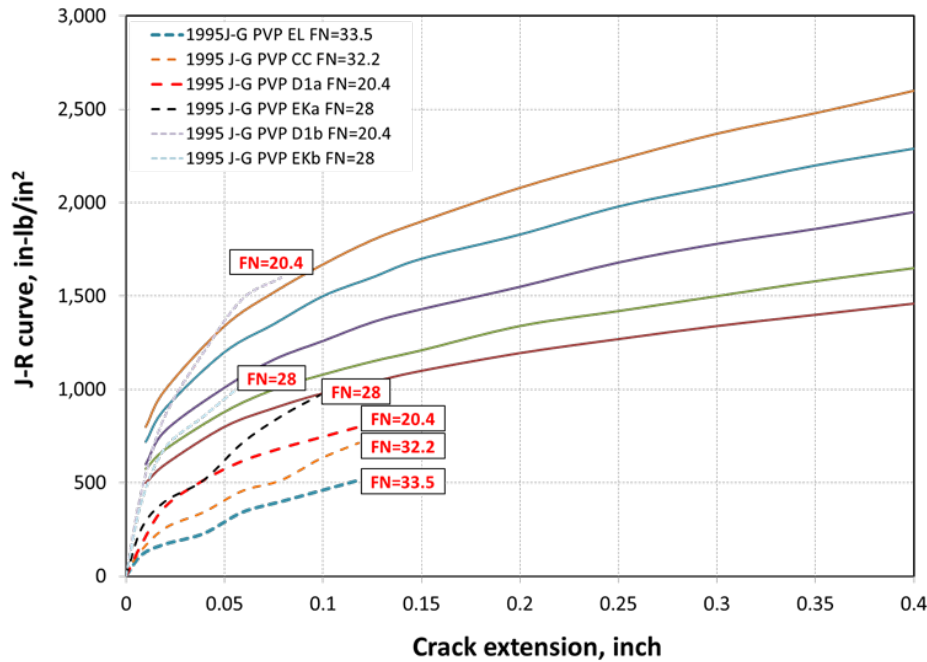
Code Case Ballots

- NRC staff members (3) and contractors (2) voted negative at both the Working Group and Subgroup levels
- Negative votes were based on confidence issues in the best estimate models and selection of input parameter uncertainties
- Through discussions and sensitivity analyses, most issues were addressed
- Issue of proper fracture toughness distribution remains

Aged CASS Toughness

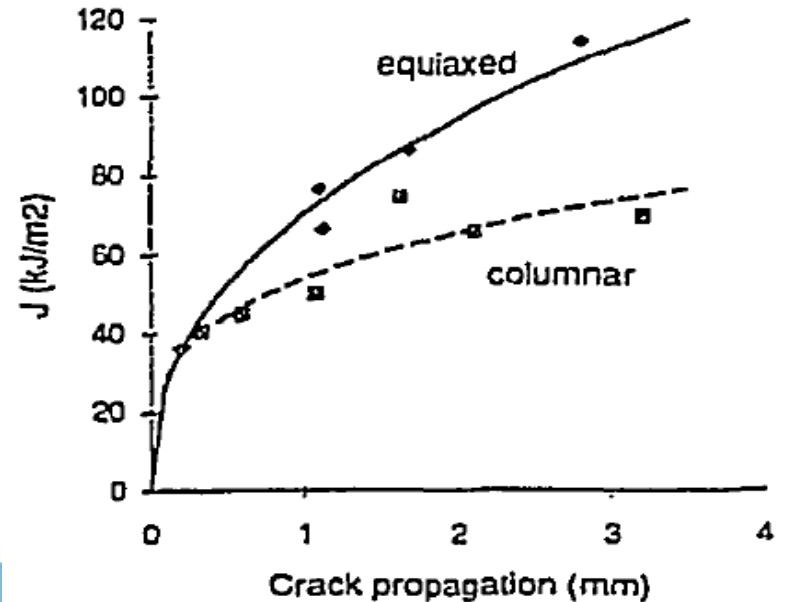
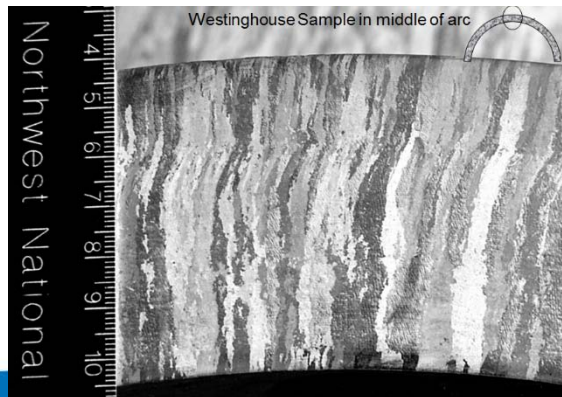
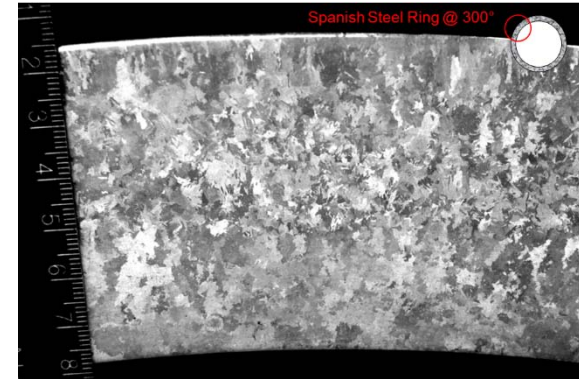
- SIA developed aged CASS toughness distribution from data published by Argonne National Laboratory (ANL)
- Emc² (NRC contractor) located applicable data from leak-before-break (LBB) submittals and foreign operators that suggest much lower toughness than in ANL reports
- CASS toughness highly dependent on grain size and orientation

Toughness Comparison



MRP-362 Aged CASS J-R curves

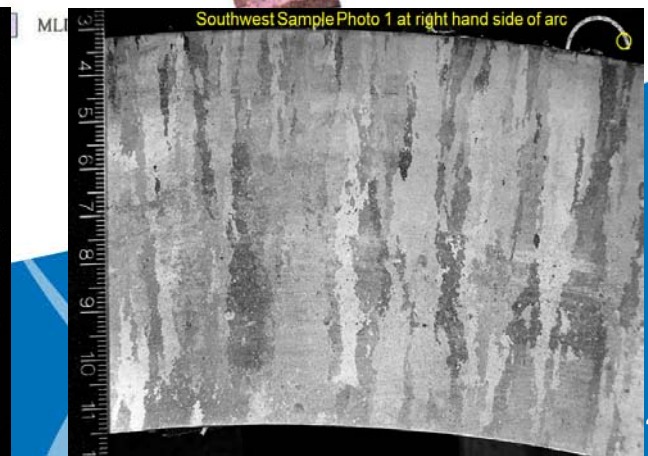
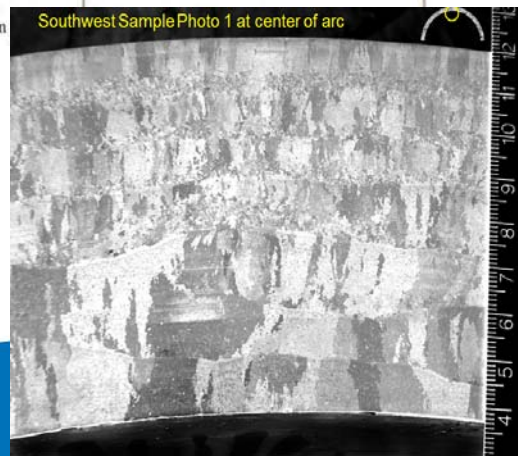
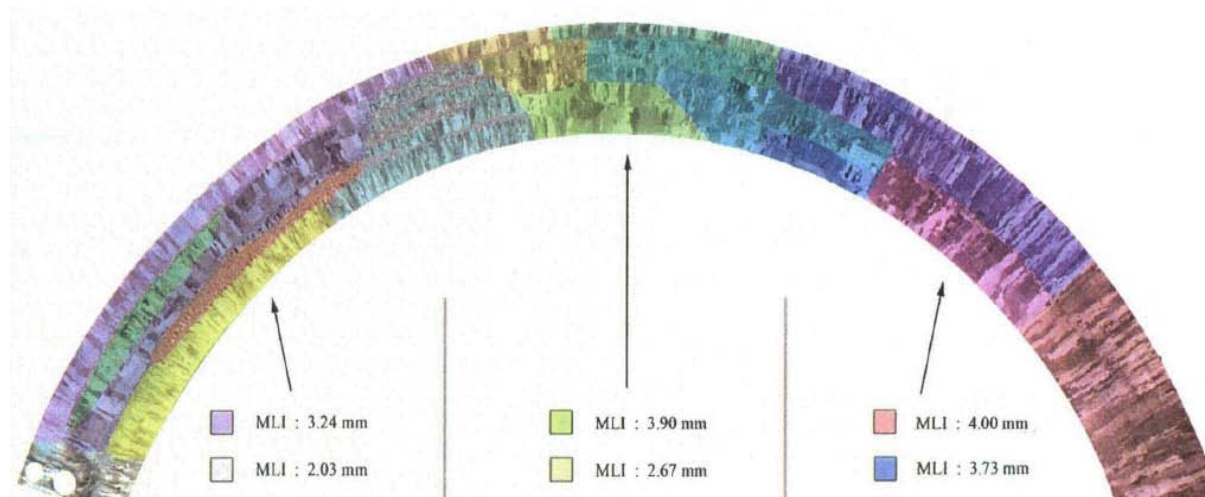
99-percentile
90-percentile
mean
10-percentile
1-percentile



1995 French PVP paper

Grain Size/Orientation

- PNNL NDE report showed grain sizes/orientation differences for CASS piping
 - SwRI ring – variable grains more typical of 1965 and earlier castings



Path Forward

- Emc² plans:
 - Develop revised distributions of fracture toughness for fully aged CASS
 - Different cases where chemistry is available for CF8M
 - Develop realistic coefficient of variance
 - Establish how the strength changes with aging for the same materials
 - Possible to have concise cross-correlation of strength and toughness
- Conduct confirmatory probabilistic analyses
 - Use PROLOCA
- Continue discussions at Working Group level