



# PLANT AGING AND MATERIALS DEGRADATION ISSUES

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# Acronyms

- ASME: American Society of Mechanical Engineers
- BWR: Boiling-water reactor
- CCDF: Conditional core damage frequency
- IASCC: Irradiation-assisted stress-corrosion cracking
- IGSCC: Intergranular stress-corrosion cracking
- ISI: Inservice inspection
- NRR: Office of Nuclear Reactor Regulation
- PIRT: Phenomena identification and ranking table
- PWR: Pressurized-water reactor
- PWSCC: Primary water stress-corrosion cracking
- RCS: Reactor coolant system
- RES: Office of Nuclear Regulatory Research
- RPV: Reactor pressure vessel

# Regulatory Overview

- Regulatory framework
- Historical issues with materials degradation
- Current challenges
- Future goals

# Regulatory Framework

- Regulations
  - ASME Code requirements for design and inspection
- Technical Specifications
  - Leakage monitoring
- Bulletins and Orders – short term, emergent issues

# Regulatory Framework (continued)

- Integration of Research for degradation management programs
- Industry actions and initiatives

# Regulatory Framework (continued)

- Regulatory Oversight
  - Baseline ISI
  - Temporary Instructions
  - Follow up interactions with licensees
  - Reactor Oversight Process indicators and findings

# Historical Issues With Materials Degradation

- Radiation embrittlement of RPVs
- IGSCC in BWR piping
- BWR internals cracking
- Steam generator tube degradation
- PWSCC in PWRs
- Boric acid corrosion
- IASCC in PWRs
- Vibratory fatigue
- Thermal fatigue
- Erosion/corrosion

# Current Challenges

- PWSCC of penetration nozzles in reactor and other vessels, nozzle welds
  - Addressed through Bulletins and Order
- PWSCC in dissimilar metal butt welds of RCS piping
  - Regulatory action being considered



# Current Challenges (continued)

- Extended power uprate adverse flow effects
  - Steam dryer cracking
  - Feedwater probe failure
  - Staff monitoring industry actions

# Current Challenges (continued)

- Steam generator degradation
  - Active NRC oversight
  - Implementing new regulatory framework through technical specifications

# Future Goals

- Return to more stable regulation
- Increase reliance on industry
- Proactive oversight
- Operating experience monitoring
- Independent NRC research

# Proactive Materials Degradation Assessment

- Research input into regulatory activities
- Approach
- Short-term program
- Longer term program
- Implementation schedule
- Utilization of results

# Research Input Into Regulatory Activities

- Environmentally assisted cracking
  - BWR pipe cracking
  - Internals cracking
- Steam generator integrity
- Nondestructive Examination
- Pressure vessel integrity

# Approach

- Some of the materials degradation in nuclear power plant components experienced in the past has surprised both NRC and industry
- NRC & industry pursuing proactive approach to materials degradation

# Approach (Continued)

- Identify components of interest to ensure reliability
- Coordinate research for effective implementation of proactive materials degradation management

# Approach (Continued)

- Activities to identify components
  - Information on degradation that has been experienced – short-term results
  - Phenomena identification and ranking table (PIRT) for potential future degradation – longer term results



# Short-term Program

- Identified components that have already experienced degradation
- Evaluating inspection and leak monitoring techniques and requirements
- Provide input to conditional core damage frequency (CCDF)
- Probabilities of failure for probabilistic risk assessments

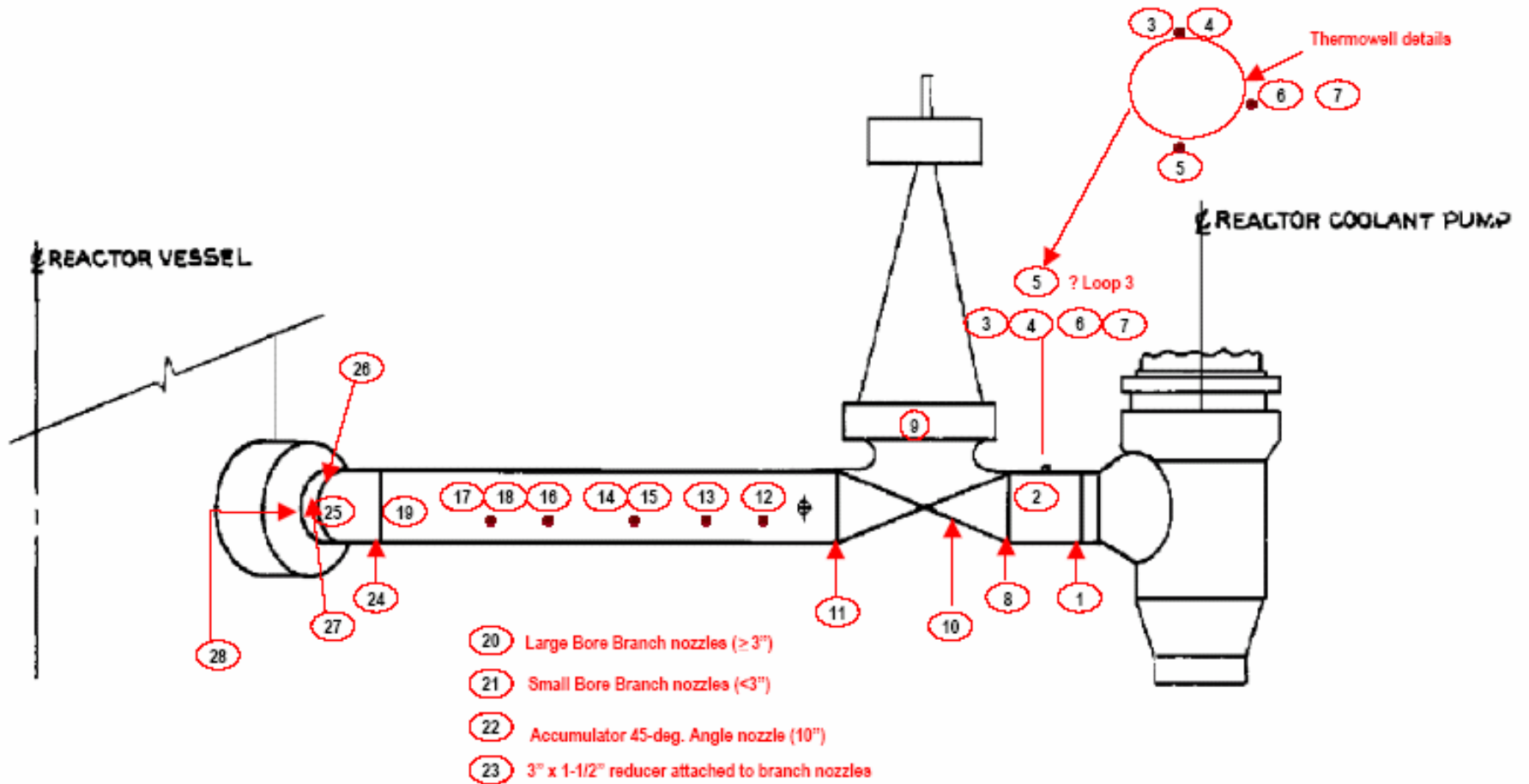
# Longer Term Program

- PIRT process
  - Expert elicitation
- International in scope
- Bounded – important plant systems being addressed

# Longer Term Program (Continued)

- Background information provided to expert panel members
  - Component's environment and operational experience
- Experts identify and rate degradation mechanisms, assess knowledge levels, and provide bases for decisions

# GROUP 1: RCS Cold Leg Piping (Covers worksheets RCS-CL – 1 thru 28)



# Implementation Schedule

- First two PIRT meetings on PWR reactor coolant system and emergency core cooling system completed
  - Potential future degradation being identified
- Six more meetings to complete PWR and BWR evaluations
- PWR report – June 2005
- BWR report – December 2005

# Utilization of Results

- Lists of components susceptible to future degradation, bases for calls, and knowledge levels
- Input to cooperative integrated research programs
- Technical basis for effective proactive materials degradation management by NRC and industry