

Overview of NRC Funded Nickel-based Alloy NDE Research Activities at PNNL

October 24, 2006

NRC Funded NDE Projects

- ▶ Removed from service CRDMs
- ▶ International PINC Program
- ▶ Leak Before Break and mitigation of PWSCC
- ▶ Other NDE Issues

Removed from Service CRDMs

JCN Y6867

Steven Doctor and George Schuster
Meeting with NRC-Industry
October 24, 2006

Presentation Outline

- ▶ Objectives
- ▶ Scope
- ▶ Products
- ▶ Schedule
- ▶ Discussion

Objectives

- ▶ Study removed from service degraded CRDMs that contain PWSCC
- ▶ Characterize the degradation present through destructive and nondestructive testing
- ▶ Assess the effectiveness of NDE to detect and characterize the degradation
- ▶ Determine the NDE responses for the various types of degradation detected
- ▶ Coordinate work with industry as the CRDMs belong to EPRI

Scope

- ▶ Work started considering Davis-Besse CRDMs and North Anna 2 CRDMs – work focused on the latter
- ▶ 4 CRDMs studied in earlier industry exercise
- ▶ Two CRDMs selected for PNNL based laboratory studies
- ▶ CRDM # 31 the focus of current studies

Products

- ▶ Determination of any degradation present in CRDM # 31 and fully documented in a NUREG/CR report - validated by destructive testing
- ▶ Assessment of the effectiveness of various NDE methods to detect and characterize the degradation
- ▶ Providing NDE response data for various NDE methods as a function of degradation type and morphology for use in PINC program “Atlas”

Schedule

- ▶ NDE testing completed November 2006
- ▶ Destructive validation testing completed March 2007
- ▶ NUREG/CR report – draft completed July 2007 and published January 2008

International Program for Inspection of Nickel-alloy Components (PINC)

JCN Y6534, N6329

George J. Schuster
Steven R. Doctor

Pacific Northwest National Laboratory

Presentation Outline

- ▶ Project Objectives
- ▶ The International Cooperative
- ▶ Products
 - PINC Atlas – PWSCC/NDE Relational Database
 - NDE Effectiveness from Round Robin Tests
- ▶ Schedule
- ▶ Discussion

PINC Objectives

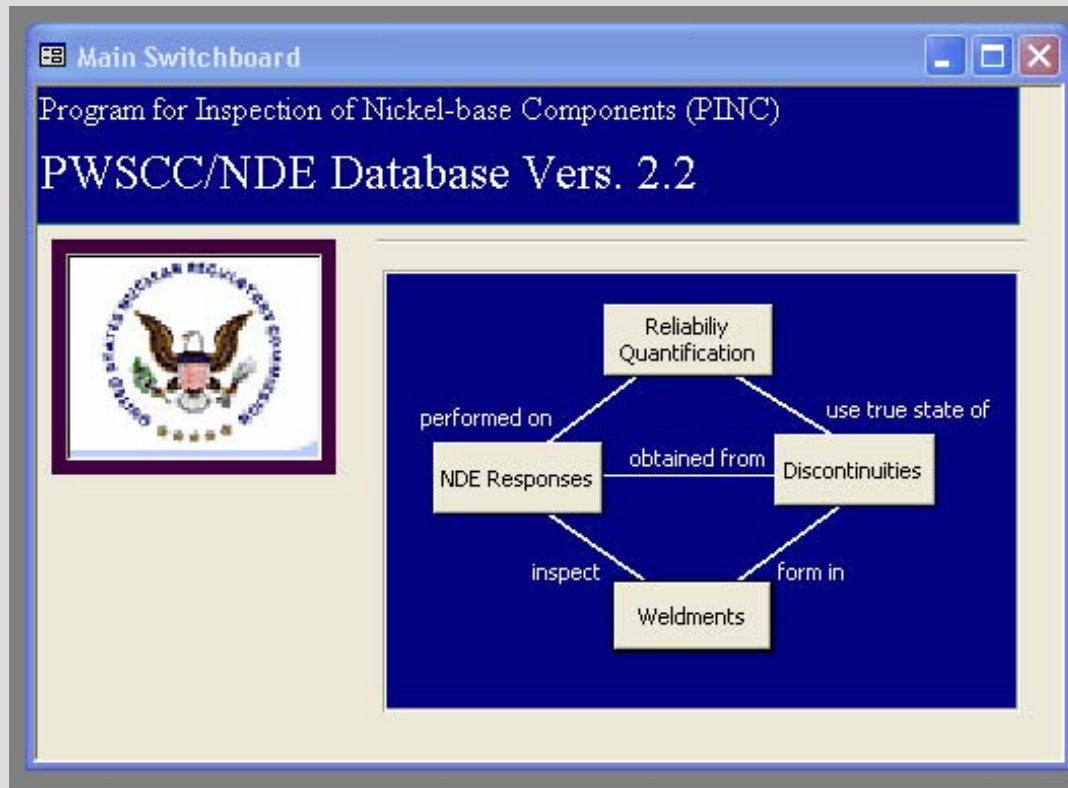
- ▶ Document PWSCC morphology in an Atlas
- ▶ Document NDE responses associated with PWSCC
- ▶ Quantify NDE Effectiveness for detection and characterization
- ▶ Evaluate methods of manufacturing cracks that simulate PWSCC's NDE responses
- ▶ Recommend changes in national codes and standards

The International Cooperative

- ▶ Five nations: Sweden, Japan, Finland, South Korea, USA
- ▶ Eight Organizations
- ▶ Two task groups
 - PWSCC morphology/NDE atlas group
 - NDE technology assessment group – quantification of NDE procedure effectiveness
- ▶ Regulators, NDE qualification institutions, research organizations, and industrial companies

Products

PINC Atlas – PWSCC/NDE Relational Database



- ▶ DMW, CRDM, BMIs
- ▶ North Anna 2 and PINC mockups
- ▶ PWSCC and manufactured cracks
- ▶ NDE responses
- ▶ NDE effectiveness

Products

NDE Effectiveness from Round Robin Tests

▶ Three Round Robin Test Categories

- Dissimilar Metal Welds: 9 test blocks with 30 cracks
- CRDMs: 7 test blocks with 44 cracks
- BMIs: 6 test blocks with 30 cracks

▶ Thirteen Round Robin Teams

- Japan: 4 teams
- Korea: 5 teams
- Europe: 2 teams
- USA: 2 teams

Schedule

- ▶ 7th PINC meeting: Oct 2006
- ▶ Atlas database Version 2: Dec 2006
- ▶ DMW Round Robin: Oct 2006 – Aug 2007
- ▶ CRDM Round Robin: Mar 2007 – Dec 2007
- ▶ BMI Round Robin: June 2007 – Mar 2008
- ▶ DAG-Validation of Flaws: Sept 2007 – May 2008
- ▶ PINC Final Report: June 2008

Questions and Discussion

Leak Before Break, PWSCC and Mitigation JCN N6319

Steven Doctor and George Schuster
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October 24, 2006

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Objectives

- ▶ Conducting research to assist RES in developing a position on management of PWSCC in LBB piping systems
- ▶ Part of team from Battelle Columbus Laboratories and Engineering Mechanics Corporation of Columbus to address specific aspects of the issue
- ▶ PNNL work involves assessing the NDE inspection reliability of piping locations susceptible to PWSCC before and after the application of mitigation processes

Scope

- ▶ PNNL has lead role in coordinating BCL and EMC2 input
- ▶ Work focuses on all butt weld configurations that are susceptible to PWSCC and where LBB has been granted
- ▶ Consider mitigation methods such as
 - Mechanical stress improvement process (MSIP)
 - Induction heating stress improvement (IHSI)
 - Material replacement/weld overlay repairs
- ▶ Develop long term strategy for managing PWSCC

Products

- ▶ Use representative field configurations and industry mitigation practice for components under study – obtain data from industry
- ▶ Conduct laboratory studies on SCC to quantify NDE effectiveness before and after the application of mitigation process – document in NUREG/CR report
- ▶ Develop a NUREG/CR report identifying methodologies involving inspection and mitigation that will be needed to ensure that the probability of fluid system piping rupture is extremely low

Schedule

- ▶ Program started June 2006
- ▶ NUREG/CR on NDE effectiveness – **Planned for FY-2007**
 - Coordinate with industry for determining POD and as-built configurations/limitations to ISI
 - Awaiting MRP response to NRC request
 - Assess UT performance pre- and post-MSIP and on weld overlay repairs
- ▶ NUREG/CR on long term strategy to manage PWSCC – **June 2008**

Other PWSCC and NDE Issues

JCN Y6604 N6398

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Presentation Outline

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- ▶ Scope
- ▶ Products
- ▶ Schedule
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Objectives

- ▶ Assess the effectiveness of NDE for required ISI
- ▶ Assess the impact of the NDE reliability on the integrity of reactor components
- ▶ Identify if improvements in NDE are needed and how they can be achieved
- ▶ Recommend improvements to codes and standards, if needed

Scope

- ▶ Covers all passive safety related components
- ▶ Focus is on UT since that is the dominant form of NDE conducted during ISI for volumetric examinations
- ▶ Work includes other NDE methods such as ET for surface examinations and remote VT
- ▶ Substantial efforts on Performance Demonstration testing, cast stainless steels, dissimilar metal welds, reactor internals, reactor pressure vessels

Products

- ▶ Addressing coarse grained material inspection problem that includes CSS, far side inspection of austenitic welds, corrosion resistant clad, dissimilar metal welds and overlays
 - NUREG/CR report on ET of CSS submitted in October to NRC for publication
 - NUREG/CR on low frequency UT for inspection of CSS submitted to NRC September 2006 for review
 - Aggressive schedule on other work being pursued when new JCN begins in FY 2007
 - Meetings with TGCSS to start development of Supplement 9 on Qualification Requirements on Cast Austenitic Piping Welds
 - Nickel-based alloys also fall into this generic classification of coarse grained materials
 - Overlays – need to quantify NDE effectiveness but work not started

Products cont'd

- ▶ Conducting stress analysis for determining severity of flaws that may remain after inspection
 - Appendix L NUREG/CR report will be submitted in October/November 2006 for publication
 - Assessing critical flaw size for CSS and NDE effectiveness – Input to TGCSS
 - Planned involvement in testing PRO-LOCA code
- ▶ Conducting studies on remote visual testing and what requirements are needed to insure service degradation can be reliably detected
 - Second NUREG/CR report on work submitted for NRC review – September 2006

Products Cont'd

- ▶ Development of fabrication flaw density and distributions in reactor pressure vessels – work started 16 years ago and recent PTS analysis shows that with this data PTS is a non issue for most reactor even through 20 years of life extension
 - NUREG/CR report on fabrication flaws in repairs to be submitted for NRC review December 2006
 - Obtaining beltline weld from WNP-1 to support assessment of ISI for estimating fabrication flaws