UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 14, 2000

MEMORANDUM TO: Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: Stewart N. Bailey, Project Manager, Section 2
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Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF JUNE 29, 2000, MEETING WITH THE BABCOCK AND WILCOX OWNERS GROUP ON REMOVAL OF THE REACTOR VESSEL MISSILE SHIELD

On June 29, 2000, the U. S. Nuclear Regulatory Commission (NRC) staff met with the Babcock and Wilcox Owners Group (B&WOG) to discuss their plans for a risk-informed topical report that would justify permanently removing the reactor vessel missile shield from B&WOG plants. The topical report would be based, in part, on the guidance in Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," and is scheduled to be submitted in the first quarter of 2001.

After introductions, the B&WOG discussed the history behind this issue, including the staff's rejection of a Three Mile Island (TMI) license amendment request to remove the missile shield. The B&WOG then described the previous TMI submittal and the scope of their future submittal.

The staff had several comments on the B&WOG's proposed approach. The staff pointed out that the proposed frequency for medium-break loss-of-coolant accident (LOCA) was based on piping and may not be representative of vessel head penetrations or appurtenances. The staff also questioned the use of a generic (i.e. independent of break location) conditional core damage frequency when addressing a LOCA with the break located in the vessel head. On the question about missiles, the staff stated that the report should discuss the probability of detachment of the control rod drive mechanism (CRDM), since this would lead to a missile which could damage containment if the missile shield was removed. The staff also questioned whether the scope of the proposed failure modes analyses was sufficient to demonstrate that no CRDMs would detach during events with high primary system pressure and temperature.

The B&WOG stated that the meeting was a success and that they had received useful feedback from the staff.

A list of those attending the meeting is provided as Attachment 1. The slides used by the B&WOG during the meeting are provided in Attachment 2.

Project No. 693

Attachments: 1. Meeting Attendees
2. Slides

cc w/atts: See next page

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FRAMATOME TECHNOLOGIES, INC.

MEETING ON REMOVAL OF THE REACTOR VESSEL MISSILE SHIELD

JUNE 29, 2000

NAME	AFFILIATION
Stewart Bailey	NRC/NRR/DLPM
Steve Dembek	NRC/NRR/DLPM
Timothy Colburn	NRC/NRR/DLPM
Stephen Dinsmore	NRC/NRR/DSSA/SPSB
Jai Rajan	NRC/NRR/DE/EMEB
Keith Wichman	NRC/NRR/DE/EMCB
James Medoff	NRC/NRR/DE/EMCB
Robert Enzinna	FTI
Michael Epling	FTI
Alvin McKim	FTI
Stephen Fyfitch	FTI
Ashok Nana	FTI
Michael Schoppman	FTI
George Rombold III	AmerGen
Howard Crawford	AmerGen
Leslie Collins	Westinghouse/CE Nuclear Licensing

Attachment 1

B&W Owners Group
Risk-Informed Approach for RV Missile Shield Removal

June 29, 2000

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Meeting Purpose

- Overview of past history
- Refine technical approach
- Early dialog to discuss development of Risk-Informed Application

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FRAMATOME TECHNOLOGIES

Project History/Background

- Initial project started in Mid-1994 (pre task meeting with NRC on 9/29/94).
- Project Comprised:
  - Licensing Reviews
  - Operating Experience Review
  - Stress Analysis of Major Components
  - FMEA & Other Analyses and Evaluations

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FRAMATOME TECHNOLOGIES

Pilot Plant Implementation

- TMI-1 lead B&WOG initiative with License Amendment Request 3/31/97.
- NRC Denied TMI-1 LAR on 9/16/98.
  - LBB complicated issue

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FRAMATOME TECHNOLOGIES

Pilot Plant Implementation

- Conference call held in August 1999 between GPUN and NRC on issue.
- Staff Indicated:
  - reviewers could not find any regulations to justify the design change
  - FMEA performed by FTI was not sufficiently quantitative

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FRAMATOME TECHNOLOGIES

Pilot Plant Implementation

- Staff Recommended:
  - re-submit as a RG 1.174 application (Risk-Informed Approach to Changing Licensing Basis)
  - provide detailed flaw tolerance evaluation of the CRDM pressure housing
  - discuss ongoing active degradation mechanisms to show flaws will not create a missile

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FRAMATOME TECHNOLOGIES

Benefits/Why needed

- eliminate 2 heavy load evolutions per RFO;
  - heavy load drop DBE,
  - economic risk,
  - industrial safety risk
- 10-12 hours of critical path
- eliminate Cold SD for CRDM electrical maintenance and corresponding radwaste (primary coolant) cost
- dose reduction

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FRAMATOME TECHNOLOGIES

Original Submittal Position

- Only missile with potential to damage containment is entire CRDM
- CRDM detachment is not possible
- All postulated failure mechanisms that could result in potential missile generation are not credible or would be detected by existing inspections / procedures before CRDM could credibly become missile

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FRAMATOME TECHNOLOGIES

Original FMEA

- Evaluated CRDM pressure boundary
- Identified potential failure mechanisms
- Evaluated each failure mechanism relative to missile potential

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Original FMEA

- For each potential failure mechanism, one or more of the following apply:
  - inspection activities are frequent relative to time-scale of failure mechanism
  - failure mechanism is not credible
  - failure mechanism does not produce a missile
  - insufficient kinetic energy to threaten containment

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Original FMEA

- reviewed PRAs for Missile Shield impacts
- reviewed operating experience
- deterministic evaluation

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Structural Analyses Performed for Original FMEA

- Safety margin on bolted joint
- Kinetic Energy of bolts & studs
- Closure cap failure pressure
- Impact of shield removal on
  - seismic response
  - LOCA asymmetric cavity pressure
- Corrosion scenarios

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New Project Scope

- Develop new Topical Report that meets the five principles outlined in RG 1.174
- Perform fracture mechanics analysis of limiting portions of CRDM pressure boundary
- Address active degradation mechanisms including sulfur intrusion at TMI-1.
- Submit new report as generic BAW Topical to NRC

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Proposed New RI Analysis

- Principles of RG 1.174

  The proposed change:

  – meets the current regulations,

  – is consistent with defense-in-depth,

  – maintains sufficient safety margins,

  – when an increase in core damage frequency or risk, the increases should be small,

  – performance should be monitored.

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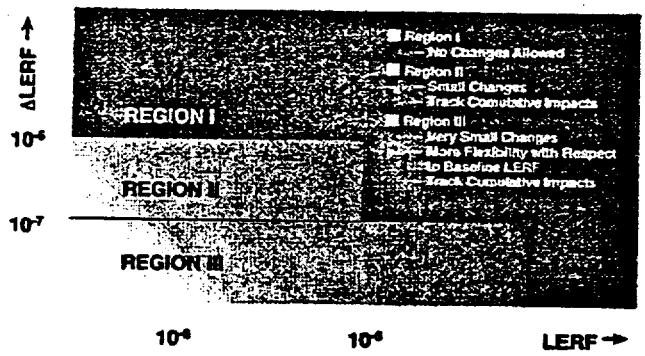
RG 1.174 Acceptance Guideline for Large Early Release Frequency (LERF)



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Is Removal of Shield a Small Risk?

- RG 1.174: small risk is ΔLERF < 1E-6/RY
- ΔLERF = CRDM Rupture Freq. x CCDP x ΔCCFP
  - CCDP = conditional core damage probability
  - ΔCCFP = change in conditional containment failure probability due to removal of missile shield

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Is ΔLERF < 1E-6/Rxyr?

- ΔLERF = CRDM Rupture Freq. x CCDP x ΔCCFP
  - CRDM Rupture is essentially MLOCA located at CRDM
  - all MLOCA = 3E-5/RY (per NUREG/CR-5750 by INEEL)
  - CCDP for MLOCA = 4E-3 (B&WOG PSAs)
- ΔLERF = 1.2E-7/RY x Δ CCFP
  - risk is "small" even before missile shield is considered
  - Δ CCFP = fraction of CRDM ruptures that are full circumferential (ie DEGB) and would have benefited from the missile shield
  - fraction of CRDM ruptures that will be full DEGB << 1.0

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FRAMATOME TECHNOLOGIES

Failure Mechanisms Considered

- Pitting
- SCC/PWSCC
- IGA
- Fatigue (Mechanical, Thermal, Environmentally-Assisted)
- Overpressure/Overtemperature
- Crevice Corrosion
- Hydrogen Damage
- Thermal Aging
- Human Error (e.g., Loose Parts)
- Mechanical Wear
- General Corrosion
- Galvanic Corrosion
- Erosion-Corrosion

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Proposed New Materials Analysis

- Most Credible Through-Wall Failure Mechanisms Requiring Evaluation
  - PWSCC of Alloy 600 material from primary water and high stress
  - IGA/SCC of Alloy 600 material from sulfur or resin intrusions

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Proposed New Materials Analysis

- Incorporation of recent evaluations
  - Prairie Island Unit 2 CRDM motor tube weld leakage assessment (BAW-2326)

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FRAMATOME TECHNOLOGIES

Proposed New Stress Analysis

- For CRDM Housing Region - New Axisymmetric Stress Analysis
- For CRDM Motor Tube Region - Existing Finite Element Analysis
- For Both Regions
  - Pressure, Thermal and Bounding Seismic and applicable LOCA Loads will be considered
  - Identification of highly stressed regions
  - Through-wall Axial and Hoop stresses for the identified regions
  - Stresses used as Inputs for fracture mechanics analysis

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FRAMATOME TECHNOLOGIES

Proposed New Stress Analysis

- J-groove penetration weld region in RV head previously justified in BAW-10190P using detailed 3-D Analysis
  - Due to Nature of Stresses, Flaws Predominantly Axial in Orientation

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FRAMATOME TECHNOLOGIES

Proposed New FM Analysis

- Fracture mechanics analyses of critical regions
- For a given region:
  - Input through-wall stresses
  - Consider fatigue crack growth and other potentially active degradation mechanisms (IGA/SCC from Sulfur/Resin Intrusions)
  - Consider potential for Through-Wall flaws existing when Sulfur/Resin Intrusions are present over extended period of operation
  - Consider preferential flaw orientation due to nature of stresses
  - Postulation of Through-Wall Circumferential and Axial Flaws

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Proposed New FM Analysis

- Perform Leak Rate Analysis
- Flaw Sizes for leakage rates of 3 to 10 gpm
- Demonstrate that these leakage flaw sizes remain stable
- Compare with Plant's Leak Detection Capability of 1 gpm

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Proposed New FM Analysis

- For degradation mechanisms other than sulfur/resin intrusions
- Partial Through-Wall Flaws will be postulated
- Initial assumed flaw depth = 1/4t
- Axial Flaws (anticipated) - Due to nature of stresses
- Consider fatigue crack growth
- Demonstrate flaws will not grow TW over the period of extended plant operations -- regions above the RV head

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Stress/FM Analysis Objectives

- Can postulated through-wall flaws grow to failure?
  - Show leakage flaws (>1gpm detect. leakage) remain stable (circumferential or axial through-wall flaw)
  - Address mechanisms such as sulfur/resin intrusions
- Show Partial Through-Wall flaws will not grow TW for the period of extended plant operations
  - Plants without sulfur/resin intrusions concern

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FRAMATOME TECHNOLOGIES

Licensing Submittal Strategy

- B&WOG submits generic topical report for approval
- Individual licensees implement under 50.59

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