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United States Nuclear Regulatory Commission
Protecting People and the Environment

FAVOR and REAP
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Outline

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- Fracture Analysis of Vessels – Oak Ridge (FAVOR)
  - Code Distribution
  - Software Quality Assurance (SQA) and Verification and Validation (V&V) assessment
  - Shallow Surface-Breaking Flaw issue resolution
  - NRC staff training: User training and Developer training
  - Future Work
- Reactor Archive Embrittlement Project (REAP)

FAVOR Code Distribution

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- Current version is V16.1
- Information available: ML16273A032 (transmittal memo), ML16273A033 (theory manual), & ML16273A034 (users manual)
- For access to the software, contact patrick.raynaud@nrc.gov
- Proposal for FAVOR User Group creation in near future
  - Linked to code distribution
  - Enhance cooperation and exchange
  - Leverage users' knowledge and developments

FAVOR SQA and V&V Assessment

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- Compilation of documentation on past SQA and V&V efforts for FAVOR completed
- Past documentation assessed against ASME-V&V-10-2006 and NUREG/BR-0167 requirements
- Draft report under NRR review
- Several SQA and V&V gaps identified
  - No SQA plan
  - No change control and documentation
  - No software configuration management
  - Need a FAVOR SQA and V&V baseline

Shallow Surface Breaking Flaw Investigations

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- Multiple axes of investigation to analytically address shallow surface flaw issue
  - Stress-free temperature
  - Thermal expansion coefficients
  - Warm pre-stress
  - Loading paths
- Investigations nearing completion and being documented
- NRC Internal review during summer 2019

FAVOR Training

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- Internal training for NRC staff held in November 2018 for FAVOR Users
  - FAVOR v16.1
  - Detailed hands-on training developed, with extensive documentation and sample problems
  - To be provided with FAVOR distribution package in the future

- Developing a 'Developers' training manual
  - Detailed descriptions of inner working of FAVOR
  - Source code exploration via useful enhancements to FAVOR (for future version)
  - Based on FAVOR v16.1
  - Targeting long-term sustainability of FAVOR code
    - Knowledge transfer from ex-ORNL staff to NRC staff

FAVOR Future Work

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- FAVOR SQA and V&V efforts (based on assessment completed in 2019)
  - Independent V&V?
  - Collaboration with Industry?
  - SQA and V&V enhancements
    - Develop missing SQA documentation
    - Implement Change Control and documentation
    - Software configuration control
    - FAVOR testing and benchmarking baseline
- Shallow Flaw issue disposition
  - Compile and summarize work to date
  - Define and execute steps for issue resolution
- FAVOR enhancements
  - I/O tools (short term)
  - Link between FAVOR and DAKOTA for enhanced probabilistic analysis capabilities (short term)
  - Source code modernization and restructuring (medium term)

Reactor Embrittlement Archive Project (REAP) Description

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- Archival source of information about the effect of neutron radiation on the properties of reactor pressure vessel (RPV) steels
- Internet-accessible RPV steel embrittlement database provides information in two forms
  - Document archive with surveillance capsule(s) reports and related technical reports, in PDF format, for the 104 commercial nuclear power plants (NPPs) in the United States, with similar reports from other countries
  - Relational database archive with detailed information extracted from the reports
- REAP focuses on data collected from surveillance capsule programs for light-water moderated, nuclear power reactor vessels operated in the United States
  - Charpy V-notch energy testing results, tensile properties
  - Material composition
  - Exposure temperatures, neutron flux and fluence
- REAP contains data from surveillance programs conducted in other countries
- REAP also contains tools focused on embrittlement data analysis

Reactor Embrittlement Archive Project (REAP) Status

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- NRC's REAP database is back online as of 11/2/2018.
  - Users must re-register at www.reapdatabase.com/Account/Register

- REAP source code undergoing modernization in view of integration with NRC public facing website
  - Target for link to REAP from NRC public site and integration of REAP into NRC's IT infrastructure: late 2020
  - Trying to make the transition as seamless as possible for users

- NRC continues to monitor for availability of new capsule reports to be added to REAP