United States Nuclear Regulatory Commission

Development of an International Research Cooperative Program on Inconel Cracking

Presented at: SMiRT-16
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Recent Events of Inconel Cracking

- V.C. Summer
- Ringhals
- Oconee
- Are there possible unconfirmed indications at other US plants?
- Awaiting results of upcoming outages to determine if other plants identify this problem

Is this a Generic Problem

- Is PWSCC a generic problem for Inconel in all PWRs?
- What factor or factors would eliminate PWSCC as a generic problem in Inconel?
- How many NSSS vendors worldwide identified a problem with PWSCC?
- Which vendors have not identified the problem and why?

Inconel Cracking

- Recent events of cracking at Nuclear Power Plants worldwide
- Generic problem
- Locations of Inconel cracking or degradation sites
- NDE methods

Inconel Cracking (con't)

- Is there adequate crack growth data for Inconel?
- Do inspection intervals need to be reduced and performed more frequently?
- Are mock ups sufficient for training?
- Is there adequate research work being performed to address this issue?

Understanding the Problem of Inconel Cracking

- What factors cause PWSCC?
- How is the growth rate affected by each factor ?
- What is the initiation time as it relates to each factor?
- What are all the locations of Inconel cracking?
- Is craze cracking a precursor to PWSCC?

Understanding the Problem of Inconel Cracking (con't)

- Is it possible that the orientation of a PWSCC crack would allow it to grow undetected ?
- Do we fully understand why some PWSCC cracks grow both axially and circumferentially?
- Is it a fact that all components will leak before they fail?

Degradation Sites

- Hot leg pipe welds
- Cold leg pipe welds
- CRDM nozzle welds
- Pressurizer welds
- Shop versus field welds
- Is the welding process a factor?
- Are certain heats of material more susceptible?

NDE of Inconel

- Can one determine what the properties of PWSCC are as they relate to various NDT methods?
- Are procedures written to state NDE methods that would detect PWSCC in a susceptible area such that inspectors radiation exposure is limited?
- Is it necessary to revise the current inspection criteria as it relates to cracking in Inconel?

NDE of Inconel (con't)

- What are the worst case dissimilar metal weld designs from an inspection standpoint?
- Can all designs be ranked in terms of inspectability?
- How do the constraints of complex grain structure of DMWs and the ID and OD conditions limit the POD and sizing accuracy that are achievable?

NDE of Inconel (con't)

- Can a simulation of PWSCC be developed for use in NDE studies and performance demonstrations?
- Can recommended NDE methods be identified?
- Must there be round robin studies conducted to quantify POD and sizing accuracy?

NDE of Inconel (con't)

- What is the best POD and sizing accuracy for PWSCC that can be achieved with current technology?
- How must NDE inspection programs be modified to insure that Inconel cracking does not lead to leaks?
- What are the implications for performance demonstrations?

Crack Growth

- Weakness in the crack growth data
- Crack growth data needs to be updated
- What are the sources for crack growth data? Who is generating data?
- Can sufficient data be generated in the near future?
- Are crack growth models adequate until sufficient data is generated?

Crack Growth

- What can be done to confirm that PWSCC is not confused with hot cracking
- Crevice chemistry needs to be understood

Industry Efforts Under Development

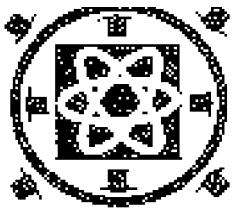
- **JRC-Petten**
  - NESC III-One DMW component similar to Ringhals and V.C.Summer
- **US - Material Reliability Project**
  - Plans to address issue on a generic basis for the US Plants
- **Japan, Korea, and Canada**
  - No information to date

Conclusions

- If answers are not available to previous questions, additional work is necessary
- Generic implications are not fully understood
- Confirmatory research should be performed in conjunction with industry initiatives to address this issue

Objectives for Research Cooperative

- Compile a knowledge base on all cracking in Inconel
- To understand the mechanism(s) that causes cracking in Inconel, specifically PWSCC
- Develop NDE methods to adequately detect, size and characterize tight cracks such as PWSCC
- Develop adequate mockups with cracks to simulate tight PWSCC indications



Meeting to Discuss

Development of an International Research Cooperative Program on Inconel Cracking

Friday, August 17, 2001

10:30am in Jackson meeting room