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CERTIFIED BY:
William Shack - 4/28/99

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF ACRS SUBCOMMITTEE MEETING ON
MATERIALS AND METALLURGY
MARCH 24-25, 1999
ROCKVILLE, MARYLAND

The ACRS Materials and Metallurgy Subcommittee held a meeting on March 24-25, 1999, at 11545 Rockville Pike, Rockville, Maryland, in Room T-2 B3. The purpose of the meeting was to hold discussions with representatives of the NRC staff, the Nuclear Energy Institute, the Boiling Water Reactor Vessel Internals Project (BWRVIP), and the Pressurized Water Reactor (PWR) Material Reliability Project (MRP) . Presentations included items related to steam generator tube integrity, BWRVIP activities, PWR MRP activities, reactor pressure vessel integrity, status of the American Society of Mechanical Engineers (ASME) Special Working Group on Seismic Rules, proposed revisions to 10 CFR 50.55a "Codes and standards," and a proposed approach for revising 10 CFR 50.61 the pressurized thermal shock (PTS) rule. The entire meeting was open to public attendance. Mr. Noel Dudley was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:00 a.m. on March 24 and adjourned at 11:15 a.m. on March 25, 1997.

ATTENDEES:

ACRS

W. Shack, Chairman
M. Fontana, Member
T. Kress, Member
R. Seale, Member
N. Dudley, Senior Staff Engineer

NRC STAFF

K. Wichman, NRR
E. Sullivan, Jr., NRR
E. Murphy, NRR
S. Long, NRR
P. Rush, NRR
C. Carpenter, Jr., NRR
J. Fair, NRR
D. Terao, NRR
A. Lee, NRR
M. Mayfield, RES
J. Muscara, RES
D. Jackson, RES
E. Hackett, RES
J. Medoff, NRR
T. Scarbrough, NRR

INDUSTRY REPRESENTATIVES

K. Cozens, NEI
J. Reily, NEI
C. Terry, Niagara Mohawk Power Corp.
C. Hoffman, ABB-CENP
R. Mullins, Southern Company
M. Short, Southern California Edison

There were no written comments or requests for time to make oral statements received from members of the public. A list of meeting attendees is available in the ACRS office files. Dr. Shack had a conflict of interest regarding steam generator tube integrity and BWRVIP issues. He did not participate in the deliberations on these issues.

INTRODUCTION:

Dr. William Shack, Materials and Metallurgy Subcommittee Chairman, convened the meeting at 8:30 a.m. on March 24, 1999, and identified the topics to be presented. He noted that the ACRS had not been updated on these topic for over a year. Dr. Shack called upon Mr. Emmett Murphy, Office of Nuclear Reactor Regulation (NRR), to begin the presentation on steam generator integrity.

STEAM GENERATOR TUBE INTEGRITY - Mr. Emmett Murphy, NRR

Mr. Murphy summarized the last staff presentation to the Subcommittee regarding a proposed generic letter and draft regulatory guide (DG)-1074, "Steam Generator Tube Integrity." He noted that the ACRS, in a letter dated September 15, 1997, had endorsed issuance of the draft generic letter and DG-1074 for public comment. Mr. Murphy explained that all PWR licensees voluntarily agreed to implement the programmatic approach described in NEI 97-06, "Steam Generator Program Guidelines," which is conceptually similar to the program approach described in DG-1074. Mr. Murphy stated that the Commission approved delaying the issuance of the draft regulatory guide while the staff works with the industry to resolve the differences between DG-1074 and NEI 97-06.

The Subcommittee members and Mr. Murphy discussed the proposed deterministic and probabilistic acceptance criteria in DG-1074, the regulatory consequences of licensees not meeting the criteria, and the operating experience of licensees related to compliance with the criteria. They also discussed different alternatives for modifying the regulatory process to ensure steam generator tube integrity.

NEI 97-06, "STEAM GENERATOR PROGRAM GUIDELINES - Mr. Jim Riley, NEI

Mr. Riley explained the industry's initiative to implement NEI 97-06. He described the guidance provided in NEI 97-06 concerning performance criteria, assessment of potential degradation mechanisms, inspection planning, tube integrity assessment, and maintenance and repair criteria. He stated that NEI plans to submit a generic license change package for steam generator program elements to the NRC for approval. The change package would include proposed technical specifications, updated final safety analysis report changes, and documentation supporting license amendment requests. Mr. Riley described the technical, regulatory, and risk issues related to steam generator tube integrity.

The Subcommittee members and industry representatives discussed:

- the relationship between industry commitments and regulatory requirements,
- whether industry commitments can be inspected and enforced,
- what steam generator tube differential pressure to use for determining the structural tube integrity criteria,
- how defense-in-depth is effected by risk-informed performance criteria, and
- when violations of risk-informed performance criteria would be cited.

Dr. Kress noted that risk-informed arguments would be beneficial in determining the appropriate structural performance criterion. He recommended not mixing probabilistic and deterministic criteria. Dr. Kress suggested that determining resulting changes in defense-in-depth be part of probabilistic assessments. He noted that determining uncertainties would have to be done in order to determine the changes in defense-in-depth.

STATUS OF NRC SG TUBE INTEGRITY ACTIVITIES - Mr. Emmett Murphy, NRR

Mr. Murphy presented the objectives of developing a new regulatory framework for ensuring steam generator tube integrity and identified the high priority technical issues that need to be resolved. He stated that agreement can be reached between the staff and the industry on the technical issues, and explained the options for resolving the open regulatory issues. He presented operational experience at Farley Unit 1 of a steam generator tube leak and at Arkansas Nuclear One (ANO) Unit 1 of a steam generator tube in-situ pressure test failure. He summarized the industry responses to generic letters (GL) 97-05, "Inspection Methodology," and GL 97-06, "Degradation of Steam Generator Internals."

The Subcommittee members and the staff discussed:

- how the proposed regulatory framework would ensure risk issues are evaluated,
- effects of eliminating the detailed guidance for conducting operational assessments,
- focusing of NRC inspections on condition monitoring results,
- definitions of tube burst and tube rupture, and
- root causes of the tube failures at Farley and ANO.

CONSIDERATION OF RISK - Mr. Steven Long, NRR

Mr. Long provided an explanation of when and why to consider risk when evaluating requests for relaxation of steam generator tube integrity regulatory requirements. He presented a table that summarized the current criteria, reason for the criteria, and the efficacy of the criteria, which are derived from design–basis accident conditions, in limiting the risk from tube failures. Mr. Long identified the proposed NEI modifications that would effect the risk of tube failures and described the associated technical issues. He explained the role of risk assessments in a risk-informed regulatory approach.

The Subcommittee members and Mr. Long discussed the definition of adequate protection, the operational leakage criterion, performance of risk assessments, and the appropriate criteria to use to ensure tube integrity.

BWR INTERNALS CRACKING ISSUES - Mr. C. E. Carpenter, Jr., NRR

Mr. Carpenter presented the history of boiling water reactor (BWR) reactor pressure vessel internals cracking, inspection results, and the voluntary industry initiatives to address the internals cracking issues. He summarized the scope of and schedule for staff reviews of BWR Vessel and Internals Project (BWRVIP) reports associated with inspection and flaw evaluation strategies, mitigative strategies, repair and replacement strategies, and license renewal. Mr. Carpenter described BWRVIP research initiatives in the areas of evaluating postulated cascading failures and welding of highly irradiated materials. He concluded that for BWRs time-dependent material degradation was being addressed and that the BWRVIP's voluntary initiative has provided generic guidance to BWR licensees.

The Subcommittee members and the staff discussed the inspection schedule for reactor vessel internal components, use of BWRVIP reports in license renewal applications, and the regulatory significance of voluntary initiatives by the industry.

BWRVIP STATUS - Mr. Carl Terry, Niagara Mohawk Power Corp.

Mr. Terry, the Chairman of the BWRVIP, presented background information on the formation of the BWRVIP, the reactor vessel internal components for which condition assessment guidelines have been prepared, and BWRVIP proactive initiates. He concluded by explaining that the BWRVIP plans to close the base program by the end of 1999 and transition into a maintenance mode, which includes maintain awareness of developing issues. The Subcommittee members and the industry representatives discussed the use of BWRVIP reports in license renewal applications and the number of BWR licensees that are members of the BWRVIP.

PWR MATERIALS RELIABILITY PROJECT - Mr. Michael Short, Southern California Edison

Mr. Short, Chairman of the Issues Integration Group of the PWR MRP, presented the PWR MRP objectives, the issue selection criteria, and project structure. He described the PWR MRP activities associated with reactor pressure vessel (RPV) head penetration cracking, RPV integrity, RPV internals, and thermal fatigue of safety injection piping. Mr. Short concluded by noting the benefits of the PWR MRP such as improving safety and reliability, focusing on issue closure, integrating industry information, and supporting license renewal. The Subcommittee members and the industry representatives discussed operational issues related to pressurized thermal shock and pressure-temperature operating limits, and the number of PWR licensees who are members of the PWR MRP.

RESEARCH ACTIVITIES ON RPV INTEGRITY - Mr. Edwin Hackett, RES

Mr. Hackett presented the objectives of the RPV Integrity Research Program and the program budget. He identified the members of a 1998 peer review panel and presented their conclusions. Mr. Hackett described the status of research activities in support of the following regulatory issues:

- pressurized thermal shock,
- embrittlement estimates,
- pressure-temperature limits,
- low temperature overpressure protection,
- flaw size assumptions, and
- inservice inspections.

Mr. Hackett listed the national laboratories, commercial contractors, and universities that are doing work for the NRC. He described the following recent accomplishments and outcomes resulting from the research program:

- development of a Code Case and a revision of ASME Section XI, Appendix G;

- completion of NUREG/CR-6471, Volume 1, on characterization of flaws;

- completion of NUREG/CR-6551 on evaluation of statistical and physical bases for embrittlement correlations; and

- development of an annealing rule and Regulatory Guide 1.16.

Mr. Hackett summarized the anticipated products and outcomes of the research program, related international and national activities, and the future of the research program.

The Subcommittee members and the staff discussed closing unwarranted programs, status of thermal-hydraulic codes associated with pressurized thermal shock, destructive testing of irradiated reactor pressure vessels, and characterization of flaws. They also discussed documenting and archiving the results of research activities, and the applicability of the results to the license renewal process.

REACTOR VESSEL HEAD PENETRATION CRACKING - Mr. James Medoff, NRR

Mr. Medoff presented the background of Generic Letter (GL) 97-01, "Degradation of Control Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations," and summarized the licensees' responses. He described the licensees' inspection results and the schedule for closing GL 97-01. The Subcommittee members and the staff discussed the Oconee inspection results, the differences between French and U.S. inspection results, and the types of methods used to do the inspections.

REACTOR PRESSURE VESSEL INTEGRITY - Ms. Andrea Lee, NRR

Ms. Lee presented the background of GL 92-01, Revision 1, Supplement 1, "Reactor Vessel Structural Integrity," and summarized the licensees' responses. She described the status of the Reactor Vessel Integrity Database and the schedule for closing GL 92-01. Ms. Lee explained the status of the change to ASME Appendix G that would allow licensees to use the lower bound on static fracture toughness (K_{IC}) instead of the lower bound on static, dynamic, and crack arrest fracture toughness (K_{IA}) in pressure-temperature curve development. The Subcommittee members and the staff discussed merging the Electric Power Research Institute and the NRC databases, staff review of changes to pressure-temperature limits, and the effect of allowing licensees to use K_{IC}.

PIPING SEISMIC DESIGN CRITERIA - Mr. John Fair, NRR

Mr. Fair provided a status report on the resolution of issues related to the 1994 Addenda to the ASME Code, Section III, that adopted revised criteria for piping design. He presented the background of the disagreement between the staff and ASME, and identified the major technical concerns. Mr. Fair described the NRC research program and the efforts of the ASME Special Working Group - Seismic Requirements. The Subcommittee members and the staff discussed the selection of margins, Code usage, validation of NRC concerns, and the results of the associated Japanese research program.

PROPOSED AMENDMENT TO 10 CFR 50.55a - Mr. Thomas Scarbrough, NRR

Mr. Scarbrough presented background information on the development of the proposed amendment to 10 CFR 50.55a and summarized the current 50.55a regulatory requirements. He explained that, based on public comments concerning the proposed amendment, the staff has now recommended eliminating the 120-month update requirement. He noted that the staff plans to issue for public comment a supplement to the propose amendment. Mr. Scarbrough identified the issues related to this supplement and presented the schedule for issuing the final rule. The Subcommittee members and the staff discussed the cost of performing a 120-month update, the requirement for performance demonstrations, enforcement implications, and reasons for retaining the 120-month update.

RE-EVALUATION OF THE PRESSURIZED THERMAL SHOCK SCREENING CRITERIA - Mr. Michael Mayfield, RES

Mr. Mayfield presented the background of 10 CFR 50.61, the pressurized thermal shock (PTS) rule, and the PTS Re-evaluation Project. He stated that the goals of the project were to:

- develop the technical basis for a fundamental revision to the PTS rule;
- approach the project as a full-participatory project with public and technical experts; and
- achieve common understand among stakeholders that the proposed revisions are practical, technically credible, cost effective, and scrutable.

Mr. Mayfield stated that a success path exists for revising the PTS rule. He identified the elements of the success path as an improved understanding of flaw distributions, improved detection of flaws, improved fluence maps, more accurate chemistry data, and identified conservatism in screening criteria calculations. He explained that a two-track approach would be used to determine the appropriate screening criteria and to reassess and revise numerous aspects of the existing rule. Mr. Mayfield concluded by presenting the major milestones and schedule for completing the project.

The Subcommittee members and the staff discussed the analyses of PTS events, use of uncertainties as part of acceptance criteria, use of a screening criterion as a limit, division of research work between the NRC and industry, and use of thermal-hydraulic codes in the analyses.

SUBCOMMITTEE COMMENTS

Dr. Kress stated that his overall impression of the staff's approach to steam generator tube integrity issues is that the staff is clinging too strongly to the traditional way of doing things. Dr. Shack noted that Mr. Long was relying on the deterministic factor of three time the tube differential pressure to provide the margin required based on his probabilistic assessment of the severe accident high temperature case.

FOLLOWUP ACTIONS

Dr. Shack agreed to identify the BWRVIP reports and associated safety evaluation reports that would be of interest for the Plant License Renewal Subcommittee.

SUBCOMMITTEE RECOMMENDATIONS

The Subcommittee requested that the following be scheduled for the April 7-10 ACRS meeting:

- a summary by Dr. Shack of the presentations related to:
    - BWRVIP and PWR MRP;
    - Resolution of GL 97-01;
    - Resolution of GL 92-01, Rev 1, Supplement 1; and
    - ASME Piping Code Special Working Group - Seismic Rule;
- a staff summary of the proposed amendment to 10 CFR 50.55a;
- a staff summary of the unresolved technical and regulatory issues associated with steam generator tube integrity;

- a staff summary of its proposed approach for modifying 10 CFR 50.61, the (PTS) rule;
- a staff summary of the risk issues associated with steam generator tube integrity; and
- a staff summary the ongoing research activities associated with the Reactor Pressure Vessel Integrity Research Program.

The Subcommittee recommended that the ACRS prepare letters to the Executive Director for Operations concerning the staff's approach to resolving the steam generator tube integrity issues and the staff's proposed amendment to 10 CFR 50.55a.

BACKGROUND MATERIAL PROVIDED TO THE SUBCOMMITTEE:

1. Federal Register Notice dated November 24, 1998, from John C. Hoyle, Secretary for the Commission, Subject: Steam Generator Tube Integrity for Operating Nuclear Power Plants; Proposed Rule: Withdrawal.
2. ACRS report dated June 20, 1997, from R.L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: Proposed Regulatory Approach Associated with Steam Generator Integrity.
3. ACRS report dated September 15, 1997, from R.L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: Proposed Generic Letter and Draft Regulatory Guide DG-1074 Concerning Steam Generator Tube Integrity.
4. Memorandum dated September 11, 1998, from Samuel J. Collins, Director, NRR, to L. Joseph Callan, Executive Director for Operations, NRC, Subject: Proposed Generic Letter 98-XX "Steam Generator Tube Integrity."
5. U.S. Nuclear Regulatory Commission SECY-98-248, "Proposed Generic Letter 98- XX, 'Steam Generator Tube Integrity'," issued October 28, 1998.
6. Memorandum dated November 18, 1998, from Noel Dudley, ACRS, to ACRS Members, Subject: Meeting Summary Concerning NRC and Industry Risk Assessments of Steam Generator Tube Integrity.
7. Letter dated December 16, 1997, from Ralph Beedle, Senior Vice President and Chief Financial Officer, Nuclear Energy Institute, Subject: NEI 97-06, "Steam Generator Guidelines."
8. U.S. Nuclear Regulatory Commission SECY, "Weekly Information Reports," seven items concerning steam generator tube integrity events from January 1998 to February 1999; and U. S. Nuclear Regulatory Commission Information Notice 98-27, "Steam Generator Tube End Cracking," dated July 24, 1998.
9. Letter dated September 25, 1997, from J.L. Rainsberry, Southern California Edison, to U.S. Nuclear Regulatory Commission, Subject: Steam Generator Run Time Analysis for Cycle 9 San Onofre Nuclear Generating Station, Unit 2.
10. Letter dated September 11, 1998, from Donald S. Brinkman, NRR, to J.E. Cross, Duquesne Light Company, Subject: Review of Beaver Valley Power Station, Unit No. 1 Cycle 13 Steam Generator Tube Inspection 90-Day Report.
11. Status of NRC review of BWRVIP reports dated January 19, 1999. **[Internal Use Only]**

12. Memorandum dated January 2, 1999, from Egan Wang, NRR, to Thomas H. Essig, NRR, Subject: Summary of Meeting Held on November 18, 1998 with NEI/EPRI to Discuss Issues Related to PWR Material Reliability Project.
13. Letter dated January 15, 1999, from L. Raghavan, NRR, to A.J. Scalice, Tennessee Valley Authority, Subject: Amendment Nos. 257 and 217 to Facility Operating Licenses Nos. DPR-52, and DPR-68: Pressure and Temperature Limits - Technical Specification Change TS-393.
14. Memorandum dated April 22, 1997, from Samuel J. Collins, Director, NRR, to David L. Morrison, Director, RES, Subject: Request for Research on Characterization of Reactor Pressure Vessel Material Toughness by the "Master Curve" Method.
15. U.S. Nuclear Regulatory Commission Generic Letter 97-01, "Degradation of Control Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations," dated April 1, 1997.
16. Memorandum dated November 5, 1998, from Jefferey F. Harold, NRR, to S. Singh Bajwa, NRR, Subject: Summary of the Meeting on September 29, 1998, Between the NRC Staff and Members of the PWR Owner's Group and NEI to Discuss the Status of Multi-Plant Action TAC. Numbers Opened in Regard to Issuance of Generic Letter (GL) 97-01.
17. U.S. Nuclear Regulatory Commission Generic Letter 92-01, Revision 1, Supplement 1, "Reactor Vessel Structural Integrity," dated May 19, 1995.
18. Memorandum dated December 14, 1998, from Noel Dudley, ACRS, to ACRS Members, Subject: Staff Meeting Summary Concerning the Pressurized Thermal Shock (PTS) Screening Criteria and the Palisades' Reactor Vessel.
19. U.S. Nuclear Regulatory Commission SECY–99-017, "Proposed Amendment to 10 CFR 50.55a," dated January 13, 1999.
20. Note dated January 22, 1999, from Noel Dudley, ACRS, to Sam Duraiswamy, ACRS, Subject: Background Information on Proposed Amendment to 10 CFR 50. 55a. **(Internal Use Only)**

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NOTE: Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, 2120 L Street, N.W., Washington, D.C. 20006, (202) 634-3274, or can be purchased from Ann Riley & Associates, LTD., 1025 Connecticut Ave., NW, Suite 1014, Washington, D.C. 20036, (202) 842-0034.

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