FEBRUARY, 2002 - CORROSION CAVITY DISCOVERED ON THE DAVIS-BESSE REACTOR VESSEL HEAD DURING INSPECTIONS FOR VESSEL HEAD PENETRATION CRACKING

EXTENT OF THE CORROSIVE ATTACK FROM A CONCENTRATED BORIC ACID SOLUTION WAS UNPRECEDENTED IN PREVIOUS NUCLEAR PLANT EXPERIENCE:

OVER 6 INCHES OF CARBON STEEL WAS DEGRADED

ONLY THE STAINLESS STEEL CLADDING (0.3 INCH THICKNESS) REMAINED AS PRESSURE BOUNDARY OVER THE DEGRADED AREA

NRC CHARTERED A LESSONS-LEARNED TASK FORCE (May 2002) TO ANSWER "WHY WAS THIS EVENT NOT PREVENTED?"
Typical Pressurized Water Reactor

- Control Rod Drive Mechanism
- Core Barrel
- Outlet Nozzle
- Control Rod Drive Shaft
- Inlet Nozzle
- Reactor Vessel Head (see detailed image)
- Reactor Vessel
- Core Support
Reactors Vessel Head Degradation Location

Control Rod Drive Mechanism

Area of Davis Besse Reactor Vessel Head Degradation

Reactor Vessel Head Carbon Steel Portion

Reactor Vessel Head Insulation

Reactor Vessel Head Stainless Steel Cladding Layer
Figure 2-3  SCHEMATIC VIEW OF TYPICAL B&W VHP NOZZLE

SA-182 F304

SB-187 UNS NO8800 (Alloy 800)

ERNiCr-3 (Alloy 82)

Outer Surface of RPV Head

Countersunk

Shrink Fit

Countersunk

RPV Head (SA-533 Gr. B Cl. 1)

Inner Surface of RPV Head (Stainless Steel Cladding)

J-Groove Weld

EniCrFe-3 (Alloy 182)
The above figure shows the Davis Besse reactor vessel head degradation between nozzle #3 and nozzle #11. This sketch was provided to the NRC by the Licensee.
Figure 2-5  BORIC ACID DEPOSITS ON RPV HEAD FLANGE

Refueling Outage 12 (2000)
DAVIES-BESSE REACTOR VESSLE HEAD DEGRADATION LESSONS LEARNED TASK FORCE
WHY WAS THE EVENT NOT PREVENTED?

- TWO MAJOR CAUSES - TECHNICAL AND ORGANIZATIONAL

- TECHNICAL

- PREVIOUS NRC AND INDUSTRY ASSESSMENTS OF AXIAL CRACKING IN REACTOR VESSEL HEAD PENETRATIONS (VHPs) CONCLUDED THAT THE CRACKING WAS NOT AN IMMEDIATE SAFETY CONCERN (MID 1990’s)

- MINDSET - BORIC ACID ON THE REACTOR VESSEL HEAD WAS CONSIDERED TO BE NOT HIGHLY CORROSIVE SINCE THE HEADS WERE HOT (600F) AND DRY

- LINKAGE BETWEEN CRACKING IN VHPs AND BORIC ACID ATTACK WAS MISSING EVEN THOUGH EVIDENCE WAS AVAILABLE
DAVIES-BESSE REACTOR VESSEL HEAD DEGRADATION LESSONS LEARNED TASK FORCE WHY WAS THE EVENT NOT PREVENTED

- ORGANIZATIONAL - THE EVENT WAS PREVENTABLE

- NRC, THE LICENSEE AND INDUSTRY FAILED TO ADEQUATELY REVIEW, ASSESS AND FOLLOW-UP ON RELEVANT OPERATING EXPERIENCE

- THE LICENSEE FAILED TO ASSURE THAT PLANT SAFETY ISSUES WOULD RECEIVE APPROPRIATE ATTENTION

- NRC FAILED TO INTEGRATE INFORMATION INTO ASSESSMENTS OF THE LICENSEE SAFETY PERFORMANCE

- OTHER INFLUENCES ALSO CONTRIBUTED:
  - REQUIREMENTS AND GUIDANCE
  - RESOURCES AND STAFFING
  - QUALITY OF LICENSEE INFORMATION
DAVIS-BESSE REACTOR VESSEL HEAD DEGRADATION
LESSONS LEARNED TASK FORCE

BACKGROUND

- TASK FORCE CHARTER OBJECTIVES
  - CONDUCT AN INDEPENDENT EVALUATION OF THE NRC’S REGULATORY PROCESSES
  - IDENTIFY AND RECOMMEND AREAS FOR IMPROVEMENT APPLICABLE TO THE NRC AND/OR THE INDUSTRY

- TASK FORCE CHARTER AND SCOPE
  - REACTOR OVERSIGHT PROCESS ISSUES
  - REGULATORY PROCESS ISSUES
  - RESEARCH ACTIVITIES
  - INTERNATIONAL PRACTICES

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DAVIES-BESSE LESSONS LEARNED TASK FORCE
SELECTED SPECIFIC RECOMMENDATIONS

- NRC SHOULD REVISE ITS PROCESSES TO REQUIRE SHORT-TERM AND LONG-TERM FOLLOW-ON VERIFICATION OF LICENSEE ACTIONS TO ADDRESS SIGNIFICANT GENERIC COMMUNICATIONS [3.1.2(1)]

- NRC SHOULD EVALUATE THE AGENCY’S CAPABILITIES TO RETAIN OPERATING EXPERIENCE INFORMATION AND TO PERFORM LONGER-TERM OPERATING EXPERIENCE REVIEWS [3.1.6(1)]

- NRC SHOULD REVISE ITS INSPECTION GUIDANCE TO PROVIDE ASSESSMENTS OF THE SAFETY IMPLICATIONS OF ... CORRECTIVE ACTIONS PHASED IN OVER SEVERAL YEARS [3.2.5(2)]

- NRC SHOULD EVALUATE THE ADEQUACY OF ANALYSIS METHODS INVOLVING THE ASSESSMENT OF RISK ASSOCIATED WITH PASSIVE COMPONENT DEGRADATION [3.3.7(3)]

[ ] - citations to report recommendations
PREVENTING STRUCTURAL FAILURES SOME COMMON ELEMENTS (Petroski, 1992)

- COMMUNICATIONS AND ORGANIZATION
- INSPECTION
- ENGINEERING DESIGN
- TIMELY DISSEMINATION OF DATA AND INFORMATION
NRC “ENVIRONMENT” SOME ADDITIONAL LESSONS

- TECHNICAL ELEMENTS ARE ONLY PART OF THE STORY
- Regulatory Framework and Issues
- Policy issues
- CRITICAL NATURE OF THE PUBLIC INTERFACE
- COMMUNICATION IS THE "KEY"
- IMPORTANCE OF RISK-ACTUAL AND PERCEIVED