UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

October 25, 2007

The Honorable Dale E. Klein
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Klein:

SUBJECT: SUMMARY REPORT – 546^{th} MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, OCTOBER 4-5, 2007, AND OTHER RELATED ACTIVITIES OF THE COMMITTEE

During its 546^{th} meeting, October 4-5, 2007, the Advisory Committee on Reactor Safeguards (ACRS) discussed several matters and completed the following report, letters, and memorandum:

<u>REPORT</u>:

Report to Dale E. Klein, Chairman, NRC, from William J. Shack, Chairman, ACRS:

- Digital Instrumentation and Control Systems Project Plan and Interim Staff Guidance, dated October 16, 2007.

<u>LETTERS</u>:

Letters to Luis A. Reyes, Executive Director for Operations, NRC, from William J. Shack, Chairman, ACRS:

- Draft Final Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems, dated October 19, 2007.

- NRC Staff's Safety Assessment of the Industry Study Related to Dissimilar Metal Weld Issues in Pressurizer Nozzles, dated October 19, 2007.

Letter to Brian Sheron, Director, Office of Nuclear Regulatory Research, NRC, from William J. Shack, Chairman, ACRS:

- ACRS Assessment of the Quality of Selected NRC Research Projects - FY 2007, dated October 19, 2007.

MEMORANDUM:

Memorandum to Luis A. Reyes, Executive Director for Operations, NRC, from Frank P. Gillespie, Executive Director, ACRS:

- Proposed Revision to Regulatory Guide 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," (DG-1175), dated October 10, 2007.

HIGHLIGHTS OF KEY ISSUES

1. Digital Instrumentation and Control Systems Project Plan and Interim Staff Guidance

The Committee met with representatives of the NRC staff and the Nuclear Energy Institute (NEI) to discuss the Digital Instrumentation and Control (I&C) Systems Project Plan and Interim Staff Guidance (ISG) issued by the NRC staff to address the issues of diversity and defense-in-depth, communications, and human factors.

The staff also discussed its followup activities to address the ACRS recommendations on evaluation of operating experience and inventory and classification system for digital failure modes.

One critical issue discussed was related to the diversity and defense-in-depth ISG regarding the acceptability of manual actions to address the need for diversity. The ISG states that when protective action is required in less than 30 minutes, the installation of an independent and diverse automated backup system is an acceptable approach. When protective action is not required for at least 30 minutes, the ISG identifies manual actions as acceptable. The industry stated that each case where manual actions are to be credited should be evaluated on its own merits. A process is needed to determine, on a case-by-case basis, whether an automated backup system should be installed or manual actions could be credited.

The diversity and defense-in-depth ISG also states that potential spurious trips and actuations are of a lesser safety concern than failures to trip or actuate. This assertion may not be justified for spurious signals that automatically reconfigure systems or initiate unintended functions during the progression of a plant transient or accident, and may cause unanticipated conditions that require operator intervention to restore the required safety functions.

Representatives of NEI addressed key issues and remaining challenges related to diversity and defense-in-depth, operating experience, communications, human factors, and cyber security.

Committee Action

The Committee issued a report to the NRC Chairman on this matter, dated October 16, 2007. The Committee stated that it was encouraged by the progress and the degree of collaboration between the staff and the industry in addressing the many challenging issues, and concluded that the staff's interim guidance reports on diversity and defense-in-depth, communications, and human factors, contain appropriate guidance to support the review of near-term licensing actions related to digital I&C. The Committee recommended that in the longer term, an alternative process to the 30-minute criterion be developed to determine the conditions under which operator manual actions can be credited as a diverse protective function, and that the issue of spurious actuations needs to be examined further.

2. Draft Final Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"

The Committee met with representatives of the NRC staff and NEI to discuss the draft final generic letter on gas ingress into the emergency core cooling system (ECCS), decay heat removal, and containment spray systems. The NRC staff stated that gas intrusion into the ECCS, decay heat removal, and containment spray systems can lead to loss of operability or degradation of performance. It may also lead to piping damage due to water hammer effects. Over the past 20 years, the NRC staff has published 20 Information Notices, two Generic Letters, and a NUREG, and also interacted with the nuclear industry many times regarding the gas intrusion issue. An event in 1997 at Oconee Unit 3 damaged two of the plant's three high-pressure injection pumps and rendered them nonfunctional. Following that event, an industry-wide initiative was undertaken to address the gas intrusion issue. Based on the industry's actions, the NRC staff concluded that no generic action was necessary at that time. However, despite the design and operational measures taken to prevent gas intrusion and accumulation in the above mentioned systems, and despite the high level of awareness of their potential impact on system performance, significant gas intrusion events have continued to occur, prompting the issuance of this Generic Letter.

The staff also presented a summary of the public comments received on this Generic Letter and the associated resolution. A representative of NEI indicated general agreement with the NRC staff position.

Committee Action

The Committee issued a letter to the Executive Director for Operations on this matter, dated October 19, 2007, recommending that the Generic Letter be issued as final.

3. Dissimilar Metal Weld Issue

The Committee met with representatives of the NRC staff and Dominion Engineering, Inc., to discuss the recent NRC staff and industry activities for addressing dissimilar metal weld issues resulting from the October 2006 inservice inspection of the Wolf Creek pressurizer nozzles. Analyses performed by the NRC staff in late 2006 and early 2007 indicated that large flaws, similar to those found at Wolf Creek, may lead to rupture before any measurable leakage occurs. As a result, the staff determined that inspections or mitigation activities on these welds at nine plants should be completed by the end of 2007 rather than during outages scheduled in spring of 2008. All other plants either do not have these types of welds or will have inspected or performed mitigation activities by the end of December 2007. The industry performed advanced finite element analyses to demonstrate that piping is not expected to rupture prior to leakage and that performing inspection or mitigation activities in the spring of 2008 at nine affected plants is acceptable. The NRC staff also developed an independent confirmatory analysis to review and verify the results of the industry analyses.

Representatives from Dominion Engineering, Inc., described the results of their advanced finite element analyses which demonstrate that the dissimilar metal welds are not expected to rupture prior to leakage. The NRC staff also described the results of its study. In general, there was excellent agreement between the industry and staff results. Therefore, the staff concluded that the advanced finite element analyses provided reasonable assurance that the nine affected plants will continue to safely operate until scheduled outages in spring 2008.

Committee Action

The Committee issued a letter to the Executive Director for Operations on this matter, dated October 19, 2007, stating that the studies undertaken by the staff and industry have been timely and helped to provide a technical basis for assessing the dissimilar metal weld issue. The Committee also supported the efforts of the staff to pursue further study of welding residual stresses.

4. Draft ACRS Report on the NRC Safety Research Program

The ACRS provides the Commission a biennial report, presenting the Committee's observations and recommendations concerning the overall NRC Safety Research Program. During the October 2007 meeting, the Committee discussed the draft ACRS report on the NRC Safety Research Program including the scope of long-term research the agency needs to consider.

Committee Action

The Committee plans to continue its discussion of the draft ACRS report on the NRC Safety Research Program during its November 2007 meeting.

5. Meeting with NEI, EPRI, and INPO to Discuss Industry Activities

At the request of NEI, the Committee met with representatives of NEI, the Electric Power Research Institute (EPRI), and the Institute of Nuclear Power Operations (INPO) to discuss the current organizational structures, ongoing and planned programs and initiatives to address various issues, and how these organizations interface with each other and the nuclear industry. A representative of NEI described the NEI mission to provide a forum to resolve technical, regulatory, and business issues for the nuclear industry, in addition to ensuring policies promoting beneficial uses of the nuclear technology. He described how NEI accomplishes this mission through a business plan, various task forces, and other activities. A representative of EPRI described the various power industry technology areas in which this non-profit energy research consortium is involved, and described their mission for the nuclear power sector. He described the national and international membership of EPRI and how their strategic and action plans address key and emerging nuclear industry issues. A representative of INPO described how this non-profit organization promotes excellence in the nuclear power industry through self regulation and peer review. He described the four INPO cornerstone programs and focus areas that function to promote excellence, and how INPO works with the World Association of Nuclear Operators (WANO). The ACRS members asked probing questions to better understand how various industry activities are coordinated between these organizations, the industry's position on many evolving NRC program areas and activities, and industry activities to ensure the research and development infrastructure needed to support the re-growth of the nuclear industry.

Committee Action

This was an information briefing. No Committee action was required.

6. Draft Final Report on Quality Assessment of Selected NRC Research Projects

The Committee discussed the draft final report on its assessment of the quality of the NRC research projects on: Cable Response to Live Fire (CAROLFIRE) Testing; Fatigue Crack Flaw Tolerance in Nuclear Power Plant Piping; and Technical Review of the Online Monitoring Techniques for Performance Assessment.

Committee Action

The Committee issued a letter to the Director of the Office of Nuclear Regulatory Research, dated October 19, 2007, transmitting its final report on the assessment of the quality of selected NRC research projects for FY 2007.

RECONCILIATION OF ACRS COMMENTS AND RECOMMENDATIONS/EDO COMMITMENTS

There were no EDO responses to reconcile during this meeting.

OTHER RELATED ACTIVITIES OF THE COMMITTEE

During the period from September 9, 2007 through October 3, 2007, the following Subcommittee meetings were held:

- Digital I&C Systems — September 13, 2007

The Subcommittee discussed the Digital I&C Systems Project Plan and draft Interim Staff Guidance (ISG) proposed by the NRC staff to address the issues of diversity and defense-in-depth, communications, human factors, and cyber security.

- Reliability and Probabilistic Risk Assessment — October 2, 2007

The Subcommittee discussed the next generation probabilistic safety assessment (PSA) software and model representation standards.

- Economic Simplified Boiling Water Reactor (ESBWR) — October 2 - 3, 2007

The Subcommittee discussed the design of the ESBWR including operating characteristics and safety features and reviewed Chapter 2 (Site Characteristics), Chapter 8 (Electric Power), and Chapter 17 (Quality Assurance) of the staff's safety evaluation report with open items for the ESBWR Design Certification.

- Planning and Procedures – October 3, 2007

The Subcommittee discussed proposed ACRS activities, practices, and procedures for conducting Committee business, and organizational and personnel matters relating to ACRS and its staff.

LIST OF MATTERS FOR THE ATTENTION OF THE EDO

- The Committee plans to review the draft final version of Revision 3 to Regulatory Guide 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," (DG-1175), after reconciliation of public comments.

- The Committee would like the opportunity to review any proposed interim measures or topical reports developed as a result of Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems."

- The Committee plans to continue discussion on its draft report on the NRC Safety Research Program during its November 2007 meeting.

PROPOSED SCHEDULE FOR THE 547th ACRS MEETING

The Committee agreed to consider the following topics during the 547th ACRS meeting, to be held on November 1-3, 2007:

- Extended Power Uprate Application for the Susquehanna Nuclear Power Plant.

- Meeting with Commissioner Lyons to discuss items of mutual interest.

- Vogtle Early Site Permit (ESP) Application.

- Staff's implementation of the lessons learned from the review of ESP applications.

- Assessment of the robustness of new nuclear plants.

- Selected chapters of the Safety Evaluation Report (SER) associated with the ESBWR design certification.

- Draft ACRS report on the NRC Safety Research Program.

Sincerely,

William J. Shack
Chairman

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/RA/

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Chairman

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Sincerely,

William J. Shack
Chairman

Distribution:
***See next page

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DATE	10/22/07	10/22/07	10/22/07	10/25/07	10/25/07

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LETTER TO: The Honorable Dale E. Klein, Chairman
U.S. Nuclear Regulatory Commission

FROM: William J. Shack, Chairman
Advisory Committee on Reactor Safeguards

SUBJECT: SUMMARY REPORT – 546th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, OCTOBER 4-5, 2007, AND OTHER RELATED ACTIVITIES OF THE COMMITTEE

DATE: October 25, 2007

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Subject: SUMMARY REPORT – 545th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, SEPTEMBER 6-8, 2007

LETTER TO:
The Honorable Dale E. Klein, NRC Chairman

FROM:
William J. Shack, ACRS Chairman

SUBJECT:
SUMMARY REPORT – 545th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, SEPTEMBER 6-8, 2007, AND OTHER RELATED ACTIVITIES OF THE COMMITTEE

DATE: 10/2/07

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Carol Anne Brown
Administrative Assistant
US Nuclear Regulatory Commission
Advisory Committee on Reactor Safeguards
Operations Support Branch
301-415-7998, MS T2-E26

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

November 26, 2007

MEMORANDUM TO: Carol A. Brown, Technical Secretary
Advisory Committee on Reactor Safeguards

FROM: William J. Shack **/RA/**
ACRS Chairman

SUBJECT: MINUTES OF THE 546th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS), October 4 - 5, 2007

I certify that based on my review of the minutes from the 546th ACRS Full Committee meeting, and to the best of my knowledge and belief, I have observed no substantive errors or omissions in the record of this proceeding subject to the comments noted below.

NA
Comments

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

MEMORANDUM TO: Carol A. Brown, Technical Secretary
Advisory Committee on Reactor Safeguards

FROM: William J. Shack /RA/
ACRS Chairman

SUBJECT: MINUTES OF THE 546th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS), October 4 - 5, 2007

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Comments

ADAMS Accession: ML073250444

	SUNSI		
NAME	JFlack		
DATE	11/26/07		

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

MEMORANDUM TO: Carol A. Brown, Technical Secretary
Advisory Committee on Reactor Safeguards

FROM: William J. Shack
ACRS Chairman

SUBJECT: MINUTES OF THE 546th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS), October 4 - 5, 2007

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Comments

ADAMS Accession: ML073250444

	SUNSI
NAME	JFlack
DATE	11/26/2007

CERTIFIED

Date Issued: 11/26/07
Date Certified: 11/26/07

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October 4-5, 2007

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REPORT:

Report to Dale E. Klein, Chairman, NRC, from William J. Shack, Chairman, ACRS:

- Digital Instrumentation and Control Systems Project Plan and Interim Staff Guidance, dated October 16, 2007.

LETTERS:

Letters to Luis A. Reyes, Executive Director for Operations, NRC, from William J. Shack, Chairman, ACRS:

1. Draft Final Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems, dated October 19, 2007.

2. NRC Staff's Safety Assessment of the Industry Study Related to Dissimilar Metal Weld Issues in Pressurizer Nozzles, dated October 19, 2007.

Letter to Brian Sheron, Director, Office of Nuclear Regulatory Research, NRC, from William J. Shack, Chairman, ACRS:

3. ACRS Assessment of the Quality of Selected NRC Research Projects - FY 2007, dated October 19, 2007.

MEMORANDUM:

Memorandum to Luis A. Reyes, Executive Director for Operations, NRC, from Frank P. Gillespie, Executive Director, ACRS:

- Proposed Revision to Regulatory Guide 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," (DG-1175), dated October 10, 2007.

MINUTES OF THE 546th MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
October 4-5, 2007
ROCKVILLE, MARYLAND

The **546th** meeting of the Advisory Committee on Reactor Safeguards (ACRS) was held in Conference Room 2B3, Two White Flint North Building, Rockville, Maryland, on **October 4 - 5, 2007**. Notice of this meeting was published in the *Federal Register* on **September 21, 2007** (72 FR **54082**) (Appendix I). The purpose of this meeting was to discuss and take appropriate action on the items listed in the meeting schedule and outline (Appendix II). The meeting was open to public attendance.

A transcript of selected portions of the meeting is available in the NRC's Public Document Room at One White Flint North, Room 1F-19, 11555 Rockville Pike, Rockville, Maryland. Copies of the transcript are available for purchase from Neal R. Gross and Co., Inc., 1323 Rhode Island Avenue, NW, Washington, DC 20005. Transcripts are also available at no cost to download from, or review on, the Internet at http://www.nrc.gov/ACRS/ACNW.

ATTENDEES

ACRS Members: Dr. William J. Shack (Chairman), Dr. Mario V. Bonaca (Vice-Chairman), Dr. Said Abdel-Khalik (Member-at-Large), Dr. George E. Apostolakis, Dr. Sam Armijo, Dr. Dennis Bley, Dr. Michael Corradini, Mr. Otto L. Maynard, Dr. Dana A. Powers, Mr. Jack Sieber, and Mr. John Stetkar. For a list of other attendees, see Appendix III.

I. Chairman's Report (Open)

[Note: Mr. Tanny Santos was the Designated Federal Official for this portion of the meeting.]

Dr. William J. Shack, Committee Chairman, convened the meeting at 8:30 A.M. He announced in his opening remarks that the meeting was being conducted in accordance with the provisions of the Federal Advisory Committee Act. In addition, he reviewed the agenda for the meeting and noted that no written comments or requests for time to make oral statements from members of the public had been received. Dr. Shack also noted that a transcript of the open portions of the meeting was being kept and speakers were requested to identify themselves and speak with clarity and volume. He discussed the items of current interest and administrative details for consideration by the full Committee.

II. Digital Instrumentation and Control Systems Project Plan and Interim Staff Guidance

[Note: Mr. Girija Shukla was the Designated Federal Official for this portion of the meeting.]

The Committee met with representatives of the NRC staff and the Nuclear Energy Institute (NEI) to discuss the Digital Instrumentation and Control (I&C) Systems Project Plan and Interim Staff Guidance (ISG) issued by the NRC staff to address the issues of diversity and defense-in-depth, communications, and human factors.

The staff also discussed its followup activities to address the ACRS recommendations on evaluation of operating experience and inventory and classification system for digital failure modes.

One critical issue discussed was related to the diversity and defense-in-depth ISG regarding the acceptability of manual actions to address the need for diversity. The ISG states that when protective action is required in less than 30 minutes, the installation of an independent and diverse automated backup system is an acceptable approach. When protective action is not required for at least 30 minutes, the ISG identifies manual actions as acceptable. The industry stated that each case where manual actions are to be credited should be evaluated on its own merits. A process is needed to determine, on a case-by-case basis, whether an automated backup system should be installed or manual actions could be credited.

The diversity and defense-in-depth ISG also states that potential spurious trips and actuations are of a lesser safety concern than failures to trip or actuate. This assertion may not be justified for spurious signals that automatically reconfigure systems or initiate unintended functions during the progression of a plant transient or accident, and may cause unanticipated conditions that require operator intervention to restore the required safety functions.

Representatives of NEI addressed key issues and remaining challenges related to diversity and defense-in-depth, operating experience, communications, human factors, and cyber security.

III. Draft Final Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"

[Note: David Bessette was the Designated Federal Official for this portion of the meeting.]

The Committee met with representatives of the NRC staff and NEI to discuss the draft final generic letter on gas ingress into the emergency core cooling system (ECCS), decay heat removal, and containment spray systems. The NRC staff stated that gas intrusion into the ECCS, decay heat removal, and containment spray systems can lead to loss of operability or degradation of performance. It may also lead to piping damage due to water hammer effects. Over the past 20 years, the NRC staff has published 20 Information Notices, two Generic Letters, and a NUREG, and also interacted with the nuclear industry many times regarding the gas intrusion issue. An event in 1997 at Oconee Unit 3 damaged two of the plant's three high-pressure injection pumps and rendered them nonfunctional. Following that event, an industry-wide initiative was undertaken to address the gas intrusion issue. Based on the industry's actions, the NRC staff concluded that no generic action was necessary at that time. However, despite the design and operational measures taken to prevent gas intrusion and accumulation in the above mentioned systems, and despite the high level of awareness of their potential impact on system performance, significant gas intrusion events have continued to occur, prompting the issuance of this Generic Letter.

The staff also presented a summary of the public comments received on this Generic Letter and the associated resolution. A representative of NEI indicated general agreement with the NRC staff position.

IV. Dissimilar Metal Weld Issue

[Note: Mr. Gary Hammer was the Designated Federal Official for this portion of the meeting.]

The Committee met with representatives of the NRC staff and Dominion Engineering, Inc., to discuss the recent NRC staff and industry activities for addressing dissimilar metal weld issues resulting from the October 2006 inservice inspection of the Wolf Creek pressurizer nozzles. Analyses performed by the NRC staff in late 2006 and early 2007 indicated that large flaws, similar to those found at Wolf Creek, may lead to rupture before any measurable leakage occurs. As a result, the staff determined that inspections or mitigation activities on these welds at nine plants should be completed by the end of 2007 rather than during outages scheduled in spring of 2008. All other plants either do not have these types of welds or will have inspected or performed mitigation activities by the end of December 2007. The industry performed advanced finite element analyses to demonstrate that piping is not expected to rupture prior to leakage and that performing inspection or mitigation activities in the spring of 2008 at nine affected plants is acceptable. The NRC staff also developed an independent confirmatory analysis to review and verify the results of the industry analyses.

Representatives from Dominion Engineering, Inc., described the results of their advanced finite element analyses which demonstrate that the dissimilar metal welds are not expected to rupture prior to leakage. The NRC staff also described the results of its study. In general, there was excellent agreement between the industry and staff results. Therefore, the staff concluded that the advanced finite element analyses provided reasonable assurance that the nine affected plants will continue to safely operate until scheduled outages in spring 2008.

V. Draft ACRS Report on the NRC Safety Research Program

[Note: Mr. Hossein Nourbakhsh was the Designated Federal Official for this portion of the meeting.]

The ACRS provides the Commission a biennial report, presenting the Committee's observations and recommendations concerning the overall NRC Safety Research Program. During the October 2007 meeting, the Committee discussed the draft ACRS report on the NRC Safety Research Program including the scope of long-term research the agency needs to consider.

VI. Meeting with NEI, EPRI, and INPO to Discuss Industry Activities

[Note: Ms. Maitri Banerjee was the Designated Federal Official for this portion of the meeting.]

At the request of NEI, the Committee met with representatives of NEI, the Electric Power Research Institute (EPRI), and the Institute of Nuclear Power Operations (INPO) to discuss the current organizational structures, ongoing and planned programs and initiatives to address various issues, and how these organizations interface with each other and the nuclear industry. A representative of NEI described the NEI mission to provide a forum to resolve technical, regulatory, and business issues for the nuclear industry, in addition to ensuring policies promoting beneficial uses of the nuclear technology. He described how NEI accomplishes this mission through a business plan, various task forces, and other activities. A representative of EPRI described the various power industry technology areas in which this non-profit energy research consortium is involved, and described their mission for the nuclear power sector. He described the national and international membership of EPRI and how their strategic and action plans address key and emerging nuclear industry issues. A representative of INPO described how this non-profit organization promotes excellence in the nuclear power industry through self regulation and peer review. He described the four INPO cornerstone programs and focus areas that function to promote excellence, and how INPO works with the World Association of Nuclear Operators (WANO). The ACRS members asked probing questions to better understand how various industry activities are coordinated between these organizations, the industry's position on many evolving NRC program areas and activities, and industry activities to ensure the research and development infrastructure needed to support the re-growth of the nuclear industry.

VII. Draft Final Report on Quality Assessment of Selected NRC Research Projects

[Note: Mr. Hossein Nourbakhsh was the Designated Federal Official for this portion of the meeting.]

The Committee discussed the draft final report on its assessment of the quality of the NRC research projects on: Cable Response to Live Fire (CAROLFIRE) Testing; Fatigue Crack Flaw Tolerance in Nuclear Power Plant Piping; and Technical Review of the Online Monitoring Techniques for Performance Assessment.

VIII. Executive Session (Open)

[Note: Mr. Frank P. Gillespie was the Designated Federal Official for this portion of the meeting.]

A. RECONCILIATION OF ACRS COMMENTS AND RECOMMENDATIONS/EDO COMMITMENTS

There were no EDO responses to reconcile during this meeting.

OTHER RELATED ACTIVITIES OF THE COMMITTEE

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The Subcommittee discussed the next generation probabilistic safety assessment (PSA) software and model representation standards.

- Economic Simplified Boiling Water Reactor (ESBWR) – October 2 - 3, 2007

The Subcommittee discussed the design of the ESBWR including operating characteristics and safety features and reviewed Chapter 2 (Site Characteristics), Chapter 8 (Electric Power), and Chapter 17 (Quality Assurance) of the staff's safety evaluation report with open items for the ESBWR Design Certification.

- Planning and Procedures – October 3, 2007

The Subcommittee discussed proposed ACRS activities, practices, and procedures for conducting Committee business and organizational and personnel matters relating to ACRS and its staff.

LIST OF MATTERS FOR THE ATTENTION OF THE EDO

- The Committee plans to review the draft final version of Revision 3 to Regulatory Guide 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," (DG-1175), after reconciliation of public comments.

- The Committee would like the opportunity to review any proposed interim measures or topical reports developed as a result of Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems."

- The Committee plans to continue discussion on its draft report on the NRC Safety Research Program during its November 2007 meeting.

PROPOSED SCHEDULE FOR THE 547th ACRS MEETING

The Committee agreed to consider the following topics during the 547th ACRS meeting, to be held on November 1-3, 2007:

- Extended Power Uprate Application for the Susquehanna Nuclear Power Plant.
- Meeting with Commissioner Lyons to discuss items of mutual interest.
- Vogtle Early Site Permit (ESP) Application.
- Staff's implementation of the lessons learned from the review of ESP applications.
- Assessment of the robustness of new nuclear plants.
- Selected chapters of the Safety Evaluation Report (SER) associated with the ESBWR design certification.
- Draft ACRS report on the NRC Safety Research Program.

B. Report on the Meeting of the Planning and Procedures Subcommittee Held on October 3, 2007

Review of the Member Assignments and Priorities for ACRS Reports and Letters for the October ACRS Meeting

Member assignments and priorities for ACRS reports and letters for the October ACRS meeting were discussed. Reports and letters that would benefit from additional consideration at a future ACRS meeting were discussed.

Anticipated Workload for ACRS Members

The anticipated workload for ACRS members through December 2007 was discussed. The objectives are to:

- Review the reasons for the scheduling of each activity and the expected work product and to make changes, as appropriate
- Manage the members' workload for these meetings
- Plan and schedule items for ACRS discussion of topical and emerging issues

During this session, the Subcommittee discussed and developed recommendations on items requiring Committee action.

Operating Plan, Self-Assessment, and Letter Matrix

The ACRS staff is in the process of preparing the ACRS/ ACNW&M Operating Plan for 2008. This is in three parts, 2008 operations, resources, and annual self-assessment. Contained within the annual self-assessment is the traditional letter matrix. The current due date to the Commission is November 1, 2007. An early draft was provided to the Planning and Procedures Subcommittee members on September 5, 2007 for information and comment as appropriate. A draft was sent to all ACRS members on September 28, 2007. The information is similar to last year's plan reformatted to eliminate material wherever possible.

Quadripartite Working Group Meeting

France's Groupe Permanent Réacteurs (GPR) will host the second Quadripartite Working Group (WG) meeting in France on the general topic of "EPR". The proposed dates are as follows:

October 9-10, 2008 OR
October 16-17, 2008 OR
October 23-24, 2008

GPR is asking for specific items/topics that the Committee would like to discuss at this WG meeting. Dr. Powers, Chairman of the EPR Subcommittee, proposes the following topics:

- PRA
- Digital I&C
- Fire Risk
- Quality Assurance

In addition, Dr. Powers recommends that the Committee authorize him, Dr. Bonaca, and Mr. Stetkar to attend this WG meeting.

Proposed ACRS Meeting Dates for CY 2008

Proposed ACRS meeting dates from CY 2008 summarized below. This was provided to the members during the September meeting for comment. We have not received any comments.

Meeting No.	Dates
	January 2008 (No Meeting)
549	February 7 – 9, 2008
550	March 6 - 8, 2008
551	April 3 - 5, 2008
552	May 8 – 10, 2008
553	June 4 – 6, 2008 (Wed – Fri)
554	July 9 – 11, 2008 (Wed – Fri)
—	August, (No Meeting)
555	September 4 – 6, 2008
556	October 2 – 4, 2008
557	November 6 – 8, 2008
558	December 4 – 6, 2008

Proposed List of Research Projects for Quality Assessment in FY 2008

A list of research projects proposed by RES for quality assessment in FY 2008 is attached (pp 20A). In view of the anticipated heavy workload, the Committee should select a maximum of 2 topics for quality assessment. Dr. Powers has selected the following two projects and an alternate:

- FRAPCON/FRAPTRAN Code Work at PNNL (Dr. Powers, Panel Chair)
- NUREG-6943, "Study of Remote Visual Methods to Detect Cracking in Reactor Components" (Dr. Armijo, Panel Chair)

Alternate: Baseline Risk Index for Initiating Events (BRIE) as documented in NUREG/CR 6932, June 2007.

Proposed Assignments for Reviewing Revisions to Regulatory Guides

During the September 2007 ACRS meeting, the Committee was informed of the RES staff's plan to update, as necessary, all NRC Regulatory Guides by December 2009. These updates will be performed in three phases:

- Phase 1, involving revisions to Regulatory Guides applicable to future plant licensing, was completed in March 2007.
- Phases 2 and 3 Regulatory Guides updates will be completed in December 2008 and December 2009, respectively.

At the September meeting, the ACRS staff committed to provide a list of proposed assignments for reviewing Phase 2 Regulatory Guides for consideration by the Subcommittee and the full Committee during their October meetings. These assignments may be changed, as needed, to balance the workload among the members.

C. Future Meeting Agenda

Appendix IV summarizes the proposed items endorsed by the Committee for the 547th ACRS Meeting, November 1 – 3, 2007.

The 546th ACRS Meeting was adjourned at 6:30 PM, October 5, 2007.

with implementation of the proposed mitigation measures that could eliminate or lessen the potential environmental impacts. The DEIS is a preliminary analysis of the environmental impacts of the proposed action and its alternatives. The Final EIS and any decision documentation regarding the proposed action will not be issued until public comments on the DEIS have been received and evaluated. Notice the availability of the Final EIS will be published in the **Federal Register.**

Dated at Rockville, Maryland, this 17th day of September, 2007.

For the U.S. Nuclear Regulatory Commission.

Scott C. Flanders,

Deputy Director, Environmental and Performance Assessment Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs.

[FR Doc. E7–18640 Filed 9–20–07; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards (ACRS); Meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment; Notice of Meeting

The ACRS Subcommittee on Reliability and Probabilistic Risk Assessment (PRA) will hold a meeting on October 2, 2007, Room T–2B3, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

Tuesday, October 2, 2007—8:30 a.m. until 12 Noon

The Subcommittee will discuss the next generation Probabilistic Safety Assessment software and model representation standards. The Subcommittee will hear presentations by and hold discussions with representatives of ABS Consulting, Electric Power Research Institute (EPRI), and ARBoost Technologies regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Dr. Hossein P. Nourbakhsh, (Telephone: 301–415–5622) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted.

Further information regarding this meeting can be obtained by contacting the Designated Federal Official between 7:30 a.m. and 4:15 p.m. (ET). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes to the agenda.

Dated: September 13, 2007.

Cayetano Santos,

Branch Chief, ACRS.

[FR Doc. E7–18629 Filed 9–20–07; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards; Meeting Notice

In accordance with the purposes of Sections 29 and 182b. of the Atomic Energy Act (42 U.S.C. 2039, 2232b), the Advisory Committee on Reactor Safeguards (ACRS) will hold a meeting on October 4–6, 2007, 11545 Rockville Pike, Rockville, Maryland. The date of this meeting was previously published in the**Federal Register** on Wednesday, November 15, 2006 (71 FR 66561).

Thursday, October 4, 2007, Conference Room T–2b3, Two White Flint North, Rockville, MD

8:30 a.m.–8:35 a.m.: Opening Remarks by the ACRS Chairman (Open)–The ACRS Chairman will make opening remarks regarding the conduct of the meeting.

8:35 a.m.–10:30 a.m.: Digital Instrumentation and Controls (I&C) Project Plan and Interim Staff Guidance (Open)—The Committee will hear presentations by and hold discussions with representatives of the NRC staff and Nuclear Energy Institute (NEI) regarding Digital I&C interim staff guidance on Cyber Security, Diversity & Defense in Depth, Highly Integrated Control Room—Communications, and Highly Integrated Control Room—Human Factors, as well as the Digital I&C Project Plan.

10:45 a.m.–12:15 p.m.: Draft Generic Letter 2007–XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems" (Open)—The Committee will hear presentations by and hold discussions with representatives of the NRC staff regarding the Draft Generic Letter 2007–XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems."

1:30 p.m.–3 p.m.: Dissimilar Metal Weld Issue (Open)—The Committee will hear presentations by and hold discussions with representatives of the NRC staff and nuclear industry regarding the advanced finite element analysis performed by the industry to provide basis for leak-before-break and the associated NRC staff's evaluation.

3:15 p.m.–5:15 p.m.: Draft ACRS Report on the NRC Safety Research Program (Open)—The Committee will discuss the draft ACRS report on the NRC Safety Research Program.

5:30 p.m.–7 p.m.: Preparation of ACRS Reports (Open)—The Committee will discuss proposed ACRS reports.

Friday, October 5, 2007, Conference Room T–2B3, Two White Flint North, Rockville, MD

8:30 a.m.–8:35 a.m.: Opening Remarks by the ACRS Chairman (Open)—The ACRS Chairman will make opening remarks regarding the conduct of the meeting.

8:35 a.m.–11 a.m.: Meeting with NEI, EPRI, and INPO to Discuss Industry Activities (Open)—The Committee will hear presentations by and hold discussions with representatives of NEI, Electric Power Research Institute (EPRI), and Institute of Nuclear power Operations (INPO) regarding industry activities.

11:15 a.m.–12:15 p.m.: Future ACRS Activities/Report of the Planning and Procedures Subcommittee (Open)—The Committee will discuss the recommendations of the Planning and Procedures Subcommittee regarding items proposed for consideration by the full Committee during future meetings. Also, it will hear a report of the Planning and Procedures Subcommittee on matters related to the conduct of ACRS business, including anticipated workload and member assignments.

1:15 p.m.–1:30 p.m.: Reconciliation of ACRS Comments and Recommendations (Open)—The Committee will discuss the responses from the NRC Executive Director for Operations to comments and recommendations included in recent ACRS reports and letters.

1:30 p.m.–2:15 p.m.: Draft Final Report on Quality Assessment of Selected NRC Research Projects (Open)—The Committee will discuss the draft final ACRS report on the results of the quality assessment of the NRC research projects on: Fatigue Crack Flaw Tolerance in Nuclear Power Plant Piping; Cable Response to Live Fire (CAROLFIRE) Testing; and Technical Review of On-Line Monitoring Techniques for Performance Assessment.

2:30 p.m.–7 p.m.: Preparation of ACRS Reports (Open)—The Committee will discuss proposed ACRS reports.

Saturday, October 6, 2007, Conference Room T–2B3, Two White Flint North, Rockville, MD

8:30 a.m.–12 p.m.: Preparation of ACRS Reports (Open)—The Committee will continue its discussion of proposed ACRS reports.

12 p.m.–12:30 p.m.: Miscellaneous (Open)—The Committee will discuss matters related to the conduct of Committee activities and matters and specific issues that were not completed during previous meetings, as time and availability of information permit.

Procedures for the conduct of and participation in ACRS meetings were published in the **Federal Register** on October

2, 2006 (71 FR 58015). In accordance with those procedures, oral or written views may be presented by members of the public, including representatives of the nuclear industry. Electronic recordings will be permitted only during the open portions of the meeting. Persons desiring to make oral statements should notify the Cognizant ACRS staff named below five days before the meeting, if possible, so that appropriate arrangements can be made to allow necessary time during the meeting for such statements. Use of still, motion picture, and television cameras during the meeting may be limited to selected portions of the meeting as determined by the Chairman. Information regarding the time to be set aside for this purpose may be obtained by contacting the Cognizant ACRS staff prior to the meeting. In view of the possibility that the schedule for ACRS meetings may be adjusted by the Chairman as necessary to facilitate the conduct of the meeting, persons planning to attend should check with the Cognizant ACRS staff if such rescheduling would result in major inconvenience.

Further information regarding topics to be discussed, whether the meeting has been canceled or rescheduled, as well as the Chairman's ruling on requests for the opportunity to present oral statements and the time allotted therefor can be obtained by contacting Mr. Giriga S. Shukla, Cognizant ACRS staff (301–415–8439), between 7:30 a.m. and 4 p.m., (ET). ACRS meeting agenda, meeting transcripts, and letter reports are available through the NRC Public Document Room at *pdr@nrc.gov*, or by calling the PDR at 1–800–397–4209, or from the Publicly Available Records System (PARS) component of NRC's document system (ADAMS) which is accessible from the NRC Web site at *http://www.nrc.gov/reading-rm/adams.html* or *http://www.nrc.gov/reading-rm/doc-collections/*(ACRS & ACNW Mtg schedules/agendas).

Video teleconferencing service is available for observing open sessions of ACRS meetings. Those wishing to use this service for observing ACRS meetings should contact Mr. Theron Brown, ACRS Audio Visual Technician (301–415–8066), between 7:30 a.m.–3:45 p.m., (ET), at least 10 days before the meeting to ensure the availability of this service. Individuals or organizations requesting this service will be responsible for telephone line charges and for providing the equipment and facilities that they use to establish the video teleconferencing link. The availability of video teleconferencing services is not guaranteed.

Dated: September 17, 2007.

Andrew L. Bates,

Advisory Committee Management Officer.

[FR Doc. E7–18633 Filed 9–20–07; 8:45 am]

BILLING CODE 7590–01–P

OFFICE OF PERSONNEL MANAGEMENT

Excepted Service

AGENCY: U.S. Office of Personnel Management (OPM).

ACTION: Notice.

SUMMARY: This gives notice of OPM decisions granting authority to make appointments under Schedules A, B, and C in the excepted service as required by 5 CFR 6.6 and 213.103.

FOR FURTHER INFORMATION CONTACT: C. Penn, Group Manager, Executive Resources Services Group, Center for Human Resources, Division for Human Capital Leadership and Merit System Accountability, 202–606–2246.

SUPPLEMENTARY INFORMATION: Appearing in the listing below are the individual authorities established under Schedules A, B, and C between July 1, 2007, and July 31, 2007. Future notices will be published on the fourth Tuesday of each month, or as soon as possible thereafter. A consolidated listing of all authorities as of June 30 is published each year.

Schedule A

(b)(1) Positions of Resident Country Directors and Deputy Resident Country Directors. The length of appointments will correspond to the length or term of the compact agreements made between the Millennium Challenge Corporation (MCC) and the country in which MCC will work, plus one additional year to cover pre- and post-compact agreement related activities. Effective July 16, 2007.

Schedule B

No Schedule B appointments were approved for July 2007.

Schedule C

The following Schedule C appointments were approved during July 2007.

Section 213.3303 Executive Office of the President

Office of Management and Budget

BOGS70014 Special Assistant to the Chief of Staff. Effective July 17, 2007.
BOGS70017 Special Assistant to the Director Office of Management and Budget. Effective July 20, 2007.

Office of the United States Trade Representative

TNGS70004 Executive Assistant to the United States Trade Representative. Effective July 10, 2007.
TNGS70005 Director of Scheduling and Advance to the United States Trade Representative. Effective July 18, 2007.

Section 213.3304 Department of State

DSGS61098 Legislative Analyst to the Assistant Secretary for Legislative and Intergovernmental Affairs. Effective July 06, 2007.
DSGS61241 Special Advisor to the Assistant Secretary for Economic and Business Affairs. Effective July 06, 2007.
DSGS67921 Special Assistant to the Chief of Protocol. Effective July 20, 2007.
DSGS61243 Special Assistant to the Director, Policy Planning Staff. Effective July 23, 2007.
DSGS61062 Foreign Affairs Officer (Visits) to the Chief of Protocol. Effective July 26, 2007.
DSGS61202 Senior Advisor to the Coordinator for International Information Programs. Effective July 26, 2007.
DSGS61058 Staff Assistant to the Assistant Secretary Oceans, International Environment and Science Affairs. Effective July 27, 2007.
DSGS61036 Staff Assistant to the Assistant Secretary for Public Affairs. Effective July 30, 2007.

Section 213.3305 Department of the Treasury

DYGS00465 Special Assistant to the Assistant Secretary (Management) and Chief Financial Officer. Effective July 06, 2007.
DYGS00467 Associate Director to the White House Liaison. Effective July 27, 2007.
DYGS00498 Deputy Executive Secretary to the Deputy Chief of Staff and Executive Secretary. Effective July 27, 2007.

Section 213.3306 Department of Defense

DDGS17055 Public Affairs Specialist to the Assistant Secretary of Defense Public Affairs. Effective July 05, 2007.
DDGS17063 Personal and Confidential Assistant to the Special Assistant to the Secretary and Deputy Secretary of Defense. Effective July 05, 2007.
DDGS17052 Confidential Assistant to the Director of Defense Research and Engineering. Effective July 06, 2007.
DDGS17057 Defense Fellow to the Special Assistant to the Secretary of Defense for White House Liaison. Effective July 09, 2007.
DDGS17058 Special Assistant to the Assistant Secretary of Defense (Legislative Affairs). Effective July 09, 2007.
DDGS17064 Protocol Specialist to the Special Assistant to the Secretary of Defense for Protocol. Effective July 09, 2007.
DDGS17062 Special Assistant to the Director, Department of Defense Office of Legislative Counsel. Effective July 11, 2007.
DDGS17050 Advisor to the Special Assistant to the Secretary and Deputy

Strike Out Version

September 13, 2007

SCHEDULE AND OUTLINE FOR DISCUSSION
546th ACRS MEETING
OCTOBER 4-6, 2007

THURSDAY, OCTOBER 4, 2007, CONFERENCE ROOM T-2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

1) 8:30 - 8:35 A.M. Opening Remarks by the ACRS Chairman (Open) (WJS/CS/SD)
- 1.1) Opening statement
- 1.2) Items of current interest

2) 8:35 - ~~10:30~~ A.M. 10:23 Digital Instrumentation and Controls (I&C) Project Plan and Interim Staff Guidance (Open) (GEA/GSS)
- 2.1) Remarks by the Subcommittee Chairman
- 2.2) Briefing by and discussions with representatives of the NRC staff and Nuclear Energy Institute (NEI) regarding Digital I&C interim staff guidance on Cyber Security, Diversity & Defense in Depth, Highly Integrated Control Room – Communications, and Highly Integrated Control Room – Human Factors, as well as the Digital I&C Project Plan.

Members of the public may provide their views, as appropriate.

~~10:30 - 10:45~~ A.M. *****BREAK*****
10:23 – 10:46 A.M.

3) ~~10:45 - 12:15~~ P.M. 10:46 – 12:10 P.M. Draft Generic Letter 2007-XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems" (Open) (SAK/DB)
- 3.1) Remarks by the Subcommittee Chairman
- 3.2) Briefing by and discussions with representatives of the NRC staff regarding the Draft Generic Letter 2007-XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems."

Representatives of the nuclear industry and members of the public may provide their views, as appropriate.

~~12:15 - 1:30~~ P.M. *****LUNCH*****
12:10 – 1:34 P.M.

4) ~~1:30 - 3:00~~ P.M. 1:34 – 3:30 P.M.

Dissimilar Metal Weld Issue (Open) (WJS/CGH)

4.1) Remarks by the Subcommittee Chairman
4.2) Briefing by and discussions with representatives of the NRC staff and nuclear industry regarding the advanced finite element analysis performed by the industry to provide basis for leak-before-break and the associated NRC staff's evaluation.

Members of the public may provide their views, as appropriate.

~~3:00 - 3:15~~ P.M. 3:30 – 3:45 P.M. *****BREAK*****

5) 3:15 - 5:15 P.M.

Draft ACRS Report on the NRC Safety Research Program (Open) (DAP/HPN)

5.1) Remarks by the Subcommittee Chairman
5.2) Discussion of the draft ACRS report on the NRC Safety Research Program.

5:15 - 5:30 P.M. *****BREAK*****

6) 5:30 - 7:00 P.M.

Preparation of ACRS Reports (Open)
Discussion of proposed ACRS reports on:

6.1) Digital I&C Interim Staff Guidance (GEA/GSS)
6.2) Draft Generic Letter 2007-XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems" (SAK/DB)
6.3) Dissimilar Metal Weld Issue (WJS/CGH)

FRIDAY, OCTOBER 5, 2007, CONFERENCE ROOM T-2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

7) ~~8:30 - 8:35~~ A.M. 8:35 – 8:40 A.M.

Opening Remarks by the ACRS Chairman (Open) (WJS/CS/SD)

8) ~~8:35 - 11:00~~ A.M. 8:40 – 10:12 A.M.

Meeting with NEI, EPRI, and INPO to Discuss Industry Activities (Open) (OLM/MB)

8.1) Remarks by the Subcommittee chairman
8.2) Briefing by and discussions with representatives of NEI, Electric Power Research Institute (EPRI), and Institute of Nuclear Power Operations (INPO) regarding industry activities.

~~11:00 - 11:15~~ A.M. *****BREAK*****

10:12 – 10:29 A.M.

8) 10:29 – 11:21 A.M.

(Continued) Meeting with NEI, EPRI, and INPO to Discuss Industry Activities (Open) (OLM/MB)

9) ~~11:15~~ 11:21 - 12:15 P.M. Future ACRS Activities/Report of the Planning and Procedures Subcommittee (Open) (WJS/FPG/SD)

9.1) Discussion of the recommendations of the Planning and Procedures Subcommittee regarding items proposed for consideration by the full Committee during future ACRS meetings.

9.2) Report of the Planning and Procedures Subcommittee on matters related to the conduct of ACRS business, including anticipated workload and member assignments.

12:15 - 1:15 P.M. *****LUNCH*****

10) 1:15 - 1:30 P.M. Reconciliation of ACRS Comments and Recommendations (Open) (WJS, et al./SD, et al.)
Discussion of the responses from the NRC Executive Director for Operations to comments and recommendations included in recent ACRS reports and letters.

11) 1:30 - 2:15 P.M. Draft Final Report on Quality Assessment of Selected NRC Research Projects (Open) (DAP/HPN)

11.1) Remarks by the Subcommittee Chairman

11.2) Discussion of the draft final ACRS report on the results of the quality assessment of the NRC research projects on: Fatigue Crack Flaw Tolerance in Nuclear Power Plant Piping; Cable Response to Live Fire (CAROLFIRE) Testing; and Technical Review of On-Line Monitoring Techniques for Performance Assessment.

2:15 - 2:30 P.M. *****BREAK*****

12) 2:30 - 7:00 P.M. Preparation of ACRS Reports (Open)
Discussion of proposed ACRS reports on:

12.1) Digital I&C Interim Staff Guidance (GEA/GSS)

12.2) Draft Generic Letter 2007-XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems" (SAK/DB)

12.3) Dissimilar Metal Weld Issue (WJS/CGH)

12.4) Draft ACRS Report on the NRC Safety Research Program (DAP/HPN)

SATURDAY, OCTOBER 6, 2007, CONFERENCE ROOM T-2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

Saturday Session was cancelled

~~13) 8:30 - 12:00 P.M.~~ ~~Preparation of ACRS Reports (Open)~~
~~**(10:30-10:45 A.M. BREAK)**~~ ~~Continue discussion of proposed ACRS reports listed under Item 12.~~

~~14) 12:00 - 12:30 P.M.~~ ~~Miscellaneous (Open) (WJS/FPG)~~
~~Discussion of matters related to the conduct of Committee activities and matters and specific issues that were not completed during previous meetings, as time and availability of information permit.~~

NOTE:

Presentation time should not exceed 50 percent of the total time allocated for a specific item. The remaining 50 percent of the time is reserved for discussion.

Thirty-Five (35) hard copies and (1) electronic copy of the presentation materials should be provided to the ACRS.

ACRS	ACRS	ACRS	Filed: CM-180
GSS/bjw	MA	CS	
09/ /07	09/ /07	09/ /07	

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546th FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT CLEARLY

NRC Attendees

TODAY'S DATE: October 4, 2007

	NAME	NRC ORGANIZATION
1	Jay Robinson	NRR/DPR/PGCB
2	Kulin Desai	NRR/DSS/SRXB
3	Tim Collins	NRR/DSS
4	Warren Lyon	NRR/DSS/SRXB
5	Martin Murphy	NRR/DPR/PGCB
6	Greg Cranston	NRR/DSS/SRXB
7	R. Hardies	RES/DE/CIB
8	Tim Lupold	NRR/DCI/CPNB
9	Allan Csontos	RES
10	Yeon-Ki Chung	NRR
11	Simon Sheng	NRR/DCI/CVIB
12	Ted Sullivan	NRR/DCI
13	Michelle Evans	NRR/DCI
14	Jocelyn Mitchell	RES
15	Shaff Mallik	RES
16	John Jolicoer	RES
17	Girija Shukla	ACRS
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546th FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT CLEARLY

NRC Attendees

TODAY'S DATE: October 5, 2007

	NAME	NRC ORGANIZATION
1	Emma Wong	NRR/DCI
2	John Burke	NRR/DCI
3	John Ridgely	RES/DE
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546th FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT CLEARLY

Visitors

TODAY'S DATE: October 4, 2007

	NAME	ORGANIZATION
1	Satoshi Hanada	MNES
2	Ryan Sprengel	GEH
3	Rich Miller	GEH
4	Gordon Clefton	NEI
5	Deann Raleigh	US, Scientech
6	Jim Riley	NEI
7	David Steininger	EPRI
8	Glenn White	Dominion Engineering, Inc.
9	Dave Rudland	EMC^2
10	Daniel Horner	Platts
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546th FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT CLEARLY

Visitors

TODAY'S DATE: October 5, 2007

	NAME	ORGANIZATION
1	Alex Marion	NEI
2	Gordon Clefton	NEI
3	Tony Pietrangelo	NEI
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546TH FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT

TODAY'S DATE: October 4, 2007

NAME	NRC ORGANIZATION
Satoshi Hanada	MNES
JAY ROBINSON	NRR / DPR / PGCB
Kulin Desai	NRR / DSS / SRXB
Tim Collins	NRR / DSS
WARREN LYON	NRR / DSS / SRXB
Martin Murphy	NRR / DPR / PGCB
GREG CRANSTON	NRR / DSS / SRXB
R. Hardies	NRC / RES / DE / CIB
Tim Lupold	NRR / DCI / CPNB
Aladar Csontos	NRC / RES
Yeon-Ki Chung	NRC / NRR
Simon Sheng	NRC / NRR / DCI / CVIB
Edmund Sullivan	NRC / NRR / DCI
Michele Evans	NRC / NRR / DCI
Jocelyn Mitchell	RES
SHAH MALIK	RES
JOHN JOLICOEUR	RES
GIRIJA SHUKLA	ACRS

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546TH FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT

TODAY'S DATE: October 5, 2007

	NAME	NRC ORGANIZATION
1	Emma Wong	NRR/DCI1
2	John Burke	NRR/DCI
3	John Ridgely	RES/DE
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546TH FULL COMMITTEE MEETING

October 4-6, 2007

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TODAY'S DATE: October 4, 2007

NAME	AFFILIATION
Ryan Sprengel	GEH
Rich Miller	GEH
Satoshi Hanada	MNES
Gordon Clefton	NEI
Deann Raleigh	LIS, Scientech
Jim Riley	NEI
DAVID STEININGER	EPRI
Glenn White	Dominion Engineering, Inc.
Dave Rudland	EMC²
Daniel HORNER	Platts

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
546TH FULL COMMITTEE MEETING

October 4-6, 2007

PLEASE PRINT

TODAY'S DATE: October 5 2007

	NAME	AFFILIATION
1	A MARION	NEI
2	Gordon Clefton	NEI
3	~~John Butler~~	~~NEI~~
4	Tony Pietrangelo	NEI
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October 16, 2007

SCHEDULE AND OUTLINE FOR DISCUSSION
547th ACRS MEETING
NOVEMBER 1-3, 2007

THURSDAY, NOVEMBER 1, 2007, CONFERENCE ROOM T-2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

1) 8:30 - 8:35 A.M. Opening Remarks by the ACRS Chairman (Open) (WJS/CS/SD)
   - 1.1) Opening statement
   - 1.2) Items of current interest

2) 8:35 - 10:30 A.M. Extended Power Uprate Application for the Susquehanna Nuclear Power Plant (Open/Closed) (SB/ZA)
   - 2.1) Remarks by the Subcommittee Chairman
   - 2.2) Briefing by and discussions with representatives of the NRC staff and the Pennsylvania Power & Light Company regarding the Extended Power Uprate Application for the Susquehanna Nuclear Power Plant, and the associated NRC staff's Safety Evaluation.

   [Note: A portion of this session may be closed to protect information that is proprietary to General Electric, AREVA, and their contractors pursuant to 5 U.S.C. 552b (c) (4).]

   Members of the public may provide their views, as appropriate.

10:30 - 10:45 A.M. ***BREAK***

3) 10:45 - 11:45 A.M. Meeting with Commissioner Peter B. Lyons (Open) (WJS/GSS)
   - 3.1) Remarks by the ACRS Chairman
   - 3.2) Discussions with Commissioner Lyons on items of mutual interest.

11:45 - 12:45 P.M. ***LUNCH***

4) 12:45 - 2:45 P.M. Vogtle Early Site Permit (ESP) Application (Open) (DAP/DCF)
   - 4.1) Remarks by the Subcommittee Chairman
   - 4.2) Briefing by and discussions with representatives of the NRC staff and Southern Nuclear Operating Company regarding Vogtle ESP application, and the associated NRC staff's Safety Evaluation Report with Open Items.

   Representatives of the nuclear industry and members of the public may provide their views, as appropriate.

2:45 - 3:00 P.M. *****BREAK*****

5) 3:00 - 4:00 P.M. Staff's Implementation of the Lessons Learned from the Review of ESP Applications (Open) (DAP/DCF)
   - 5.1) Remarks by the Subcommittee Chairman
   - 5.2) Briefing by and discussions with representatives of the NRC staff regarding the effectiveness and efficiency of the staff's implementation of the lessons learned from the review of ESP applications.

   Representatives of the nuclear industry and members of the public may provide their views, as appropriate.

4:00 - 4:15 P.M. *****BREAK*****

6) 4:15 - 6:15 P.M. Assessment of the Robustness of New Nuclear Plants **(Closed) (Room T-10E8)** (MVB/MB)
   - 6.1) Remarks by the Subcommittee chairman
   - 6.2) Briefing by and discussions with representatives of the NRC staff regarding the assessment of the robustness of new nuclear plants.

   [Note: This session will be closed to protect information classified as National Security information as well as safeguards information pursuant to 5 U.S.C. 552b (c) (1) and (3).]

6:15 - 6:30 P.M. *****BREAK*****

7) 6:30 - 7:15 P.M. Preparation of ACRS Reports (Open)
   Discussion of proposed ACRS reports on:
   - 7.1) Extended Power Uprate Application for the Susquehanna Nuclear Power Plant (SB/ZA)
   - 7.2) Vogtle Early Site Permit Application (DAP/DCF)
   - 7.3) Staff's Implementation of Lessons Learned from the Review of ESP Applications (DAP/DCF)

FRIDAY, NOVEMBER 2, 2007, CONFERENCE ROOM T-2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

8) 8:30 - 8:35 A.M. Opening Remarks by the ACRS Chairman (Open) (WJS/CS/SD)

9) 8:35 - 10:30 A.M. Selected Chapters of the SER Associated with the ESBWR Design Certification (Open/Closed) (MLC/CGH)
   - 9.1) Remarks by the Subcommittee Chairman
   - 9.2) Briefing by and discussions with representatives of the NRC staff and General Electric regarding selected chapters of the SER With Open Items associated with the ESBWR design certification.

[Note: A portion of this session may be closed to protect information that is proprietary to General Electric and their contractors pursuant to 5 U.S.C. 552b (c) (4).]

Members of the public may provide their views, as appropriate.

10:30 - 10:45 A.M. *****BREAK*****

10) 10:45 - 11:30 A.M. Future ACRS Activities/Report of the Planning and Procedures Subcommittee (Open) (WJS/FPG/SD)

10.1) Discussion of the recommendations of the Planning and Procedures Subcommittee regarding items proposed for consideration by the full Committee during future ACRS meetings.

10.2) Report of the Planning and Procedures Subcommittee on matters related to the conduct of ACRS business, including anticipated workload and member assignments.

11) 11:30 - 11:45 A.M. Reconciliation of ACRS Comments and Recommendations (Open) (WJS, et al./SD, et al.)

Disçussion of the responses from the NRC Executive Director for Operations to comments and recommendations included in recent ACRS reports and letters.

11:45 - 1:00 P.M. *****LUNCH*****

12) 1:00 - 3:00 P.M. Draft ACRS Report on the NRC Safety Research Program (Open) (DAP/HPN)

12.1) Remarks by the Subcommittee Chairman

12.2) Discussion of the draft ACRS report on the NRC Safety Research Program

3:00 - 3:15 P.M. *****BREAK*****

13) 3:15 - 7:00 P.M. Preparation of ACRS Reports (Open)

Discussion of proposed ACRS reports on:

13.1) Extended Power Uprate Application for the Susquehanna Nuclear Power Plant (SB/ZA)

13.2) Vogtle Early Site Permit (ESP) Application (DAP/DCF)

13.3) Staff's Implementation of lessons learned from the Review of ESP Applications (DAP/DCF)

13.4) Selected Chapters of the SER Associated with the ESBWR Design Certification (MLC/CGH)

SATURDAY, NOVEMBER 3, 2007, CONFERENCE ROOM T-2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

14) 8:30 - 1:30 P.M. **(10:30-10:45 A.M. BREAK)** Preparation of ACRS Reports (Open)
Continue discussion of proposed ACRS reports listed under Item 13, as well as the draft ACRS report on the NRC Safety Research Program.

15) 1:30 - 2:00 P.M. Miscellaneous (Open) (WJS/FPG)
Discussion of matters related to the conduct of Committee activities and matters and specific issues that were not completed during previous meetings, as time and availability of information permit.

NOTE:

Presentation time should not exceed 50 percent of the total time allocated for a specific item. The remaining 50 percent of the time is reserved for discussion.

Thirty-Five (35) hard copies and (1) electronic copy of the presentation materials should be provided to the ACRS.

LIST OF DOCUMENTS PROVIDED TO THE COMMITTEE
546th ACRS MEETING
October 4-6, 2007

MEETING HANDOUTS

AGENDA ITEM #	DOCUMENTS/HANDOUTS LISTED IN ORDER
1.	Opening Remarks by the ACRS Chairman
2.	Digital Instrumentation and Controls (I&C) Project Plan and Interim Staff Guidance 1. Digital Instrumentation & Control (I&C), [Slides from NEI] 2. Presentation to the ACRS on Digital Instrumentation and Control (I&C), [Slides from NRC/NRR/DE, Sosa and Arndt
3.	Draft Generic Letter 2007-XX, "Managing Gas Intrusion in ECCS, Decay Heat Removal, and Containment Spray Systems" 3. ACRS Meeting on Draft Generic Letter on Managing Gas Instrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems, [Slides from NRR, Beaulieu and Lyon] 4. Managing Gas Intrusion [Slides from NEI, Gordon Clefton]
4.	Dissimilar Metal Weld Issue 5. Pressurizer Nozzle Dissimilar Metal Weld Advanced Finite Element Analysis [Slides from EPRI] 6. Advanced Finite Element Analyses of Pressurizer Nozzle Weld Flaws: NRC Confirmatory Program [Slides from NRC/RES, Csontos] 7. Proposed Schedule for Dissimilar Metal Weld Issue Discussion [handout from CHammer of NRC/ACRS]
5.	Draft ACRS Report on the NRC Safety Research Program 8. Memo to Frank Gillespie, NRC/ACRS from James T. Wiggins, NRC/NRR on, "Request for Review and Endorsement by the Advisory Committee on Reactor Safeguards of the Proposed Generic Letter 2007-XX, "Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems." Dated: 10/01/07.
6.	Preperation of ACRS Reportt
7.	Opening Remarks by Chairman

[Note: Some documents listed herein may have been provided or prepared for the Committee use only. These documents must be reviewed prior to release to the public.]

8. Meeting with NEI, EPRI, and INPO to Discuss Industry Activities
   9. INPO Overview [Slides from INPO, Goddard]
   10. Nuclear Energy Institute: Mission, Goals and Issues [Slides from Pietrangelo]
   11. Overview of the Nuclear Power Sector at EPRI [Slides from EPRI, Gaertner

9. Future ACRS Activities/Report of the Planning and Procedures Subcommittee

9. Reconciliation of ACRS Comments and Recommendations

10. Reconciliation of ACRS Comments and Recommendations

11. Draft Report on Quality Assessment of Selected NRC Research Projects

12. Preparation of ACRS Reports

13. Preperation of ACRS Reports

**Copies of most of the handouts can be obtained through the transcript copy found in the Agency Document Management System (ADAMS) or a complete set can be requested by calling the ACRS office of the NRC.

[Note: Some documents listed herein may have been provided or prepared for the Committee use only. These documents must be reviewed prior to release to the public.]

Digital Instrumentation & Control (I&C)

October 4, 2007

NEI
NUCLEAR ENERGY INSTITUTE

Diversity and Defense-in-Depth (D3)

- Seven Problem Statements:
  - When is diversity needed?
  - How diverse is diverse enough?
- Remaining Challenges:
  - Credit for manual operator actions
  - Use of risk insights
  - Common cause failure applicability
  - Adequate diversity

NEI

Diversity and Defense-in-Depth

- **Path Forward:**
  - Develop methodology for operator response time assumptions
  - Develop process for considering risk
  - Review operating experience data
  - Complete research on adequate diversity
  - Further refine interim guidance (ISG)
  - Revise BTP-19

NEI

Operating Experience

- Obtain insights on failure modes
- Review and characterize 300+ events (NRC and INPO databases)
- Share information with NRC
- Document findings

NEI

Communications

- Problem Statement:
  - Need better guidance for inter-divisional independence and data communication
- Remaining Challenge:
  - Implementation of interim guidance (ISG)
- Path Forward:
  - Further refine ISG, if appropriate
  - Revise IEEE 7-4.3.2 and RG 1.152

NEI 5

Human Factors

- Problem Statements:
  - Minimum Inventory
  - Computer-based Procedures
  - Graded Approach to Human Factors
  - Safety Parameter Display System
- Remaining Challenges:
  - Implementation of interim guidance (ISG)
  - Completing longer-term actions

NEI 6

Human Factors

- Path Forward:
  - Further refine ISG, if appropriate
  - NRC endorse industry reports
    - Minimum Inventory
    - Computer-based Procedures
    - Graded Approach
  - Develop or modify other guidance, as appropriate

NEI 7

Cyber Security

- Problem Statement:
  - NEI 04-04 and RG 1.152 have different guidance
- NEI 04-04, Rev. 1
  - Endorsed by NRC in December 2005
  - Contains programmatic guidance
- Regulatory Guide 1.152, Rev. 2
  - Issued in January 2006
  - Contains design guidance

NEI 8

Cyber Security

- Desired Outcome:
  - Allow either RG 1.152 or NEI 04-04
- Path Forward:
  - Perform gap analysis
  - Modify NEI 04-04, if appropriate
  - Develop interim guidance (ISG)
  - Revise IEEE 7-4.3.2, RG 1.152, and SRP

NEI

9

805- 893 - 8680

2

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Presentation to the ACRS on Digital Instrumentation and Control (I&C)

October 4, 2007

Belkys Sosa
Digital I&C Task Working Group Director
Steven Arndt
Senior Technical Advisor for Digital I&C
NRR/DE

Agenda

- Digital I&C Project Plan
- Interim Staff Guidance
  - Cyber Security
  - Diversity and Defense-in-Depth (D3)
  - Highly-Integrated Control Rooms: Communications Issues
  - Highly-Integrated Control Rooms - Human Factors
- ACRS Recommendations Follow Up
  - Evaluation of Operating Experience
  - Inventory and Classification System
- Summary

2

Digital I&C Project

- Near-Term Activities
  - Develop interim staff guidance
- Long-Term Activities
  - Revise regulatory documents (RGs, SRP)
  - Continue interactions with industry to have ISG incorporated into industry standards
- Long-Term Focus of Project Plan
  - Risk Informed
  - Fuel Cycle Facilities
  - Remaining Human Factors Issues
  - Continue to refine and enhanced guidance as necessary

3

Interim Staff Guidance

- Status

– Diversity and Defense in Depth (D3)	9/28/07
– Highly Integrated Control Rooms – Communication	9/28/07
– Highly Integrated Control Rooms – Human Factors	9/28/07
– Cyber Security	10/31/07
– Licensing Process	11/30/07
– Risk Informed	03/31/08

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ACRS Interactions

- ACRS provided recommendations to the NRC staff in the area of digital I&C
  - June 22, 2007 SRM – directed the staff to develop an inventory and classification of Digital I&C systems and to evaluate Operating Experience with Digital I&C failures
  - September 13, 2007 – ACRS Subcommittee on I&C
  - October 4, 2007 - ACRS Full Committee Meeting
  - Periodic updates to ACRS Subcommittee on I&C
  - December 31, 2007 - Complete assessment of operating experience and inventory and classification (ACRS Recommendations on D3)

5

Cyber Security

- Clarify the NRC staff's guidance with regard to implementation of cyber security requirements for nuclear power plant safety systems
- Interim Staff Guidance
  - Documents regulatory guidance in this area including a cross-correlation table that maps Regulatory Positions 2.1-2.9 from RG 1.152 Rev2 to draft NEI 04-04 Rev2.

6

Diversity and Defense-in-Depth (D3)

- In the Diversity and Defense-in-Depth area there are seven problem statements
  - Adequate Diversity
  - Manual Operator Actions
  - BTP-19 Position 4 Challenges
  - Effects of CCF
  - CCF Applicability
  - Echelons of Defense
  - Single Failure

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Diversity and Defense-in-Depth (D3)

- Adequate Diversity
  - *Additional clarity is desired on what constitutes adequate D3. Determine how much D3 is enough.*
- Manual Operator Actions
  - *Clarification is desired on the use of operator action as a defensive measure and corresponding acceptable operator action times.*
- Interim Staff Guidance
  - There is no distinction in D3 guidance for digital Reactor Protection System (RPS) designs for new/future nuclear power plants and current operating plants.
  - While CCFs in digital systems are beyond design basis, the digital RPS should be protected against CCFs.
  - A D3 analysis should be performed to demonstrate that vulnerabilities to CCFs have been adequately addressed.

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Diversity and Defense-in-Depth (D3)

- Interim Staff Guidance (cont.)
  - Where the protective action that should have been automatically performed by the system subject to CCF is required in less than 30 minutes to meet the BTP-19 acceptance criteria, an independent and diverse automated backup, achieving the same or equivalent function, should be provided.
  - This automated backup guidance does not apply to follow-on actions that are handled in a manual fashion.
  - In addition, a set of displays and controls (safety or non-safety) should be provided in the main control room for manual actuation and control of safety equipment to manage plant critical safety functions.
- Bases for 30-minute Operator Action Time
  - Minimizing operator burden under the conditions of a digital system CCF
  - Past regulatory decisions
  - Regulatory practices applied in the international community
  - Engineering judgment

9

Diversity and Defense-in-Depth (D3)

- Effects of CCF
  - *BTP-19 guidance recommends consideration of CCFs that "disable a safety function." Additional clarity is required regarding the effects that should be considered (e.g., fails to actuate and/or spurious actuation)*
  - *Industry also requested that the staff determine whether spurious actuations should be considered when evaluating software CCF*
- Interim Staff Guidance
  - In general, spurious trips and actuations are of lesser safety concern than failures to trip or actuate.
  - There may be plant and safety system challenges and stresses; however, these challenges are not as significant as failure to respond to a Chapter 15 event.
  - Software CCFs resulting in a spurious trip or actuation of a safety-related digital protection system do not need to be considered in the single failure analysis.

10

Diversity and Defense-in-Depth (D3)

- CCF Applicability
  - *Clarification is required on identification of design attributes that are sufficient to eliminate consideration of CCFs (e.g., degree of simplicity)*
- Interim Staff Guidance
  - Diversity: If sufficient diversity exists in the reactor protection system such that CCFs within the channels are considered to be fully addressed, then no additional diversity would be required in the safety system.
  - Testability: If a system is sufficiently simple such that it is fully tested and found to produce only correct responses, then no additional diversity would be needed in the safety system.

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Diversity and Defense-in-Depth (D3)

- For Further Consideration
  - Work with industry to have ISG refined
    - Adequate diversity strategies
  - Staff assessment of ACRS recommendations on operating experience and inventory/classification
  - Revise the Standard Review Plan

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Highly-Integrated Control Rooms: Communications Issues

- Interdivisional Communications
  - *Communications among different safety divisions or between any safety division and any system or equipment that is not safety-related*
- Interim Staff Guidance
  - Acceptable ***provided*** the safety function processor is not encumbered by the communication process.
  - Separate processor & shared memory for communications
  - Limited to support of safety function
  - Communication failures & failures outside a division must not inhibit division's safety function
  - Division must not need input from other divisions to complete its safety function (other than voting logic)

Highly-Integrated Control Rooms: Communications Issues

- Command Prioritization
  - *The process of selecting a particular command to forward to plant equipment when multiple commands exist*
- Interim Staff Guidance
  - Safety command from safety system always has priority
  - Hardware-based: physical device with inputs from safety and non-safety sources via hard wire and/or data link
    - Suitable for D3
    - May utilize software external to safety function processor
  - Software-based: safety-grade code executed by safety function processor
    - Not suitable for D3

Highly-Integrated Control Rooms: Communications Issues

- Multidivisional Control and Display Stations
  - *Non-safety control station that can send commands to and/or receive information from equipment in multiple safety and non-safety divisions*
- Interim Staff Guidance
  - Must be supplemented by safety-grade stations for safety-related components & functions
    - Safety functions must be carried out using safety controls & indications (per IEEE603)
  - Cannot interfere with safety functions
    - No override except by priority module
    - No bypass initiation or removal except as explicitly permitted by safety system
  - Communications & prioritization should be as described on previous slides

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Highly-Integrated Control Rooms: Communications Issues

- For Further Consideration
  - Plant safety analyses must be consistent with possible failure modes
    - Spurious actuations could affect initial conditions
    - Spurious stoppages could affect event progress
  - Spurious events may be initiated by multidivisional stations, or may be initiated by failures in control processors
    - Safety analyses must accommodate what might happen, regardless of the source of the event

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Highly Integrated Control Room –Human Factors

- Minimum Inventory
  - *Better describe the process for developing the actual minimum inventory of alarms, controls, and displays needed to implement the emergency operating procedures, bring the plant to a safe condition, and to carry out those operator actions shown to be important by the applicant's PRA, both in the main control room and at the remote shutdown facility.*
- Interim Staff Guidance
  - Applicable only to new reactors
  - Identifies
    - Selection criteria
    - Process development considerations
    - Verification
  - Two step process consistent with the design acceptance criteria concept

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Highly Integrated Control Room –Human Factors

- Computer-Based Procedures
  - *Develop review guidance and acceptance criteria that are sufficiently detailed to adequately review computerized procedures and associated soft controls, to determine their effect on safety.*
- Interim Staff Guidance
  - The content of paper and computer-based procedures can be essentially the same
  - Computer-based procedures should not limit the control or situation awareness of the procedure user
  - Computer-based procedures can incorporate different levels of automation:
    - None (manual)
    - Advisory – Prompts for an action e.g. Start pump "A"
    - Shared – Monitor a process but be unable to access all necessary information about the system due to lack of instrumentation.
    - Automated – Performs the procedure step automatically

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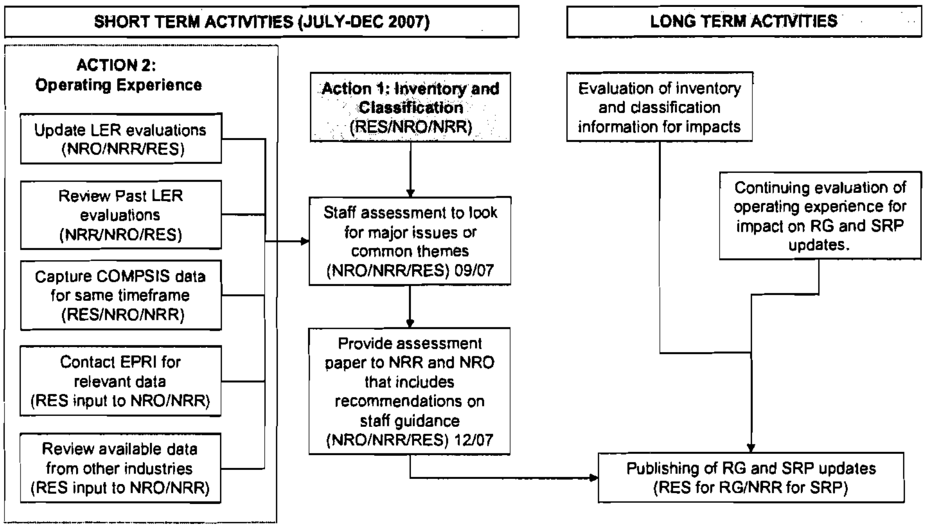
Operating Experience and Inventory/Classification



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Operating Experience and Inventory/Classification

- Assessment of operating experience in nuclear and other industries:
  - Internal assessment of operating experience and LER failure data ('87-'06)
  - I&C digital system failures in nuclear power plants ('94-'99)
  - COMPSIS database
  - Contacted EPRI and NEI for similar operating experience failure data
  - *Survey of Digital I&C Failures* (ORNL)
  - *Risk Informed Safety Assurance and PRA of Mission-Critical Software-Intensive Systems* (NASA)

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Operating Experience and Inventory/Classification

- Preliminary findings of review of operational experience
  - Availability of quality data is limited
  - Exact causal data is particularly difficult to locate
  - CCFs are credible
    - Other industries use diverse systems to mitigate the effects of CCFs
  - Ongoing NRC programs (e.g., operating experience program) are valuable in that they collect, analyze and distribute information providing lessons learned to staff, applicants, vendors, and licensees.

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Operating Experience and Inventory/Classification

- The inventory and classification research will provide
  - A framework for collecting operational data
  - Guidance for evaluating operational data
  - A process for translating operational data into D3 regulatory guidance
- Regulatory-based Classification systems
- Design-based Classification systems
- Operational-based Classification systems

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Operating Experience and Inventory/Classification

- NRC reviews of operational data have revealed that nuclear system failure classes are similar to failure classes in systems studied by Rashly, Perrow, and NASA
- A proposed failure-type classification expands on the work done by Rashly, Perrow, Aldemir, and NASA
- The proposed classification consists of three attributes
  - Complexity (including hardware and software complexity and testability of the system)
  - Interactions/inter-conductivity (including inter-system communications and the importance of timing and feedback with other systems)
  - Importance (including risk importance, how important the system is for maintaining defense-in-depth and the consequence of system failures)

Operating Experience and Inventory/Classification

- Preliminary Conclusion
  - On the basis of an assessment of existing classification systems and operating experience data,
  - *No changes to the proposed D3 ISGs are required.*
- Future Plans
  - September 28, 2007
    - Complete short-term staff assessment
  - December 31, 2007
    - Provide white paper that details potential impact upon staff guidance
    - Capture assessment results of inventory/classification and operating experience
  - 2008 and beyond
    - Provide inputs for proposed long-term activities to refine guidance
    - Continue ongoing operating experience program reviews

Overall Summary

- Steering committee is functioning effectively
- Project plan is in place
- Interim Staff Guidance is being developed
- Continuing interactions with ACRS Sub-committee on I&C
- Strong industry support
- Staff is on-schedule to complete near-term deliverables

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ACRS Meeting on Draft Generic Letter on Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems

October 4, 2007

David P. Beaulieu
Generic Communications and Power Uprate Branch
Office of Nuclear Reactor Regulation

Warren C. Lyon,
Reactor Systems Branch
Division of Safety Systems

OUTLINE

- Background
- Purpose of Generic Letter
- Desired Outcome of Generic Letter
- Principal Concerns And Applicable Regulations
- Requested Actions and Information
- Public Comments
- Recommendation

Purpose of Generic Letter

- Request that licensees submit information that demonstrates that NRC regulations are being applied to ECCS, DHR, and containment spray system regarding licensing basis, design, testing, operability, and corrective actions to assure that gas intrusion is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified.

BACKGROUND

- **Gas intrusion events have occurred since the beginning of commercial nuclear power operation**
  - **Subject of many NRC generic communications**
  - **Following 1997 Oconee Unit 3 common-mode failure of high pressure injection, no NRC generic action taken based on industry actions**
  - **More than 60 gas intrusion events reported since the 1997 Oconee Unit 3 event**
  - **The number of identified gas intrusion problems and their significance at some facilities raise concerns about whether similar unrecognized design, configuration, and operability problems exist at other facilities.**

DESIRED OUTCOME OF GENERIC LETTER

- **Periodic testing of the subject systems which includes:**
  - measuring and recording the volume of gas voids at each high point in the subject systems that could impact operability
  - venting/removing identified gas voids of any volume to restore the subject systems to a filled condition which may necessitate installation of additional vent valves
  - if the location-dependent acceptance criteria for gas void volume exceeded, initiate corrective actions that provides reasonable assurance of operability until the next test
    - accelerated test frequency
    - identify and correct source of gas

PRINCIPAL CONCERNS AND APPLICABLE REGULATIONS

- **Licensing Basis**
  - FSAR – specifies that systems are filled with water
  - TS – surveillance to verify filled
    - May cover only portion of system
    - Operability not assessed
    - Some verifying some sections not possible/practical
- **Design**
  - 10 CFR 50, App B, Criterion III, Design Control
  - Inadequate provisions (e.g., vent valves) to satisfy design basis filled condition

PRINCIPAL CONCERNS AND APPLICABLE REGULATIONS - 2

- **Testing**
  - **10 CFR 50, App B, Criterion V, Instructions, Procedures, and Drawings**
    - Instances of written test procedures do not incorporate the requirements and acceptance limits
  - **10 CFR 50, App B, Criterion XI, Test Control**
    - Instances of not testing all segments to confirm acceptance limits and operability (excluded segments justified)
    - Required testing includes, but is not limited to, TS surveillances. TS Task Force to address TS later.
  - **10 CFR 50, App B, Criterion XVII, Quality Assurance Records**
    - Instances of not recording test results (gas void volume), the acceptability, and the action taken for deficiencies

PRINCIPAL CONCERNS AND APPLICABLE REGULATIONS - 3

- **Operability**
  - **Technical Specifications**
    - **Instances of not maintaining operable due to gas instrusion**
- **Corrective Actions**
  - **10 CFR 50, App B, Criterion XVI, Corrective Actions**
    - **Gas treated as expected condition rather than a nonconforming condition**
    - **Substantial gas quantities not documented**
    - **Based on the as-found volume and location of gas, corrective actions beyond simply refilling a system may be necessary to provide reasonable assurance that the affected system will remain operable until the next surveillance.**

REQUESTED ACTIONS

- **Evaluate their ECCS, DHR system, and containment spray system licensing basis, design, testing, operability, and corrective actions to assure that gas intrusion is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified.**

REQUESTED INFORMATION

- **Results of the evaluations done pursuant to the REQUESTED ACTIONS**
- **Information to demonstrate compliance**
  - **10 CFR 50, Appendix B, Criteria III, V, XI, XVI, and XVII**
  - **Licensing basis**
  - **Operating license (Tech Specs)**

PUBLIC COMMENTS - 1

- **Studies will have to be completed**
  - **In order to develop realistic criteria to determine the amount of gas that could impact operability**
  - **Gas detection techniques and the associated accuracies.**
    - **The GL provides technical considerations but leaves it to the industry to address these issues**

PUBLIC COMMENTS – 2

- **The draft Generic Letter does not consider ALARA, personnel safety, or accessibility**
  - **Testing of all segments of piping and components in the subject systems is necessary to confirm acceptance limits and operability unless it has been acceptability established that some items may be excluded.**

PUBLIC COMMENTS - 3

- **For BWRs, proposed GL does not demonstrate that a generic problem of high safety significance exists to justify costs**
  - staff reviews have clearly established the susceptibility of all plant designs
  - Potential to render redundant trains of one or more systems inoperable

- **Does venting that is preventive in nature need to be documented and quantified?**
  - Existence of gas is contrary to TS and the FSAR. The affect of this non-conforming condition on operability must be understood.

PUBLIC COMMENTS - 4

- **Systems are typically presumed operable when a surveillance is current and acceptance criteria are met and documented.**
  - **Based on the as found volume and location of gas, corrective actions beyond simply refilling a system may be necessary to provide reasonable assurance that the affected system will remain operable until the next surveillance.**

RECOMMENDATION

- **ACRS endorse issuance of draft generic letter**

Managing Gas Intrusion

Gordon Clefton

Nuclear Energy Institute

October 04, 2007

NEI NUCLEAR ENERGY INSTITUTE

Managing Gas Intrusion

- Operational Challenges
- BWROG Activities
- PWROG Activities
- Industry Activities

NEI

Operational Challenges

- Implementing Technical Specifications
  - Words say 'full'
  - Basis says normally expect gas intrusion
- Accessing vent locations
- Tracking/trending of vent discharges
- Maintaining appropriate surveillance intervals

BWROG Activities

- BWROG General Meeting
  - Agenda item presentation on ECCS Gas Intrusion
  - Support / interest from Prime Representatives
- BWROG Chairman
  - Presented topic to BWROG Executive Officers
    - Recognized problem
    - Funded strategic planning in 2007
  - Staffed a Committee
    - ECCS Gas Intrusion Committee
    - Coordinating with BWROG & NEI
    - Prepared to respond to GL-xxxx action items

NEI

PWRoG Activities

- PWROG using Westinghouse
  - Working Group
    - Monroeville PA
    - Staff and industry experts
- Draft road map for gas voiding concern
  - 1. Provide acceptance criteria
    - a. Acceptance criteria in piping (suction piping)
      - i. Amount of gas transport
      - ii. Pump Tolerance to gas void
      - iii. Issues of gas intrusion from tanks during accident
      - iv. Temperature effects on gas transport
    - b. Source and rate of gas intrusion
    - c. Criteria to characterize discharge piping pressure pulsations in systems with gas voids
    - d. Best practices to reduce gas in systems
    - e. Gas void detection
  - 2. Provide Technical Specifications revisions

NEI

Industry Activities

- NSSSOG
  - Agenda item at quarterly meeting
  - Resolution progress reported
- NEI
  - First steering committee meeting
    - On 11oct07 at NEI
    - Industry experts, BWROG, and PWROG
  - NEI-NRC 'drop-in' meeting
    - On 12Oct07 at NEI
    - Strategic information sharing

NEI

Managing Gas Intrusion

- Questions?
- Comments?
- Concerns?

NEI

Managing Gas Intrusion

Gordon Clefton

Nuclear Energy Institute

October 04, 2007

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ELECTRIC POWER RESEARCH INSTITUTE

Pressurizer Nozzle Dissimilar Metal Weld Advanced Finite Element Analyses

ACRS Main Committee
October 4, 2007

Glenn White
Dominion Engineering, Inc.

Topics

- Objective and Approach
- Summary of Methodology
  - Plant Inputs
  - Welding Residual Stress
  - Crack Growth Modeling
  - Critical Crack Size Calculations
  - Leak Rate Modeling
- Analytical Results
- Conclusions

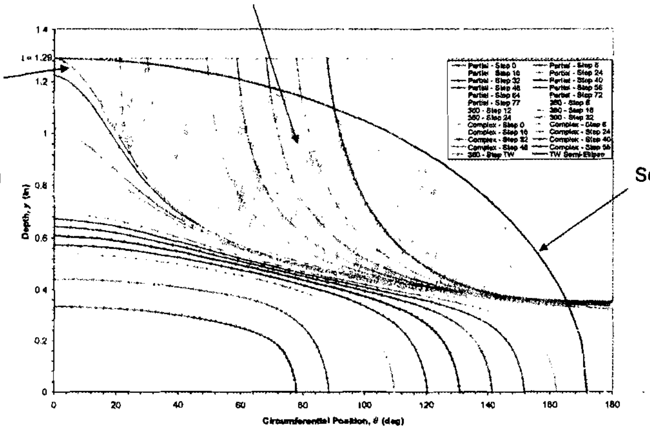
Project Approach

Artificial Conservatism of Semi-Elliptical Crack Assumption

Semi-ellipse assumption over predicted extent of cracked material in this zone vs. the arbitrary shape methodology for the Wolf Creek nozzle benchmark run

Arbitrary Crack Shape at Initial Through Wall

Growth at each point on the crack front as a function of the stress intensity factor calculated at that point



Semi-Ellipse Crack Shape at Initial Through Wall

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Project Approach

Key Project Activities

- Software capability development within FEACrack
- Develop and execute an analysis parametric sensitivity case matrix
  - Develop and apply a sensitivity matrix of welding residual stress (WRS) profiles, including weld repairs
  - Crack growth calculations for custom crack shape
- Critical crack size calculations to define the end point for the crack growth calculation
- Leak rate calculations - PICEP and SQUIRT models
- Software verification and benchmarking
- Validation
- Expert panel input and review throughout the project

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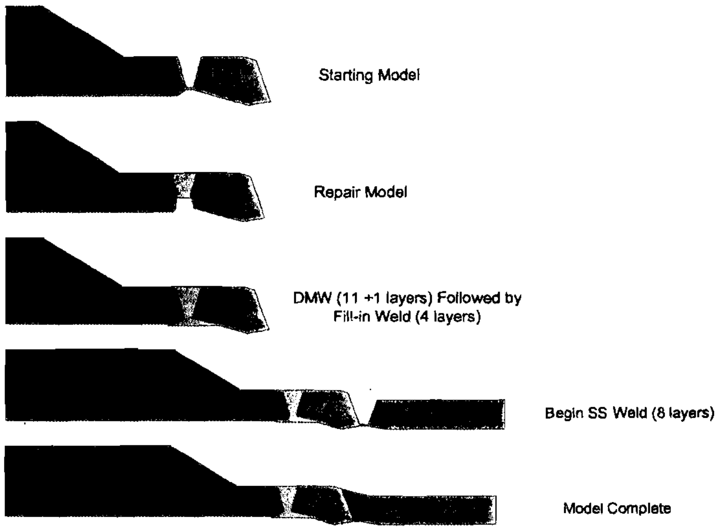
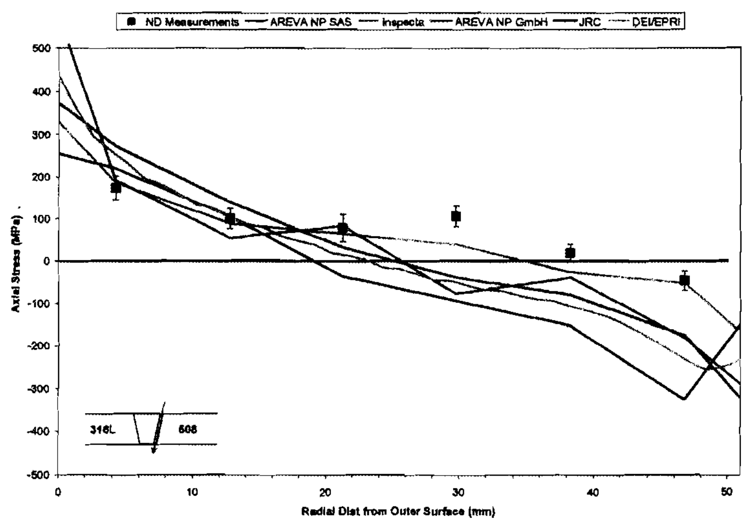
WRS Modeling

Type 8 Surge Nozzle Analysis Progression



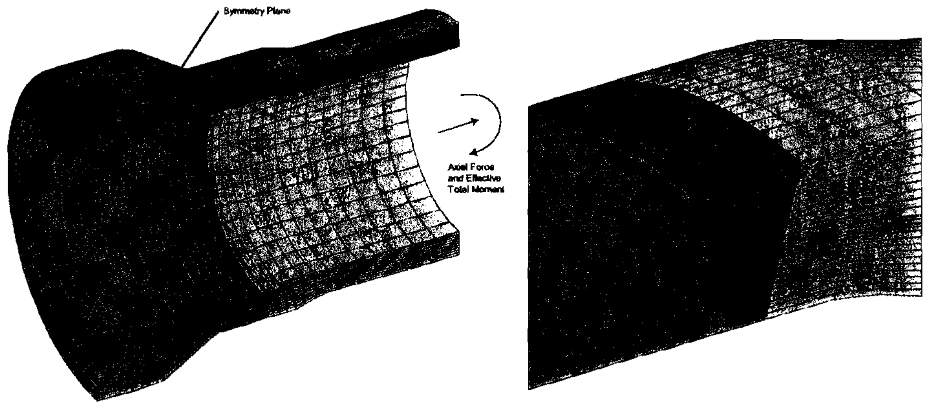
WRS Validation and Benchmarking

EU Mockup—DEI Butter Axial Stress
(Through-Wall Section at Butter Layer Center)



Crack Growth Modeling Approach

Nozzle-to-Safe-End Model (Type 8 Surge Nozzle)



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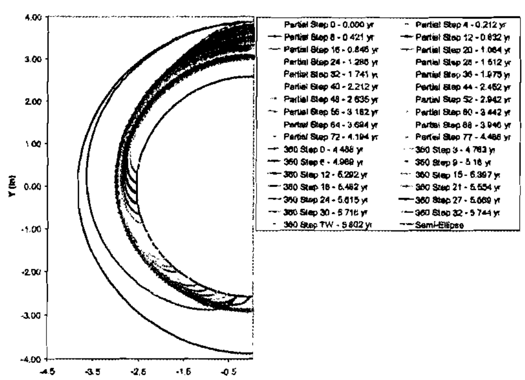
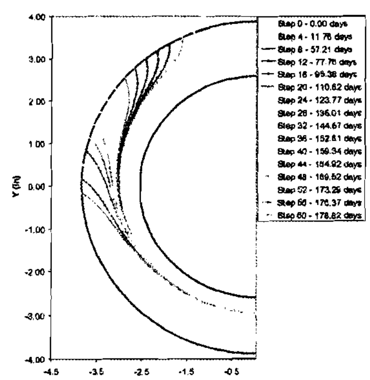
Phase I Crack Growth Calculations

Results for WC Relief Nozzle (December 2006 Inputs)



Surface Crack Progression



Complex Crack Progression

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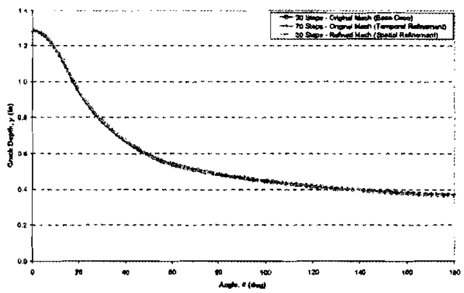
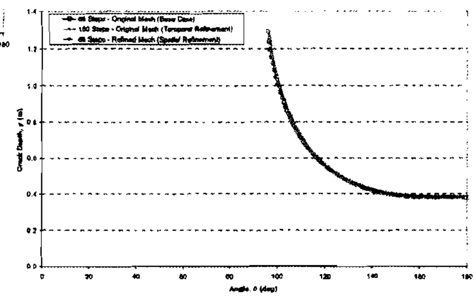
Crack Growth Convergence Checks

Temporal and Spatial Checks Demonstrating Convergence



Surface Crack Growth Progression Starting from Identical Initial Surface Flaw (Case 1c)

Complex Crack Growth Progression Starting from Identical Initial Complex Flaw (Case 1c)



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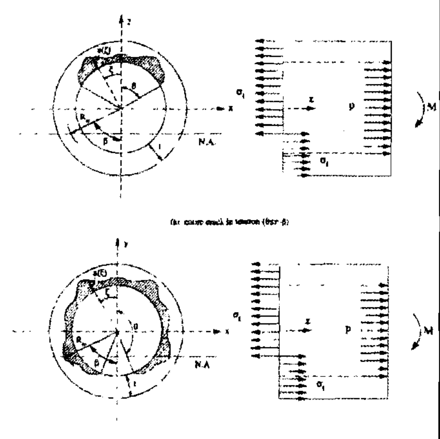
Critical Crack Size Calculations

Force and Moment Equilibrium for Arbitrary Crack

- Rahman and Wilkowski have published the thin-wall solution for axial force and applied moment equilibrium given a circumferential flaw with arbitrary depth profile
- DEI implemented this solution in spreadsheet form
- The solution was applied to crack profiles calculated by the FEACrack software
  - Case 1: Entire crack in tension
  - Case 2a: Part of crack in compression zone with crack taking compression
  - Case 2b: Part of crack in compression zone with crack not taking compression
- Arbitrary Net Section Collapse (ANSC) software by Structural Integrity Associates used to validate spreadsheet calculation
  - ANSC also allows arbitrary moment direction, unlike Rahman and Wilkowski



S. Rahman and G. Wilkowski, "Net-Section-Collapse Analysis of Circumferentially Cracked Cylinders—Part I: Arbitrary-Shaped Cracks and Generalized Equations," *Engineering Fracture Mechanics*, Vol. 61, pp. 191-211, 1998.

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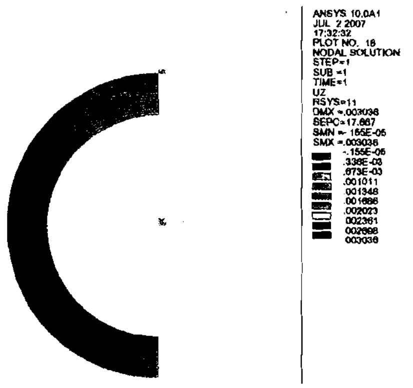
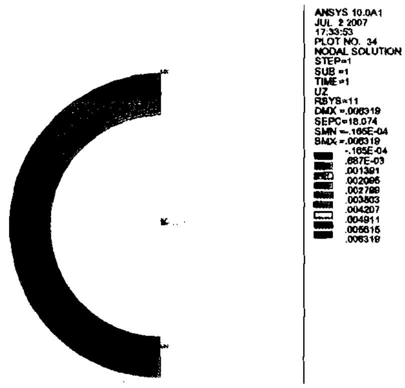
Leak Rate Modeling
Example Crack Opening Displacements (Half COD)



Case 12 – 1 gpm leak rate



Case 12 – Stability Load Margin Factor = 1.2

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Analysis Case Matrix
Evaluation Criteria

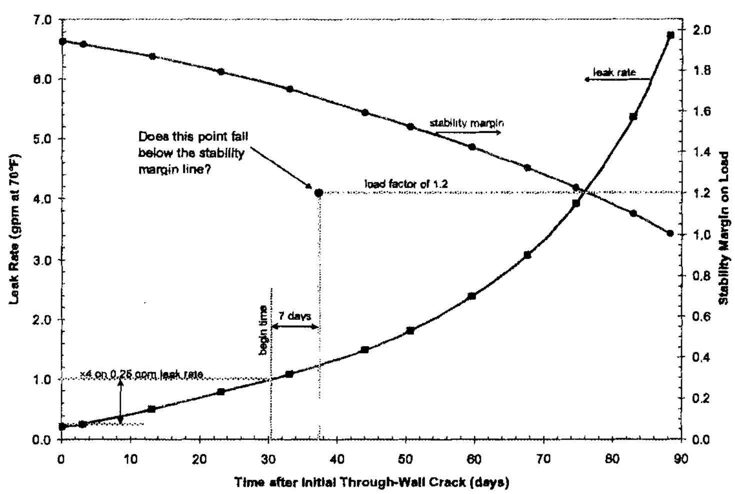

Illustration of Approach for Hypothetical Leakage and Stability Data

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Analysis Case Matrix

Definition of Case Matrix

- Up to three WRS profiles applied to each case
  - Geometry and load base cases (1-20)
    - Axisymmetric WRS
    - Moment load varied up to maximum reported for specific configuration
  - ID repair base cases (21-26)
    - Non-axisymmetric WRS based on ID repair WRS FEA
  - Further bending moment sensitivity cases (27-30)
  - Sensitivity cases to investigate potential uncertainty in as-built dimensions (31-32)
    - Hypothetical ±10% variation in weld thickness
  - Axial membrane load sensitivity cases (33-34)
    - Relatively narrow range in membrane load for each geometry
  - Effect of length over which thermal strain simulating WRS is applied (35)

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Analysis Case Matrix

Definition of Case Matrix (cont'd)

- Simulation of elastic-plastic redistribution of stress at ID (36)
- Effect of initial crack shape and depth (37-41)
- Effect of stress intensity factor dependence of crack growth rate equation (42-47)
  - 5th percentile exponent of 1.0 or 95th percentile exponent of 2.2 assumed
- Effect of pressure drop along leaking crack (48)
  - Other cases assume full primary pressure applies to leaking crack face
- Effect of relaxation of normal operating thermal load (49-51)
  - For through-wall portion of crack growth progression, the normal thermal load has been eliminated for these sensitivity cases (for crack growth, leak rate, and critical crack size calculations)
- Effect of nozzle-to-safe-end crack growth model vs. standard cylindrical crack growth model (52-53)
  - Investigate effect of detailed geometry
- Supplementary cases specific to effect of multiple flaws on limiting surge nozzles (S1-S9)

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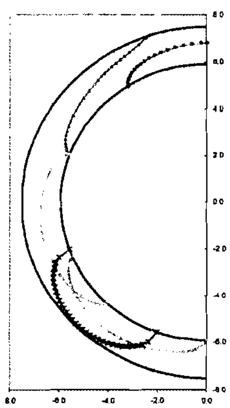
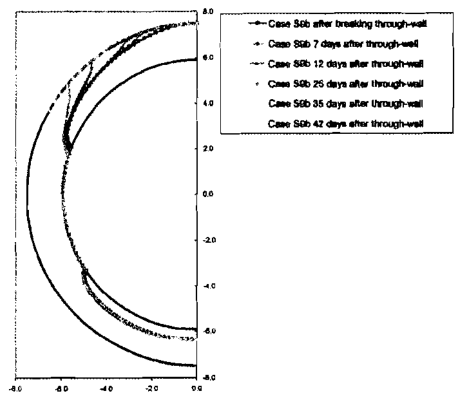
Analysis Matrix Results
Multiple Crack Cases



Profiles of Pairs of Additional Cracks Applied in Stability Calculations for Cases S4b through S7b Based on Case 17b



Case S9b Growth Progression Based on Individual Growth of Initial 21:1 Aspect Ratio 26% through-wall Flaws Placed at Top and Bottom of Weld Cross Section

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Analysis Matrix Results
Summary

- All 109 completed cases in the main sensitivity matrix showed either
  - stable crack arrest (60 cases), or
  - crack leakage and crack stability results satisfying the evaluation criteria (49 cases)
  - generally considerable margins beyond evaluation criteria
- 10 supplemental cases further investigated the effect of multiple flaws on limiting surge nozzle cases
  - Conservative application of the three Wolf Creek surge nozzle indications with limiting surge nozzles (fill-in weld and relatively high moment load) gives results meeting the evaluation criteria with additional margin
  - A case with two long initial partial-arc flaws covering 46% of the ID circumference as opposed to a single initial flaw covering half this circumferential extent (and centered at the location of maximum axial bending stress) has only a modest effect on crack stability
  - On this basis, it is concluded that the concern for multiple flaws in the limiting surge nozzles is adequately addressed by cases that satisfy the evaluation criteria with additional margin

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Conclusions (cont'd)

- In summary, this study demonstrates the viability of leak detection to preclude the potential for rupture for the pressurizer nozzle DM welds in the group of subject PWRs
- DEI, Quest Reliability, and EPRI plan to submit a paper to a refereed scientific journal on this topic

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6.

Advanced Finite Element Analyses of Pressurizer Nozzle Weld Flaws: NRC Confirmatory Program

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Protecting People and the Environment

Al Csontos, Ph.D
October 4, 2007

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Advanced FEA Project: Chronology

NRC Scoping Study

- WC Indications Reported to NRC
- NRC Scoping Study Initiated
- MRP 2006-041 Submitted to NRC
- Public Meeting: Implications of WC Indications
- NRC Scoping Study Completed
- Public Meeting: NRC Scoping Study
- Industry Evaluates NRC Scoping Study
- Public Meeting: NRC Safety Concerns

Phase I Analyses

- MRP 2007-003 Submitted to NRC
- Industry Proposes Advanced FEA Project
- Industry Advanced FEA Project Initiated
- NRC Advanced FEA Confirmatory Project Initiated
- Confirmatory Action Letters Submitted to NRC
- NRC Comments to Industry's Advanced FEA Project
- ACRS Meeting: NRC Scoping Study & MRP Evaluations
- Public Meeting: Advanced FEA Project Outline
- Public Meeting: Phase I Results

Phase II Analyses

- Public Meeting: Fabrication & WRS
- Public Meeting: Phase II Proposed Matrix Cases
- Public Meeting: Resolve Technical Issues & Updates
- Public Meeting: Project Updates & Phase II Results
- ACRS Meeting on Phase I & II Results
- Public Meeting: NRC Initial Comments on Industry Report
- Public Meeting: NRC Final Comments on Industry Report
- Public Meeting: Summary of Advanced FEA Projects

Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07

Advanced FEA Project: Phase II Safety/Relief Results

Case #	DEI Case #	Time at first leakage (yr)		Margin at 1gpm leak		Time since 1gpm leak to 1.2 margin (Month)	
		DEI	Emc2	DEI	Emc2	DEI	Emc2
1	1c	17.4	20.16	2.24	2.46	3.63	2.18
1-1	1b	Arrest	Arrest	Arrest	Arrest	Arrest	Arrest
3	3c	26.3	29.40	2.40	2.55	4.17	2.42
6	6c	3.4	4.13	1.70	1.79	1.37	1.13
6-4	35c	2.9	3.26	1.62	1.81	1.07	0.70
9-1	9c	32.2	119.18	2.50	2.50	4.80	2.90

- In addition to the Phase I relief line results, the Phase II results for the safety/relief lines confirm the industry results that margins exist between leak and rupture

Advanced FEA Project: Phase II Spray Line Results

Case #	DEI Case #	Time at first leakage (yr)		Margin at 1gpm leak		Time since 1gpm leak to 1.2 margin (Month)	
		DEI	Emc2	DEI	Emc2	DEI	Emc2
10	10c	21.2	51.36	2.07	2.48	2.43	1.85
11-1	11c	25.3	Arrest	2.08	Arrest	2.43	Arrest
15	15c	Arrest	Arrest	Arrest	Arrest	Arrest	Arrest

- Phase II results for the spray lines confirm the industry results that margins exist between leak and rupture
- Results also indicate significantly long times for leakage to occur or complete crack arrest

Advanced FEA Project: Phase II Surge Line Results

Case #	DEI Case #	Time at first leakage (yr)		Margin at 1gpm leak		Time since 1gpm leak to 1.2 margin (Month)	
		DEI	Emc2	DEI	Emc2	DEI	Emc2
17-1	S1b	1.2	1.30	1.03	1.00	0.00	0.00
17-2	17b	1.2	1.36	1.71	1.80	1.17	N/A
17-8	17a	Arrest	6.15	Arrest	1.58	Arrest	N/A
19-1	19b	Arrest	9.50	Arrest	1.58	Arrest	1.18
20	20b	Arrest	Arrest	Arrest	Arrest	Arrest	Arrest
17-11	25b	0.50	0.86	1.36	1.37	0.43	0.31

- Surge lines results confirm industry results for cases 17-1/S1b, 17-2/17b, 20/20b, and 17-11/25b
- Some divergence occurred for cases 17-8/17a & 19-1/19b, but, substantial margins exist

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Advanced FEA Project: Phase II Results

- Generally good agreement between the NRC and industry advanced FEA benchmarked cases
- Of the 30 cases in the NRC confirmatory program:
  - All 11 safety/relief cases showed either arrest or substantial margin between leakage and rupture
  - 3 out of 4 spray cases showed crack arrest with the final case predicting >50 years to leakage with substantial margins between leakage and rupture
  - 9 out of 15 surge line cases show either arrest or adequate margin between leakage and rupture
  - 6 out of 15 surge line cases show little margin due to multiple conservatisms used in the analysis

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Advanced FEA Project: WRS Validation

- NRC & industry conducted a weld residual stress (WRS) validation exercise since the Phase II results were most affected by the assumed WRS profiles
- NRC & industry WRS models were validated to the European Union Network for Evaluating Structural Components-III round robin study on the assessment of dissimilar weld integrity
- NRC & industry WRS models were validated to physical measurements of dissimilar metal butt welds
- WRS benchmarking showed generally good agreement between the NRC and industry models

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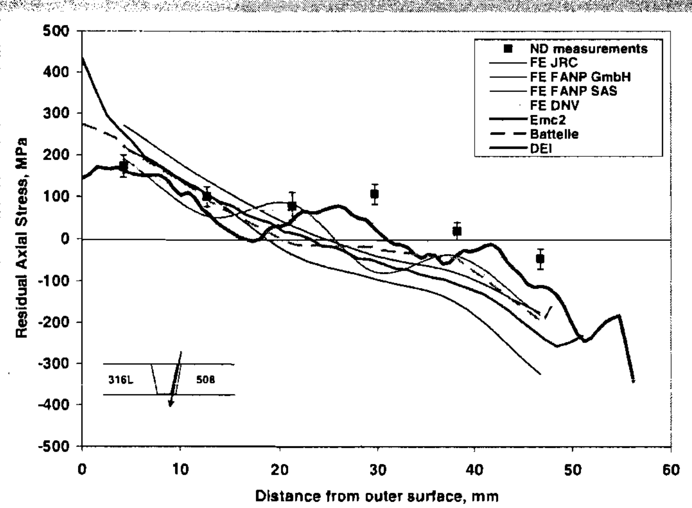
Advanced FEA Project: WRS Validation



Confirmatory Project Summary

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- NRC confirmatory program developed to benchmark, verify, and evaluate industry's analyses and results
- Unlike the NRC Wolf Creek scoping study, Phase I results predict margins between leak and rupture
- Phase I & II results show good agreement between the industry & NRC advanced FEA model results
- Validation effort provided useful information for understanding the uncertainties in WRS distributions

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Advanced FEA Safety Assessment

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Ted Sullivan (NRR)
October 4, 2007

Safety Factors

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- Safety factors (SFs) were used to cover uncertainties in the:
  - Fracture mechanics methodology and analytical assumptions
  - WRS caused by FE modeling differences
  - Leakage calculations
- NRC staff's goal was to satisfy SFs of:
  - 1.5 on stability for a minimum of 1 week and 5 on leakage
  - that is, 1 week after leakage was 5 X higher than action level of CALs, stability margin of 1.5 is to be met
- Staff did not consider it necessary to satisfy these SFs for sensitivity cases with highly conservative assumptions
  - Not all sensitivity cases reflect realistic or expected conditions

Base Cases

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- Base cases reflect:
  - WRSs calculated by finite element modeling for safety/relief and surge nozzles with and without effect of the stainless steel safe end to pipe weld
  - ASME WRS for safety/relief and spray
  - Nozzle, weld, safe end geometries and fabrication steps
  - Range of Loads
  - Range of Initial flaw assumptions
- All base cases either resulted in crack arrest or substantial margin satisfying NRC staff SF goals
- Base cases supplemented by additional sensitivity cases to study additional conditions and assumptions

U.S.NRC — Safety/Relief Nozzle Welds

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- All cases with WRS calculated by finite element modeling with or without safe end to pipe weld resulted in crack arrest
- ASME WRS introduced to provide through wall crack results
  - conservatively addresses uncertainties in calculated WRSs
- DEI ran 12 sensitivity cases and Emc^2 ran 3 cases
  - Results of all cases satisfy staff SF goals except case DEI 42c

U.S.NRC — Safety/Relief Nozzle Welds

UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

- Limiting safety/relief nozzle case 42c:
  - Crack growth rate assumption is highly conservative for majority of crack growth
  - Stability SF falls below 1.5 within a couple of days of leakage SF being satisfied
- All cases with MRP-115 CGRs result in either arrest or satisfying NRC staff SF goals
- Staff concluded that analyses demonstrate reasonable assurance of safety

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Spray Nozzle Welds

- WRSs from safety/relief welds used for spray welds
  - Spray nozzle welds have configurations similar to safety/relief
- DEI and Emc² spray nozzle weld cases resulted in either arrest or substantial margin satisfying staff SF goals
- Staff concluded that analyses demonstrate reasonable assurance of safety

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Surge Nozzle Welds

- WRSs calculated by finite element modeling
- DEI & Emc² both ran numerous surge nozzle sensitivity cases
  - Majority of cases show either arrest or adequate margin between leakage and rupture
  - All cases with Wolf Creek-like flaws resulted in arrest or adequate margins
- Limiting cases combined most unfavorable conditions
  - Highest plant loading
  - ID back-chipping and welding
  - WRS from model without safe end weld even though weld is present – addresses uncertainties in calculated WRSs
  - 360° 10% initial flaw
- Limiting cases with these assumptions resulted in stability SF at first leakage of slightly larger than 1

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Surge Nozzle Welds

- Staff approach for assessing this limiting case retained previously stated assumptions but accounted for certain conservatisms in the analysis methodology
- Emc[2] case 17-10 was run with
  - A knock down factor of 0.6 (based on industry analyses) to account for drop in secondary pipe thermal loads with rotation of the crack and
  - Flow stress based on the more neutral assumption of a crack in the middle of the weld rather than close to the safe end
- Results of this analysis satisfied staff SF goals

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Surge Nozzle Welds

- Staff also ran a sensitivity case with limiting thermal loads
  - ID back-chipping and welding
  - WRS of model without safe end weld
  - 360° 10% initial flaw
  - Knock down factor of 0.6 on secondary pipe thermal loads after crack leakage, and
  - Flow stress based on crack in middle of weld
- Results of this case were ~10% lower than SF goals
  - Staff considered results acceptable because of conservative initial flaw assumption
- Staff concluded that analyses demonstrate reasonable assurance of safety

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Advanced FEA Project: Summary

- Staff's evaluation of all sensitivity cases showed adequate margins between leak and rupture:
  - Majority of cases show either crack arrest or large margins
  - Balance of cases have adequate margins when conservatisms are considered
- Advanced FEA provided reasonable assurance that the 9 plants will continue to safely operate past the 12/31/07 industry imposed deadline to the next refueling outages in Spring 2008

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
DISSIMILAR METAL WELD ISSUE
October 4, 2007
ROCKVILLE, MD

-PROPOSED SCHEDULE-

Cognizant Staff Engineer: Charles G. Hammer, cgh@nrc.gov (301) 415-7363

Topics	Presenters	Time
Opening Remarks	W. Shack, ACRS	1:30 - 1:35 pm
Industry analysis of dissimilar metal weld flaws	G. White, Dominion Engineering, Inc.	1:35 - 2:25 pm
NRC staff evaluation of industry analysis of dissimilar metal weld flaws	E. Sullivan, NRR A. Csontos, RES D. Rudland, EMCC	2:25 - 2:55 pm
Committee Discussion	W. Shack, ACRS	2:55 - 3:00 pm

Note

- Presentation time should not exceed 50 percent of the total time allocated for specific items. The remaining 50 percent of the time is reserved for discussion.
- 35 copies of the presentation materials to be provided to the Committee.

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

October 1, 2007

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MEMORANDUM TO: Frank P. Gillespie, Executive Director
Advisory Committee on Reactor Safeguards

FROM: James T. Wiggins, Deputy Director
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR REVIEW AND ENDORSEMENT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS OF THE PROPOSED GENERIC LETTER 2007-XX, "MANAGING GAS INTRUSION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SPRAY SYSTEMS"

The Office of Nuclear Reactor Regulation (NRR) requests that the Advisory Committee on Reactor Safeguards (ACRS) review and endorse the subject generic letter (GL), which is provided as Enclosure 1 to this memorandum. Enclosure 2 provides NRR's responses to the public comments received from external stakeholders in response to the solicitation for comments published in the *Federal Register* on May 23, 2007. Enclosure 3 is a redline/strikeout version of the proposed GL showing changes made to address public comments.

The proposed GL is sponsored by William H. Ruland, Director, Division of Safety Systems, NRR.

CONTACT: Warren Lyon, NRR/DSS
(301) 415-2897

Enclosure 1: Proposed Generic Letter 2007-XX (ML053460427)
Enclosure 2: Staff Resolution of Public Comments Received on the Proposed Generic Letter (ML072410212)
Enclosure 3: Redline/Strikeout Version of Proposed GL Showing Changes Due to Public Comments (ML072410253)

OMB Control No.: 3150-0011

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

NRC GENERIC LETTER 2007-XX: MANAGING GAS INTRUSION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SPRAY SYSTEMS

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this generic letter (GL) to address the issue of gas[1] intrusion into the emergency core cooling, decay heat removal[2], and containment spray systems (hereinafter referred to as the "subject systems"). Specifically, the NRC is issuing this GL:

(1) to request addressees to submit information to demonstrate that the subject systems are in compliance with the current licensing and design bases and applicable regulatory requirements, and that suitable design, operational, and testing control measures are in place for maintaining this compliance, and

(2) to collect the requested information to determine if additional regulatory action is required.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.54(f), addressees are required to submit a written response to this GL.

ML053460427

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[1] Gas as used here includes, air, nitrogen, hydrogen, water vapor, or any other void that is not filled with liquid water.

[2] Decay heat removal (DHR), residual heat removal (RHR), and shutdown cooling (SDC) are common names for systems used to cool the reactor coolant system (RCS) during some phases of shutdown operation. The NRC staff generally uses DHR here.

BACKGROUND

Instances of gas intrusion into the subject systems have occurred since the beginning of commercial nuclear power plant operation. The NRC has published 20 information notices (INs), two GLs, and a NUREG[3] that are related to this issue and has interacted with the nuclear industry many times in relation to these publications and in response to gas intrusion events. The following paragraphs summarize a few events to illustrate some of the technical and regulatory requirements issues.

In May 1997, at Oconee Nuclear Station Unit 3, hydrogen ingestion during plant cooldown damaged and rendered nonfunctional two high-pressure injection (HPI) pumps. If the operators had started the remaining HPI pump, it too would have been damaged. The NRC responded with an augmented inspection team (IN 97-38, "Level-Sensing System Initiates Common-Mode Failure of High-Pressure-Injection Pumps," Agencywide Documents Access and Management System (ADAMS) Accession No. ML031050514, June 24, 1997). The NRC team reported that there had been a total lack of HPI capability during power operation, a failure to meet technical specification (TS) HPI operability requirements, design deficiencies, inadequate maintenance practices, operators that were less than attentive to plant parameters, a failure to adequately assess operating experience, and a violation of 10 CFR Part 50, Appendix B, Criterion III ("Notice of Violation and Proposed Imposition of Civil Penalties - $330,000," August 27, 1997, http://www.nrc.gov/reading-rm/doc-collections/enforcement/actions/reactors/ea97297.html).

As a result of this Oconee Unit 3 event, the industry initiated an industry-wide improvement activity to address the gas issue. Based on the industry actions, the NRC concluded that no generic action was necessary. However, significant gas events that jeopardized the operability of the subject systems continued to occur, as illustrated in the following paragraphs.

Dresden Nuclear Power Station Unit 3 experienced a reactor scram on July 5, 2001, that was accompanied by a water hammer[4] as a result of high pressure coolant injection (HPCI) system voids due to inadequate pipe venting. The licensee discovered a damaged pipe support that rendered the HPCI system inoperable on July 19, 2001. On September 28, 2001, NRC inspectors discovered discrepancies in another HPCI hanger that may have been caused by the water hammer. The licensee repaired the hangers on September 30, 2001, and vented the system. An NRC inspector identified a high point that had not been vented and air was removed when the licensee vented that location. The HPCI system was inoperable from July 5, 2001, to September 30, 2001 (NRC Supplemental Inspection Report 50-237, 50-239/2003-012, ML033530204, December 18, 2003). The NRC found violations of

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[3]GL 88-17, "Loss of Decay Heat Removal," October 17, 1988 (ML031200496); GL 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," October 7, 1997 (ML031110062); and NUREG-0897, Revision 1, "Containment Emergency Sump Performance—Technical Findings Related to USI A-43," October 1985.

[4]"Water hammer" refers to any transient pressure condition that is caused by or exacerbated by presence of a void in a system regardless of whether the pressure condition was benign or resulted in damage.

10 CFR 50.9, a TS, and 10 CFR Part 50, Appendix B, Criterion XVI ("Notice of Violation and Proposed Imposition of Civil Penalty - $60,000, and Final Significance Determination for a White Finding," ML031740755, June 23, 2003).

On June 4, 2003, Quad Cities operators performed a monthly TS surveillance to demonstrate that the 1B core spray pump discharge piping was full of water. The piping was vented for 12 minutes before water flow was observed and the NRC inspectors determined the licensee had failed to provide a correct venting procedure that would ensure continued pump operability. The system engineer estimated that the piping was about one-half empty. A water hammer with the potential to cause damage would have occurred if the core spray pump had been started and the core spray system was determined to be inoperable in the as-found condition. The NRC inspectors also determined that the ECCS surveillance procedures were incorrect, that licensee review in response to the excess gas was inadequate, and that TS 3.0.4 had been violated. This was considered to be a licensee-identified violation, the finding was greater than minor because of the pump inoperability, and the finding was considered to be of very low safety significance because it did not result in an actual loss of function. It was dispositioned as a Non-Cited Violation and entered into the corrective action program. (NRC Inspection Report 50-254/03-05, 50-265/03-05, ML031980621, July 17, 2003).

On August 14, 2003, the Perry Nuclear Power Plant scrammed from 100 percent power due to a loss of offsite power. This caused a momentary loss of common water leg pumps[5] and a discharge pressure decrease from 44 psig to 7 psig allowed accumulated gas to completely void a water leg pump and the associated feedwater leakage control system piping. Pump operation was restored by venting the pump casing but a piping high point that was not included in fill and vent procedures was not vented. On September 10, 2003, the licensee vented enough gas from the high point that would have caused the pump to be non-functional if another loss of offsite power would occur. If the RHR and/or the low-pressure core spray pumps had started while the leakage control system piping was voided, the resulting water hammer could have caused the system piping to rupture. The NRC characterized the inspection finding as white; the finding resulted in a TS violation, escalated enforcement action, and a supplemental inspection (NRC Inspection Report 50-440/2003-009, ML032880107, October 10, 2003, and ML040330980, January 30, 2004).

On July 28, 2004, the Palo Verde licensee identified that emergency core cooling system (ECCS) suction piping voids in all three Palo Verde units could have resulted in a loss of the ECCS during transfer to the recirculation mode for some loss-of-coolant accident (LOCA) conditions. The condition had existed since plant startups in 1986, was contrary to the Palo Verde final safety analysis reports (FSARs), and would not be identified during testing because water is not drawn from the containment emergency sumps. The NRC inspectors identified multiple violations of 10 CFR Part 50, Appendix B, Criteria III and V, and violations of 10 CFR 50.59. The NRC responded with a special inspection, issued a yellow finding, and imposed a civil penalty of $50,000 (NRC Special Inspection Report 50-328, 50-329,

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[5]These are 40-gpm pumps used to compensate for back-leakage through check valves in RHR and low-pressure core spray piping into the suppression pool. The purpose is to keep piping full of water where the pipe elevation is higher than the suppression pool. The system is often referred to as a "keep-full" system.

50-330/2004-014, ML050050287, January 5, 2005). The Palo Verde licensee identified the ECCS piping suction voids after being contacted by an engineer from another plant where an NRC inspector identified the same problem.

In February 2005, an HPI pump at Indian Point Energy Center Unit 2 was found inoperable because the pump casing was filled with gas. The licensee then found several locations in the ECCS piping with gas accumulation. The licensee did not initially understand the implications of the gas condition, and the licensee's early assessments were inadequate, particularly with respect to assessing the operability of the other two HPI pumps. The NRC conducted a special inspection that found one HPI pump was not functional and the other two HPI pumps had a 75 percent failure probability. The NRC found several violations of 10 CFR 50, Appendix B, Criterion XVI, and issued a white finding (NRC Inspection Report 50-247/2005-006, ML051680119, June 17, 2005).

In March 2005, the NRC reported that Diablo Canyon had a sustained history of gas voiding in piping that could possibly result in gas binding or damage to the centrifugal charging pumps or the HPSI pumps during switchover from cold-leg to hot-leg injection.[6] Ten recent gas voiding occurrences were listed in the inspection report and the NRC inspectors concluded that the licensee focused on managing the symptom of the problem rather than finding and eliminating the cause, which is contrary to 10 CFR 50, Appendix B, Criterion XVI. The finding was more than minor in that the voiding could have caused mitigating equipment to fail but was of very low safety significance because the inspectors concluded there was no loss of function. This was a Non-Cited Violation (NRC Inspection Report 50-275, 50-323/2005-006, ML050910120, March 31, 2005).

In September 2005, operators discovered a void in the HPCI pump discharge piping at the Duane Arnold Energy Center due to "turbulent penetration" that caused hot water from the feedwater pipe to penetrate downward into the HPCI discharge pipe. This heated the HPCI pipe on the low pressure side of a closed valve to greater than the saturation temperature and caused steam to be generated in the low pressure pipe as fast as it was vented. The condition had existed since plant startup (Licensee Event Report 50-331/2005-004, ML053360261, November 28, 2005). The NRC opened an unresolved item (URI 05000331/2006002-03) for further NRC review of the licensee's piping analysis that evaluated HPSI system operability with the voided piping. The condition was determined to be adverse to quality since it was not identified by the licensee and was uncorrected. The issue was found to be of very low safety significance and entered into the corrective action program. The violation was treated as a Non-Cited Violation. (NRC Inspection Report 50-331/2006-002, ML061210448, April 27, 2006, and NRC Inspection Report 50-331/2006-008, ML070640515, March 2, 2007).

In October 2005, an NRC inspection team at the Palo Verde Nuclear Generating Station identified that, following a postulated accident when refueling water tank (RWT) level reached

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[6]A similar gas accumulation problem under closed valves in the recirculation piping from the DHR discharge to the HPSI and charging pump suctions has occurred at several plants. This has the potential to cause loss of all high pressure RCS makeup capability when shifting suction to the emergency containment sump from the refueling water or borated water storage tank following a LOCA.

the setpoint for containment sump recirculation, the licensee's design basis credited containment pressure for preventing the ECCS pumps from continuing to reduce RWT level and drawing air into the ECCS. However, a recent licensee analysis showed that the minimum containment pressure would be less than needed. The licensee declared the ECCS inoperable at all three units, requiring a shutdown of Units 2 and 3 (Unit 1 was already shut down). The NRC found multiple violations of 10 CFR 50, Appendix B, Criteria III and V (NRC Supplemental Inspection Report 50-528, 50-529, 50-530/2005-012, ML060300193, January 27, 2006).

These are a few of the more than 60 gas intrusion events reported since the 1997 Oconee Unit 3 event.

APPLICABLE REGULATORY REQUIREMENTS

The regulations in Appendix A to 10 CFR Part 50 or similar plant-specific principal design criteria[7] provide design requirements, and Appendix B to 10 CFR Part 50, TSs, and licensee quality assurance programs provide operating requirements. Appendix A requirements applicable to gas management in the subject systems include the following:

- General Design Criterion (GDC) 1 requires that the subject systems be designed, fabricated, erected, and tested to quality standards.

- GDC 34 requires an RHR system designed to maintain specified acceptable fuel design limits and to meet design conditions that are not exceeded if a single failure occurs and specified electrical power systems fail.

- GDC 35, 36, and 37 require an ECCS design that meets performance, inspection, and testing requirements. Specified performance criteria are provided in 10 CFR 50.46.

- GDC 38, 39, and 40 require a containment heat removal system design that meets performance, inspection, and testing requirements.

Quality assurance criteria provided in Appendix B that apply to gas management in the subject systems include the following:

- Criteria III and V require measures to assure that applicable regulatory requirements and the design basis, as defined in 10 CFR 50.2, "Definitions," and as specified in the license application, are correctly translated into controlled specifications, drawings, procedures, and instructions.

- Criterion XI requires a test program to assure that the subject systems will perform satisfactorily in service. Test results shall be documented and evaluated to assure that test requirements have been satisfied.

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[7]For facilities with a construction permit issued prior to May 21, 1972, that are not licensed to Appendix A.

- Criterion XVI requires measures to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified, corrected, documented, and reported to management.

- Criterion XVII requires maintenance of records of activities affecting quality.

Further, as part of the licensing basis, licensees have committed to certain quality assurance provisions that are identified in both their TSs and quality assurance programs. Licensees have committed to use the guidance of Regulatory Guide (RG) 1.33, Revision 2 (February 1978), "Quality Assurance Requirements (Operation)," which endorses American National Standards Institute (ANSI) N18.7-1976/American Nuclear Society 3.2, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants," or equivalent licensee-specific guidance. Section 5.3.4.4, "Process Monitoring Procedures," of ANSI N18.7 that states that procedures for monitoring performance of plant systems shall be required to assure that engineered safety features and emergency equipment are in a state of readiness to maintain the plant in a safe condition if needed. The limits (maximum and minimum) for significant process parameters shall be identified. Operating procedures shall address the nature and frequency of this monitoring, as appropriate.

10 CFR 50.36 (c)(3) defines TS surveillance requirements (SRs) as "relating to test, calibration, or inspection to assure" maintenance of quality, operation within safety limits, and operability. Typically, TS Section 5 or 6 requires that licensees establish, implement, and maintain written procedures covering the applicable procedures recommended in Appendix A to RG 1.33. Appendix A to RG 1.33 identifies instructions for filling and venting the ECCS and DHR system, as well as for draining and refilling heat exchangers. Surveillance requirements to verify that at least some of the subject system piping is filled are provided in standard TSs and in most licensee TSs.

DISCUSSION

The events discussed in the BACKGROUND section illustrate that several of the regulatory requirements identified in the APPLICABLE REGULATORY REQUIREMENTS section were not being met. Those requirements in the operating license and regulations require adequate design, tests, procedures, records and corrective actions whereas operating experience and NRC inspections have revealed inadequate designs, test programs, procedures, test result documentation and corrective actions at licensed facilities. This GL requires licensees to provide information on methods used to comply with these NRC requirements. The NRC will evaluate this information to determine if further regulatory action is necessary to assure compliance.

It is important that the subject systems are sufficiently filled with water to ensure that they can reliably perform their intended functions under all LOCA and non-LOCA conditions that require makeup to the RCS. Portions of these systems and some of the associated pumps are normally in a standby condition while other pumps provide both ECCS and operational functions. For example, some high-pressure pumps are used for normal RCS makeup, and some low-pressure pumps provide a normal DHR capability.

The following examples illustrate how inadequate gas control can have safety implications:

(1) The introduction of gas into a pump can cause the pump to become air-bound with little or no flow, rendering the pump inoperable. Air-binding can render more than one pump inoperable when pumps share common discharge or suction headers, or when the gas accumulation process affects more than one train, greatly increasing the risk significance. Such a common-mode failure would result in the inability of the ECCS or the DHR system to provide adequate core cooling and the inability of the containment spray system to maintain the containment pressure and temperature below design limits. An air-bound pump can become damaged quickly, eliminating the possibility of recovering the pump during an event by subsequently venting the pump and suction piping.

(2) Gas introduced into a pump can render the pump inoperable, even if the gas does not air bind the pump, because the gas can reduce the pump discharge pressure and flow capacity to the point that the pump cannot perform its design function. For example, an HPI pump that is pumping air-entrained water may not develop sufficient discharge pressure to inject under certain small break LOCA scenarios.

(3) Gas accumulation can result in water hammer or a system pressure transient, particularly in pump discharge piping following a pump start, which can cause piping and component damage or failure. Gas accumulation in the DHR system has resulted in pressure transients that have caused DHR system relief valves to open. In some plants, the relief valve reseating pressure is less than the existing RCS pressure, a condition that complicates recovery. This was encountered, for example, during an event at Sequoyah where a pressure pulse due to gas in RHR discharge piping caused a relief valve to open and rendered both RHR trains inoperable for 6 hours because the relief valve failed to reseat.

(4) Unbalanced loads due to entrained gas and the reduction in inlet pressure at a pump due to gas in a vertical suction line that causes pump cavitation can result in additional stresses that lead to premature failure of pump components.

(5) Gas intrusion can result in pumping noncondensible gas into the reactor vessel that may affect core cooling flow.

(6) The time needed to fill voided discharge piping can delay delivery of water beyond the time frame assumed in the accident analysis.

The number of identified gas intrusion problems and their significance at some facilities raise concerns about whether similar unrecognized design, configuration, and operability problems exist at other facilities.

A review of the operating experience has identified the following principal concerns, which are the focus of this GL:

(1) **Licensing Basis.** The FSARs at many facilities state that the subject systems are full of water and TSs often require periodic surveillances to confirm this condition. Some plant TSs have incomplete SRs that cover only portions of the system. For example, the TSs may require verifying that ECCS discharge piping is full of water but may not include verification of the suction piping or containment spray piping despite the realistic concern that gas in suction piping may be more serious than gas in discharge piping. In addition, since the subject systems may be rendered inoperable or degraded by gas in any section of piping, the regulations require that presence of gas in all piping be assessed to establish operability. There may be some parts of these systems where it is not currently possible or practical to verify them to be full of water. Hence, the current TSs and FSARs may establish a standard that may not be realistic to establish system operability. A realistic licensing basis should bound the volume of gas that may impact pump operability and the volume for which water-hammer-induced stress limits may be exceeded.

(2) **Design.** Criterion III of Appendix B to 10 CFR Part 50 and the operating license identify regulatory requirements for the design of the subject systems. The failure to translate the design basis, such as the system maintained full of water, into drawings, specifications, procedures, and instructions would be contrary to Criterion III of Appendix B of 10 CFR Part 50. Subject system designs vary widely regarding potential gas sources and capability to control gas. Potential gas sources and symptoms of gas leakage from these sources should be identified and potential gas accumulation locations should be known and provisions made to address gas accumulation at these locations. The NRC staff has observed high point vents that were not located at actual high points, non-existent vents where drawings showed vents existed, and failure to provide vents or methods for controlling gas at high points. The NRC staff also notes that drawings and isometric diagrams often show piping as level whereas as-installed piping is sloped.

(3) **Testing.** Criteria V and XI of Appendix B to 10 CFR Part 50 and the operating license require licensees to perform testing using written test procedures that incorporate the requirements and acceptance limits contained in applicable design and licensing documents and Criterion XVII requires appropriate records. Testing of all segments of piping and components in the subject systems is necessary to confirm acceptance limits and operability unless it has been acceptability established that some items may be excluded. In practice it is not uncommon for licensees to vent gas during periodic surveillances and then conclude the subject systems were and are operable without addressing the pre-venting condition. With the exception of planned draining or maintenance, existence of gas in the system is not consistent with such TSs and FSARs.

(4) **Operability.** The operating license and licensing basis identify regulatory requirements for the operation of the subject systems. Operability is required during operational modes defined in TSs when in the specified modes with the exception of allowed outage

times. Surveillance and testing that do not ensure operability prior to a surveillance, at the time of the surveillance, and for the time period until the next surveillance are not consistent with this requirement.

(5) **Corrective Actions.** Some licensees have treated the accumulation of substantial gas quantities as an expected condition rather than a nonconforming condition and have not documented the condition even when it involved a substantial volume of gas that clearly constituted a significant condition adverse to quality. In such cases, Criterion XVI of Appendix B to 10 CFR Part 50 requires that the cause of the condition be determined and corrective action taken to preclude repetition. Based on the as-found volume and location of gas, corrective actions beyond simply refilling a system may be necessary to provide reasonable assurance that the affected system will remain operable until the next surveillance.

The NRC staff is initiating a Technical Specifications Task Force (TSTF) activity to address the recognized TS weaknesses associated with gas intrusion concerns. The information in the GL and GL responses should be useful in formulating the Traveler and the schedule for the TSTF Traveler development will be consistent with the GL response schedule.

The enclosure to this GL, "Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability," provides additional information. Addressees should consider this information when preparing responses to this GL. Further, the NRC staff plans to use this information during activities that are being planned as a followup to this GL and for guidance in the TSTF program to develop improved TSs.

REQUESTED ACTIONS

Each addressee is requested to evaluate their ECCS, DHR system, and containment spray system licensing basis, design, testing, operability, and corrective actions to assure that gas intrusion is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified. The evaluation should include the issues and considerations identified above and in the enclosure to this GL.

REQUESTED INFORMATION

Each addressee is requested to provide a description of the results of the evaluations done pursuant to the REQUESTED ACTIONS within 6 months of the date of this GL. This description should provide sufficient information to demonstrate compliance with the quality assurance criteria in 10 CFR 50, Appendix B, Sections III, V, XI, XVI, and XVII and the licensing basis and operating license as those requirements apply to the subject systems.

REQUIRED RESPONSE

In accordance with 10 CFR 50.54(f), in order to determine whether a facility license should be modified, suspended, or revoked, or whether other action should be taken, an addressee is required to respond as described below.

Within 6 months of the date of this generic letter, an addressee is required to submit a written response consistent with the requested actions and information. If an addressee is unable to provide the information or can not meet the requested completion date, the addressee shall provide a response within 45 days and shall describe the alternative course of action that it proposes to take, including the basis for the acceptability of the proposed alternative course of action.

The required written response should be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, 11555 Rockville Pike, Rockville, MD 20852, under oath or affirmation under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f). In addition, submit a copy of the response to the appropriate regional administrator.

REASONS FOR INFORMATION REQUEST

The NRC is requesting this information because a review of operating experience and NRC inspection results shows several recent instances of gas intrusion events involving the subject systems that have rendered or potentially rendered these risk-significant systems inoperable.

RELATED GENERIC COMMUNICATIONS

Document Number	Document Name	ADAMS Accession No
GL 88-17	Loss of Decay Heat Removal	ML031200496
GL 97-04	Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps	ML031110062
IN 86-63	Loss of Safety Injection Capability	ML031250058
IN 86-80	Unit Startup with Degraded High Pressure Safety Injection System	ML031250214
IN 87-63	Inadequate Net Positive Suction Head in Low Pressure Safety Systems	ML031180034
IN 88-23 IN 88-23, Supp. 1 IN 88-23, Supp. 2 IN 88-23, Supp. 3 IN 88-23, Supp. 4	Potential for Gas Binding of High-Pressure Safety Injection Pumps During a Loss-of-Coolant Accident	ML031150208 ML881230018 ML900125002 ML901204023 ML921215001
IN 88-74	Potentially Inadequate Performance of ECCS in PWRs during Recirculation Operation Following a LOCA	ML031150118

Document Number	Document Name	ADAMS Accession No
IN 89-67	Loss of Residual Heat Removal Caused by Accumulator Nitrogen Injection	ML031180745
IN 89-80	Potential for Water Hammer, Thermal Stratification, and Steam Binding in High-Pressure Coolant Injection Piping	ML031190089
IN 90-64	Potential for Common-Mode Failure of High Pressure Safety Injection Pumps or Release of Reactor Coolant Outside Containment During a Loss-of-Coolant Accident	ML031103251
IN 91-50	A Review of Water Hammer Events after 1985	ML031190397
IN 94-36	Undetected Accumulation of Gas in Reactor System	ML031060539
IN 94-76	Recent Failures of Charging/Safety Injection Pump Shafts	ML031060430
IN 95-03	Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition	ML031060404
IN 96-55	Inadequate Net Positive Suction Head of Emergency Core Cooling and Containment Heat Removal Pumps under Design Basis Accident Conditions	ML031050598
IN 96-65	Undetected Accumulation of Gas in Reactor Coolant System and Inaccurate Reactor Water Level Indication During Shutdown	ML031050500
IN 97-38	Level-Sensing System Initiates Common-Mode Failure of High Pressure Injection Pumps	ML031050514
IN 97-40	Potential Nitrogen Accumulation Resulting from Back-Leakage from Safety Injection Tanks	ML031050497
IN 98-40	Design Deficiencies Can Lead to Reduced ECCS Pump Net Positive Suction Head During Design-Basis Accidents	ML031040547
IN 02-15 IN 02-15 Supp. 1	Potential Hydrogen Combustion Events in BWR Piping	ML020980466 ML031210054
IN 02-18	Effect of Adding Gas Into Water Storage Tanks on the Net Positive Suction Head for Pumps	ML021570158
IN 06-21	Operating Experience Regarding Entrainment of Air Into Emergency Core Cooling and Containment Spray Systems	ML062570468

BACKFIT DISCUSSION

Under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, this GL requests a review and appropriate resulting actions for the purpose of assuring compliance with applicable existing requirements. No backfit is either intended or approved by the issuance of this GL. Therefore, the NRC staff has not performed a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment on this generic letter was published in the *Federal Register* (72 FR 29010) on May 23, 2007. Seven sets of comments were received, all from the nuclear industry. The NRC staff considered all comments that were received. The NRC staff's evaluation of the comments is publicly available through the NRC's Agencywide Documents Access and Management System (ADAMS) under Accession No. ML072410212.

CONGRESSIONAL REVIEW ACT

In accordance with the Congressional Review Act, the NRC has determined that this GL is not a major rule and the Office of Information and Regulatory Affairs of the Office of Management and Budget has confirmed this determination.

PAPERWORK REDUCTION ACT STATEMENT

This GL contains an information collection that is subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). The Office of Management and Budget approved this information collection under clearance number 3150-0011 which expires on June 30, 2010.

The burden to the public for this mandatory information collection is estimated to average 300 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection.

Send comments on any aspect of this information collection, including suggestions for reducing the burden, to the Records and FOIA/Privacy Services Branch (T5-F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by Internet electronic mail to infocollects@nrc.gov; and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0011), Office of Management and Budget, Washington, DC 20503.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

CONTACT

Please direct any questions about this matter to the technical contact or the Lead Project Manager listed below, or to the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Warren C. Lyon, NRR
301-415-2897
e-mail: wcl@nrc.gov

Lead Project Manager: David P. Beaulieu, NRR
301-415-3243
e-mail: dpb@nrc.gov

Enclosure:

"Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability"

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

CONTACT

Please direct any questions about this matter to the technical contact or the Lead Project Manager listed below, or to the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Warren C. Lyon, NRR
301-415-2897
e-mail: wcl@nrc.gov

Lead Project Manager: David P. Beaulieu, NRR
301-415-3243
e-mail: dpb@nrc.gov

Enclosure:

"Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability"

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Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability

Overview

This enclosure provides a discussion of some of the technical issues that should be considered when evaluating the design, operability, testing, and corrective actions for gas intrusion concerns in emergency core cooling, decay heat removal, and containment spray systems.

Gas accumulation in the subject nuclear power plant systems can cause water hammer, gas binding in pumps, and inadvertent relief valve actuation that may damage pumps, valves, piping, and supports and may lead to loss of system operability. Consequently, these systems are equipped with vents, and some of the subject systems have keep-full systems that are intended to avoid these problems by maintaining them full of water. However, as summarized in the generic letter (GL), history has shown that the subject systems, as designed and maintained, have been exposed to gas accumulations sufficient to cause potential and actual loss of operability. This memorandum provides insights that addressees should consider when responding to the GL.

The root causes of gas accumulation include poor designs that allow gas introduction and accumulation, licensees failing to properly fill and vent the system following drain-down or maintenance, ineffective controls on gas accumulation during operation, inappropriate technical specifications (TSs), and, in some cases, unanticipated problems with keep-full systems.

The correct objective of gas control measures is to limit the volume of gas accumulation to a quantity that does not jeopardize system operability. An acceptable volume depends on a variety of factors including, but not necessarily limited to, the location, the type of pump, the net positive suction head (NPSH) margin, the gas volume fraction at the pump impeller, and the flow rate. A gas volume downstream of an emergency core cooling system (ECCS) pump that would not cause a loss of system function might cause a pump failure if located upstream of the pump.

The amount and location of gas are important in addressing system operability. Additional work is necessary to develop realistic criteria to determine the amount of gas that could impact operability including:

- Characterizations of the sources and rate of generation of gases in systems,
- Ingestion of gas from tanks and recirculation sumps[8] (vortexing),
- Characterization of gas transport in the subject system piping as a function of system flow requirements,

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[8]This includes potential gas accumulation downstream of containment emergency sump screens and post-accumulation transport.

- Allowable limits on ingested gas volume in pump suction piping to ensure pump operability, as well as for the pump discharge piping to alleviate water hammer concerns such as slamming check valves or a water cannon effect on the piping,

- Allowable limits on ingested gas volume to mitigate dynamic pressure pulsation,

- Development of guidance on the sequence of venting to prevent void formation in high points remote from the vent location,

- Identification of those portions of systems in which venting is unnecessary such as downstream of the CS spray isolation valve to the spray headers,

- Evaluation of gas detection techniques and the associated accuracies.

This enclosure addresses the following six topics:

(1) sources of gas
(2) gas accumulation locations
(3) determination of gas quantity
(4) water hammer and acceptable gas quantity
(5) pump operation and acceptable gas quantity
(6) control of gas

(1) <u>Sources of Gas</u>

Some sources of gas include:

- leakage from accumulators;

- leakage from the reactor coolant system (RCS);

- outgassing of dissolved gas because of a pressure reduction such as through control valves, orifices, and emergency sump screens, or due to elevation changes or venting;

- draining, system realignments, incorrect maintenance procedures, and failure to follow procedures;

- failure of level instruments to indicate correct level;

- leakage through test header valves;

- leakage through faulty vent system components when local pressure is less than the nominal downstream pressure;

- temperatures at or above saturation temperature; and

- vortexing in suction sources or gas introduced from suction sources.

Gas in discharge piping can be an indicator of potential backleakage from high-pressure sources such as accumulators or the RCS, and the gas may have moved into the pumps and the pump suction piping. Such gas may have flowed through multiple closed in-series valves. For this reason, it is important to reassess gas accumulation conditions following system operations and valve manipulations. In addition, many plants have a dozen or more test valves that connect to a common header and provide multiple potential leak paths. For example, the gas accumulation rates at the Sequoyah Nuclear Plant were significantly reduced in 2002 by test header valve maintenance and, at Indian Point Energy Center Unit 2, the test header provided a leakage pathway through multiple closed valves into both high-pressure injection (HPI) lines in January 2005.

Some pressurized-water reactors (PWRs) have experienced gas accumulation due to outgassing in charging pump bypass orifices. Installing multiple-stage orifices essentially eliminated the problem by reducing the pressure drop at each orifice to reduce or eliminate non-equilibrium conditions that caused local gas generation.

(2) <u>Gas Accumulation Locations</u>

Some locations where gas can accumulate include:

- in high points in pipe runs, including elevation variation in nominally horizontal pipes;
- under closed valves;
- in decay heat removal (DHR)[9] system heat exchanger U-tubes;
- in horizontal pipe diameter transitions that introduce traps at the top of the larger pipe;
- in tees where gas in flowing water can pass into a stagnant pipe where it accumulates;
- in valve bonnets
- in pump casings; and
- in piping when the temperature is at or above the saturation temperature.

Some locations, such as tees, horizontal pipes, and valve bonnets, are commonly overlooked. Gas accumulation due to separation of liquid and gas at a tee has caused significant problems. In some PWRs, gas accumulates under the isolation valve in the crossover piping between the DHR pump discharge to the suction of the HPI pumps where there are no vents. The crossover

[9]DHR, residual heat removal (RHR), and shutdown cooling (SDC) are common names for systems used to cool the reactor coolant system (RCS) during some phases of shutdown operation. The author generally uses DHR here to be consistent with the GL.

piping is especially vulnerable because system testing usually does not involve flow through that location and licensees may not have correctly determined the acceptable gas volume. Further, some TS surveillance requirements (SRs) do not specify suction piping. Often, licensees consider the crossover piping to be suction piping that does not have to be checked for gas.

Gas accumulation can be exacerbated by failure to adequately determine actual system high points and failure to have vents where gas accumulates. For example, plant isometric drawings sometimes indicate that a length of pipe is horizontal, but an in-plant examination will reveal that the pipe is sloped, sometimes by several inches. This is an important consideration for vent locations and for using ultrasonic testing (UT) to determine gas volume.

(3) Determination of Gas Quantity

Some common methods to determine gas quantity in the subject systems are to measure the volume of gas released through vents or to determine the gas volume by UT.

Some hard-piped vents exhaust at a remote location or into a vent manifold where it is difficult to determine whether any gas was released. Closed systems may have sight glasses for observing bubbles. When the flow rate is adequate to force the gas from the high point down through the vent line to a clean sight glass, and the venting period is long enough for the gas to have traveled through the sight glass, personnel can tell if all gas has been removed. However, it is difficult to accurately determine the volume of gas removed. In some cases, vent flow is passed into a test header with a flow meter, but the accuracy of this method of determining gas quantity is difficult to establish. Vents consisting of a valve with a removable blind flange immediately downstream of the valve allow the effluent to be observed and are often used in conjunction with other means to determine the vented volume. Procedures should cover venting and post-venting actions such as recording observations and/or gas volumes and should ensure a followup if specified criteria related to the gas volume are not met.

Several conditions may effect the accuracy of a vented volume determination. In some locations, venting changes the pressure, and a volume estimate based on venting time may therefore be in error because the venting rate is not constant. In some cases, opening and closing or repositioning the throttle valve during venting may affect timing. Gas and water vapor released from the liquid during depressurization may also affect volume determinations. Saturated water vapor will superheat when pressure decreases and will condense if exposed to a temperature below the saturation temperature. Saturated water may boil during venting when pressure is decreased. These conditions may result in a misleading assessment of gas quantity if the behavior is not recognized.

Other methods of determining gas volume are available. UT can provide accurate gas volumes regardless of vent locations. A known volume of water can be injected into an isolated section of piping (or a heat exchanger) and the void can then be calculated from the known pressures and injected volume. Another method is to record DHR system flow rate behavior immediately following pump start to estimate gas volume in the DHR system discharge piping. NRC Special Inspection Report 50-400/02-06 stated that this method is useful in determining whether the

DHR heat exchangers are void free. This has been used at Sequoyah. When a DHR pump was started for testing with the DHR system configured for injection into the RCS, the flow rate indicated on a local gauge immediately downstream of the DHR pump should increase approximately linearly for the first 8 seconds as the minimum flow line flow control valve opens and should then level off at approximately 550 gallons per minute (gpm) if there is no gas volume downstream of the pump. In this case, there is no actual injection since the RCS pressure is higher than the DHR system pump discharge pressure and the flow is through the minimum flow line. With gas present, the flow rate typically increases more rapidly to a value greater than approximately 550 gpm and then decreases to approximately 550 gpm within roughly 20 seconds.

The accuracy necessary for void determination is also of interest. An approximate void determination method will be adequate when the anticipated void is significantly removed from an operability concern based on the historical record and, in that case, recording a parameter that is indicative of the void quantity would be sufficient. Anticipation of more significant voids, sudden increases in void accumulation rate, or observation of other plant behavior such as decreasing accumulator level may require more accurate means to obtain the void size and/or a reduction in time between surveillances[10].

With respect to accuracy, UT can provide a quantitative datum that, when considered in combination with temperature and pressure within a pipe, will yield an accurate void volume. Use of vent valves to obtain a pre-test void volume is more difficult and is often more qualitative. Time to vent to obtain a clear liquid stream, with an acceptance criterion conservatively determined from a correlation of vent time to an acceptable volume for each vent location, may be adequate for trending purposes when anticipated vented volumes are clearly well removed from a region of concern. Volumes that are close to impacting operability may require more sophisticated measurement.

(4) <u>Water Hammer and Acceptable Gas Quantity</u>

A principal water-hammer concern is the sudden pressure increase in the pump discharge piping and associated components when systems are put into service. Another concern is pressurization of the DHR system when it is initially connected to the RCS when the RCS pressure is near the DHR system relief valve set pressure. A small pressure perturbation because of a minor water hammer can open DHR system relief valves, which then might fail to close. The relief valve reseating pressure could be less than the RCS pressure, which complicates recovery. Therefore, it is particularly important to initiate DHR system operation by a process that minimizes the potential to cause a pressure pulse. However, application of such techniques must be carefully considered if used for performing surveillances to assess operability. During testing, any proceduralized deviation from normal system operation must be evaluated for the potential to cause unacceptable preconditioning. If the ECCS must start and operate under accident conditions without benefit of pressure-pulse-reducing techniques, then it should be tested in a manner that demonstrates it is capable of doing so without those techniques.

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[10]Variation of time between surveillances is discussed in Item (6).

(5) Pump Operation and Acceptable Gas Quantity

The amount of gas that can be ingested without a significant impact on pump operability and reliability is not well established. It is known to depend on pump design, gas dispersion, and flow rate. The presence of gas is undesirable because gas may initiate a long-term failure mechanism such as shaft fatigue, wear ring degradation, bearing wear, or seal wear. Unfortunately, a no-gas condition during initial pump operation or following alignment changes cannot be assured in practice, and the operational goal should be to minimize the amount of gas consistent with the requirement that operability must be reasonably assured.

A single-stage pump, such as a DHR system pump with significant clearances between moving parts, can often withstand a large slug of gas that completely stops flow, and the pump may be restored to operation when the gas is removed. However, in some cases, physical pump failure has occurred after ingesting gas. A similar no-flow or reduced-flow condition with a multistage pump that has close tolerances between moving parts, such as the multi-stage pumps used in the ECCS, will likely cause permanent damage.

All pumps will exhibit a loss of developed head when exposed to gas at the pump impeller. The following general conclusions appear reasonable for single-stage pumps that are operating at close to rated flow rate:

- Less than about 0.5 to 1 percent gas by volume at the impeller may not have a significant effect on pump head.
- Pump head may be degraded with 1 to 2 percent gas by volume.
- Some pumps may fail to provide significant head at 5 percent gas by volume.
- Most pumps may fail to provide significant head at 10 percent gas by volume.

However, these percentages are a function of flow rate. With respect to developed head, NUREG/CR-2792[11] states that expert opinions on the level of gas ingestion giving negligible degradation ranged from 1 to 3 percent. These experts generally agreed that for flow rates less than 50 percent at best efficiency, the presence of gas might cause gas binding that would not occur at full flow in some pump designs. The experts apparently agreed that gas in the suction lines increased NPSH requirements, but no quantitative data were found. NUREG/CR-2792 also identified a problem that does not appear to be widely recognized. At reduced flow rates with gas ingestion rates that are not normally a problem, gas can accumulate with time and the pump can eventually become gas bound. According to NUREG/CR-2792, this is possible with less than 2 percent gas by volume at low flow rates. Gas binding because of this effect is a potential concern since ECCS pumps are often initially operated at low flow rates when the gas volume passing through the pump may be at a maximum.

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[11] Kamath, P. S., et al., "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions," Creare, Inc., NUREG/CR-2792.

There is some evidence that a multistage pump can tolerate a higher fraction of incoming gas than a single-stage pump without completely losing developed head. This characteristic is attributed to compression of the gas in the early stages so that later stages are exposed to a lower void fraction and consequently continue to develop head. However, this is only true if the flow rate remains a substantial fraction of the best-efficiency flow rate. A significantly reduced flow rate may result in pump damage that makes the pump non-functional. For example, in large break loss-of-coolant accidents (LOCAs) where there is little backpressure, the high-pressure ECCS pumps may continue to function with a substantial void fraction at the first stage impeller, but the high backpressure associated with small LOCAs could cause pump damage at the same void fraction.

There is concern that more than 5 percent gas passing through a multistage pump may result in impeller load imbalance that could bend the shaft or initiate shaft cracks, although this did not occur in tests conducted by Palo Verde Nuclear Generating Station in 2004, where flow rates remained high. If such damage occurred, it is not clear how long the pump would continue to operate. Moreover, such damage may not be evident from developed head tests or pump vibration observation. On the other hand, a few cubic feet of finely dispersed 2 percent gas by volume, although undesirable in a multistage pump, may not cause immediately evident pump damage if the exposure time was short, pump flow rate remained high, and the exposure did not occur repeatedly.

These considerations lead to the conclusion that the commonly used limit of 5 percent gas into pumps may be reasonable only if a substantial flow rate can be assured. For low flow rates, it may be a nonconservative limit. Further, such gas percentages are undesirable due to the potential to cause damage to the pump.

(6) <u>Control of Gas</u>

Venting for a fixed time at what are perceived as local high points is often performed to satisfy TS surveillance requirements (SRs) to assure that gas accumulation in the ECCS and DHR system will not jeopardize operation. However, the SR should reasonably assure that gas has not affected operability will not likely accumulate in sufficient quantity to jeopardize operability before the next surveillance. Venting is sometimes performed where the effluent cannot be directly observed. The venting times are sometimes specified, but they may be too short for an unexpectedly large gas accumulation. In such cases, effective corrective actions may include modifying vents to accommodate direct observation and to provide actions keyed to the observed venting results.

Although the subject systems are often susceptible to gas intrusion, all plants may not have vent valves at one or more system high points. Further, vents in long, nominally horizontal pipes might not be completely effective in eliminating gas. Licensees have also found vents that were supposed to be installed at a high point but were actually installed at a different location. Where high points are not vented, the important questions are whether the licensee is aware of the potential problems, whether the licensee's controls and practices sufficiently reflect this awareness, and whether modifications should be accomplished. For example, where vents are not installed at high points, UT measurements can provide a check for gas, and a high flow rate may be useful to assure gas has been swept from high points. In other cases, design modifications, such as adding vent valves, may be a reasonable approach to problem resolution. For example, one licensee found it needed to install an additional 21 high-point vent valves. Another licensee, who installed an additional 17 vent valves, determined that the primary cause of the gas voiding problem was that the original design specification did not call for a sufficient number of vent valves. No specific NRC requirement mandates the installation of vent valves on the subject systems. However, failure to translate the design basis of assuring the system is maintained sufficiently full of water to maintain operability into drawings, specifications, procedures, and instructions is a violation of Criterion III in Appendix B of 10 CFR Part 50.

In some cases, it may not be necessary to conduct a surveillance to assure operability. An assessment for such plants that (1) acceptably eliminates other means of introducing gas, (2) establishes acceptable verification that the lines are essentially full following a condition that reduces the discharge line pressure, and (3) establishes an operating history confirming that gas has not accumulated may be adequate justification for not conducting surveillances inside containment or at locations that constitute a hazard to personnel performing the assessment. For example, some three loop plants designed by Westinghouse maintain high pressure safety injection discharge lines at a pressure greater than the RCS operating pressure. This eliminates the potential for leakage from the accumulators or the RCS as a possible means to introduce gas into the discharge lines.

If venting from hazardous locations is necessary to maintain operability, measures such as relocating vent valves could be taken in order to address ALARA principles and personnel safety considerations.

With similar justifications and additional considerations, extending the time between surveillances of certain sections of piping may be reasonable. For example, consideration should be given to such conditions as changes in accumulator level and pressure or other indicators of potential gas problems. In regard to significant extension of surveillance times, consideration should be given to the possibility of a previous surveillance, such as a pump test, causing a change in gas behavior, such as a check valve failing to close as tightly as prior to the surveillance, a change that appears to have contributed to the Indian Point Unit 2 event described in the GL. Finally, although not covered by existing TSs, some addressees have correctly increased selected surveillance rates when problems were observed.

Hydrogen is sometimes vented and ignition may be a concern if the area to which the hydrogen is vented is small and not well ventilated. The source of the gas to be vented should be determined and, if the gas is hydrogen, steps to monitor and control the effluent should be considered.

ENCLOSURE 2

NRC REPORT ADDRESSING COMMENTS ON PROPOSED GENERIC LETTER, "*MANAGING GAS INTRUSION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SYSTEMS*" (72FR29010, DATED MAY 23, 2007)

Table 1. Sources of Comments

Comment Designator	Reference	ADAMS Accession Number
BWR	Bunt, Randy, "Comments on Proposed Generic Letter, Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal and Containment Spray Systems," Letter to USNRC from BWROG Chair, BWROG-07039, July 23, 2007.	ML072060068
Duke	Harrall, Thomas P., Jr., "Comments on Proposed Generic Communication; Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Published in the *Federal Register* (72 FR 29010) on May 23, 2007," Letter to USNRC from Vice President, Duke Energy, July 23, 2007.	ML072080348
Exelon	Helker, D. P., "Comments on Proposed Generic Letter, '*Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Systems*' (72FR29010, dated May 23, 2007)," Letter to USNRC from Manager - Licensing, Exelon/AmerGen, July 26, 2007.	ML072190101
NEI	James H. Riley, "Comments on Proposed Generic Letter: Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal and Containment Spray Systems," Letter to USNRC from Director, Engineering, Nuclear Energy Institute (NEI), July 23, 2007.	ML072080345
PWR	Schiffley, Frederick P. "Ted" II, "Comments to Draft Generic Letter 'Managing Gas Intrusion in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems' (PA-SEE-0365), Letter to USNRC from Chairman, PWR Owners Group, July 23, 2007.	ML072060362
STARS	Moser, T., "Strategic Teaming and Resource Sharing (STARS) Comments of Proposed Generic Letter, 72FR29010 (May 23, 2007)," Letter to USNRC from Chairman, STARS Integrated Regulatory Affairs Group, August 3, 2007 (Received by NRC August 10, 2007).	ML072250284
TVA	Wetzel, Beth A., "Comments ON Proposed Generic Communication CONCERNING Managing gas intrusion (Vol. 72 FR 29010-29015)," Letter to USNRC from Manager, Corporate Licensing and Industry Affairs, Tennessee Valley Authority, July 23, 2007.	ML072080346

Comments and Comment Resolution

Several commenters requested a more precise description of the required response. In response, the NRC staff has reorganized part of the **DESCRIPTION** section of the generic letter (GL) and has made editorial changes to better articulate the concerns and has modified the **REQUESTED ACTIONS, REQUESTED INFORMATION**, and **REQUIRED RESPONSE** sections to more precisely describe the response requirements.

Several commenters requested additional detail similar to or in addition to information provided in the NRC memorandum referenced in the draft GL, "Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability," ML072190151. To consolidate the information in one location, the information provided in the memorandum is now contained in an enclosure to the GL. Some of the details that were in the body of the GL have also been moved to the new GL enclosure.

In the following list, each comment is identified by the Table 1 "Comment Designator" and is addressed below.

BWR Comment

"The proposed generic letter puts forth a view that, since some licensees have not met requirements, all licensees must now provide a substantial amount of information to demonstrate compliance. This information would then be reviewed by NRC to 'determine if additional regulatory action is required.' As noted in the proposed generic letter there is ample regulation applicable to gas management. Our overall sense of the operating experience cited in the letter is that this information alone is not sufficient to validate that a generic issue exists. Proper venting in BWR systems is satisfied by plant design features, programs, and analyses including: keep fill systems with alarms, operator rounds, routine venting, periodic flow testing, fill and venting procedures and hydrogen accumulation studies.

"Licensees are responsible for assuring compliance with NRC regulations and technical specifications. In our view, any questions regarding the status of licensee compliance with NRC regulations could better be addressed using the existing inspection and oversight processes, including the use of NRC Inspection Manual Temporary Instructions (TIs).

"The initial cost for assembly of information is minimal, but the evaluation costs of the information submitted by the licensees will be large. Resolving follow-up questions and developing actions would require extensive manpower resources. An additional burden for the US nuclear utilities will be the NRC cost recovery for the review of the information. Resources, which at this time cannot be quantified, will be required of licensees to defend against potential allegations of non-compliance (implied in the proposed generic letter) or to implement new programs or procedures to meet some new standard of documentation.

"Since the proposed generic letter does not demonstrate a generic problem of high safety significance exists, the BWROG suggests that, rather than issuing a proposed generic letter, NRC management address the issue via existing processes at the disposal of the NRC."

NRC Staff Response to BWR Comment

The NRC staff has categorized the BWR letter as providing five comments. Each is listed and addressed below:

BWR Comment 1

The proposed GL puts forth a view that, since some licensees have not met requirements, all licensees must now provide a substantial amount of information to demonstrate compliance.

BWR Comment 2

The information cited in the GL is not sufficient to validate that a generic issue exists. Since the proposed GL does not demonstrate that a generic problem of high safety significance exists, the BWROG suggests that, rather than issuing a proposed GL, NRC management address the issue via existing processes at the disposal of the NRC.

BWR Comment 3

Proper venting in BWR systems is satisfied by plant design features, programs, and analyses including: keep fill systems with alarms, operator rounds, routine venting, periodic flow testing, fill and venting procedures, and hydrogen accumulation studies.

NRC Staff Response to BWR Comments 1-3

The NRC staff provided a few examples of past events in the draft GL to illustrate the generic nature of the issues and the need for the GL. In light of the BWR comments, the following example has been added to the draft GL:

> On June 4, 2003, Quad Cities operators performed a monthly TS surveillance to demonstrate that the 1B core spray pump discharge piping was full of water. The piping was vented for 12 minutes before water flow was observed and the NRC inspectors determined the licensee had failed to provide a correct venting procedure that would ensure continued pump operability. The system engineer estimated that the piping was about one-half empty. A water hammer with the potential to cause damage would have occurred if the core spray pump had been started and the core spray system was determined to be inoperable in the as-found condition. The NRC inspectors also determined that the ECCS surveillance procedures were incorrect, that licensee review in response to the excess gas was inadequate, and that TS 3.0.4 had been violated. This was considered to be a licensee-identified violation, the finding was greater than minor because of the pump inoperability, and the finding was considered to be of very low safety significance because it did not result in an actual loss of function. It was dispositioned as a Non-Cited Violation and entered into the corrective action program. (NRC Inspection Report 50-254/03-05, 50-265/03-05, ML031980621, July 17, 2003).

BWR Comment 4

Licensees are responsible for assuring compliance with NRC regulations and TSs. Questions regarding the status of licensee compliance with NRC regulations could better be addressed using the existing inspection and oversight processes, including the use of NRC Inspection Manual Temporary Instructions (TIs).

BWR Comment 5

The evaluation costs of the information submitted by the licensees will be large. Resolving follow-up questions and developing actions would require extensive manpower resources. An additional burden for the US nuclear utilities will be the NRC cost recovery for the review of the information. Resources, which at this time cannot be quantified, will be required of licensees to defend against potential allegations of non-compliance (implied in the proposed generic letter) or to implement new programs or procedures to meet some new standard of documentation.

NRC Staff Response to BWR Comments 1-5

It is the NRC staff's intent to minimize the burden associated with resolution of the gas intrusion issues discussed in the draft GL. However, the staff's overriding consideration is the safety concern that gas intrusion in safety systems can result in degradation or failure of those systems to perform their intended safety functions. Information cited and referenced in the GL demonstrates that gas intrusion events have been widespread and of a continuing nature despite existing processes. Furthermore, industry assessments, NRC inspections, and NRC staff reviews have clearly established the susceptibility of all plant designs to these issues. Therefore, the staff believes that use of the GL process is appropriate.

NRC Staff General Response to BWR Comments

The BWR comments appear to reflect a misunderstanding of the need for the GL and the detail provided in the draft GL. In response, the information provided in the NRC memorandum (ML072190151) that was referenced in the draft GL, as well as some details in the draft GL, have been moved to a new GL enclosure.

Duke Comment 1

"In the DISCUSSION section, page 10, the GL suggests that a TS surveillance should address operability prior to the surveillance and during the interval until the next surveillance. (See DISCUSSION section, page 10). SSCs (structures, systems, and components) are typically presumed operable when a surveillance is current and acceptance criteria are met and documented. This would be an appropriate consideration for establishing the SR (surveillance requirement) frequency and may be a valid expectation for a TS SR basis document. However, once established, the principle of presumed operability between surveillances should not be challenged."

NRC Staff Response to Duke Comment 1

This comment applies to the end of the first paragraph in the draft GL DISCUSSION section which states:

> Additional issues include TSs, which often do not require venting of suction piping despite voids in suction pipes generally being of more concern than in discharge piping, and do not adequately address operability of the subject systems prior to surveillance and for the time span until the next surveillance. This GL and the anticipated NRC followup to this GL are intended to correct such conditions.

The NRC staff's intent was to identify that existing SRs often result in venting an unquantified gas quantity that may have been sufficient to cause an inoperable condition prior to venting and that gas accumulation at the existing rate may result in inoperability prior to the next SR. This is inconsistent with the intent of SRs which, as implied by **Duke Comment 1**, is to provide assurance that the subject system was operable when the surveillance was conducted and is expected to remain operable until the next surveillance. In response to **Duke Comment 1**, in addition to responding to other commenters, the **DISCUSSION** Section has been reorganized to improve clarity and information detail has been moved to the GL enclosure. This should address **Duke Comment 1**.

Duke Comment 2

"In the DISCUSSION section, page 11, discussion of pump cavitation should be removed from the document entirely. Cavitation is not relevant to gas intrusion. It is, by definition, the formation and subsequent collapsing of vapor bubbles in a flow stream. Moreover, it is strictly a design issue. Cavitation potential is a function of system geometry, flow rates, pressure, and fluid temperatures. Venting and surveillances for system voids, which are entirely appropriate for gas intrusion, will have no bearing on the potential for cavitation."

NRC Staff Response to Duke Comment 2

The Duke comment is with respect to the following draft GL statement:

> (4) Pump cavitation caused by entrained gas results in additional stresses that can lead to premature failure of pump components that can render the pump inoperable.

The GL statement has been rewritten as follows:

> (4) Unbalanced loads due to entrained gas and the reduction in inlet pressure at a pump due to gas in a vertical suction line that causes pump cavitation can result in additional stresses that lead to premature failure of pump components.

Duke Comment 3

"If a licensee has no TS SR requirement and no established design criterion (calculated limit on gas quantity) by which to establish acceptance criteria, does the GL require or expect that the limit be determined and surveillance be implemented in the interim while a TS change is processed?"

NRC Staff Response to Duke Comment 3

The NRC staff notes the draft GL provides information that addressees may consider when responding to the GL request for information. A GL does not provide new requirements although it may reference existing requirements. In response to the Duke question, each addressee is expected to meet the regulatory requirements summarized in the GL in accordance with its plant's licensing basis and a sample history of staff inspections relative to the regulatory requirements was provided to illustrate the staff concerns. Although the NRC staff has not planned interim inspections on the GL topics, any routine inspections, inspections in response to events, or inspections in response to discovery of inoperable systems may include consideration of the information provided in the GL. This is consistent with past NRC practice where topics identified in the GL have been assessed during inspections.

Duke Comment 4

"Input from pump vendors will probably be required to determine acceptable limits for entrained gas volumes. Implementation schedules will need to reflect this factor."

NRC Staff Response to Duke Comment 4

The NRC staff agrees and the draft GL allows this flexibility. In regard to this topic, the NRC staff will expect that substantiating data will be available to support vendor claims.

Duke Comment 5

"In the DISCUSSION section, page 14, the proposed GL states, 'the NRC staff will consider justification for not conducting a periodic surveillance or for extending the time between surveillances of certain sections of piping if an addressee considers surveillance to be unnecessary.' The GL in a subsequent sentence on the same page states, 'An assessment for such plants that (1) acceptably eliminates other means of introducing gas, (2) establishes acceptable verification that the lines are essentially full following a condition that reduces the discharge line pressure, and (3) establishes an operating history confirming that gas has not accumulated will be adequate justification for not conducting surveillances inside containment or at locations that constitute a hazard to personnel performing the assessment.' With proper justification by the utility, this specific exemption from surveillance should apply regardless of the physical location."

NRC Staff Response to Duke Comment 5

The NRC staff agrees. The draft GL has been rewritten as discussed in **NRC Staff Response to PWR Comment 14** with additional discussion in **NRC Staff Response to PWR Comment 13**.

Duke Comment 6

"Venting may release explosive gas mixtures as a result of supersaturated hydrogenated fluid in the primary systems. Accordingly, personnel safety issues may be raised as a result of the new venting requirements. The gas may not necessarily be in the form of a pocket within the piping system but rather may simply release from the fluid when exposed (vented) to atmospheric conditions."

NRC Staff Response to Duke Comment 6

As previously stated, the GL does not provide new requirements although new requirements may result during resolution of issues identified in the GL and the GL Enclosure. The potential for hydrogen is identified at the end of the GL Enclosure and the NRC staff concluded this was sufficient to address **Duke Comment 6.**

Exelon Comment

"Exelon/AmerGen support the comments submitted by the Nuclear Energy Institute (NEI) on behalf of the industry in its letter dated July 23, 2007."

NRC Staff Response to Exelon Comment

See NRC staff responses to NEI comments, below.

NEI Comment 1

"An industry review of the proposed generic letter was conducted and it has been determined that while the proposed Requested Actions may address ECCS gas intrusion, the proposed text could be misinterpreted. The intent of the Requested Actions to confirm system operability is acceptable; however, the choice of words ("minimized" and "monitored") could lead to unreasonable interpretations in light of the examples provided within the Discussion section of the proposed generic letter. Generally "minimized" means striving to the absolute minimum amount; this is not necessary. Likewise "monitored" could imply continuously recording; this is beyond the frequency necessary to confirm operability."

NRC Staff Response to NEI Comment 1

The REQUESTED ACTIONS statement has been rewritten as described in the **NRC Staff Response to NEI Comments 1 and 4,** below. The words "minimized" and "monitored" are no longer used.

NEI Comment 2

"The proposed generic letter implies in some areas that the piping in the subject systems must be "full of water" and air intrusion must be "precluded" to satisfy the systems design basis. The Discussion section, page 13, item (2) implies that the accumulation of gas is an unacceptable condition; however, the Technical Specification bases for the referenced Surveillance Requirements from the BWR 6 Standard Technical Specification (NUREG 1434) states:

'The 31 day Frequency is based on operating experience, on the procedural controls governing system operation, and on the gradual nature of void buildup in the ECCS piping.'

Similar words are in each standard Technical Specifications. This recognizes that some accumulation of gas is expected. Since systems are capable of accepting some amount of gas with negligible effect on their function, use of the absolute limits implied are unnecessary and may not be possible to achieve. The ability of a piping and pumping system to pass some gas acceptably can be a function of the specifics of a plant's pump and piping system; therefore, the system's ability can be open to interpretation."

NRC Staff Response to NEI Comment 2

The rewritten **DISCUSSION** Section of the GL is intended to address **NEI Comment 2.**

NEI Comment 3

"Also, in the Discussion section, it appears that the Staff is expecting that every venting performed by the plant needs to be documented even when the venting is preventive in nature. The quantity of gas vented could be difficult to quantify and may not be of much value in most cases. As discussed in the proposed generic letter and the NRC memorandum referenced on page 15, (Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability, ML071030382, April 17, 2007), the measurement of air volume is not straightforward and the affect of air in the system is uncertain. Periodic venting that results in gas in amounts that do not affect the operability of the system should only be tracked for trending purposes, not established as absolute limits or repeatedly minimized."

NRC Staff Response to NEI Comment 3

The discussion section of the has been rewritten as follows:

(3) **Testing.** Criteria V and XI of Appendix B to 10 CFR Part 50 and the operating license require licensees to perform testing using written test procedures that incorporate the requirements and acceptance limits contained in applicable design and licensing documents and Criterion XVII requires appropriate records. Testing of all segments of piping and components in the subject systems is necessary to confirm acceptance limits and operability unless it has been acceptability established that some items may be excluded. In practice it is not uncommon for licensees to vent gas during periodic surveillances and then conclude the subject systems were and are operable without addressing the pre-venting condition. With the exception of planned draining or maintenance, existence of gas in the system is not consistent with such TSs and FSARs.

NEI Comment 4

"We suggest that the Requested Action section be re-written to be more precise and the Discussion section be revised to be consistent with the above comments. Thus, the proposed generic letter would ask licensees to confirm that gas intrusion is maintained less than the amount that challenges operability and that it is validated, as necessary, to confirm operability."

NRC Staff Response to NEI Comments 1 and 4

The NRC staff has rewritten the **DISCUSSION** Section to include the Licensing Basis, Design, Testing, Operability, and Corrective Actions as principal concerns. The **REQUESTED ACTIONS** statement has been rewritten as follows:

> Each addressee is requested to evaluate their ECCS, DHR system, and containment spray system licensing basis, design, testing, operability, and corrective actions to assure that gas intrusion is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified. The evaluation should include the issues and considerations identified above and in the enclosure to this GL.

And the **REQUESTED INFORMATION** Section has been rewritten to be consistent with the **REQUESTED ACTIONS**:

> Each addressee is requested to provide a description of the results of the evaluations done pursuant to the REQUESTED ACTIONS within 6 months of the date of this GL. This description should provide sufficient information to demonstrate compliance with the quality assurance criteria in 10 CFR 50, Appendix B, Sections III, V, XI, XVI, and XVII and the licensing basis and operating license as those requirements apply to the subject systems.

PWR General Comment

"The PWROG agrees that the subject systems need to be maintained 'sufficiently full of water' to ensure operability, as opposed to 'full of water.' Maintaining the subject systems sufficiently 'full of water' acknowledges that gas intrusion in the subject systems does not necessarily render the system(s) inoperable. The amount and location of the gas are important in determining whether the system(s) are inoperable. In order to develop realistic criteria to determine the amount of gas that could impact operability, several studies need to be completed, such as:

- ✓ Characterizations of the sources and rate of generation of gases in systems
- ✓ Ingestion of gas from tanks and recirculation sumps (vortexing)
- ✓ Characterization of gas transport in the subject system piping as a function of system flow requirements
- ✓ Allowable limits on the ingested gas volume for pump suction piping for assessing pump operability, as well as for the pump discharge piping to alleviate water hammer (slamming check valves or water cannon effect on the piping)
- ✓ Allowable limits on ingested gas volume in pump suction piping to ensure pump operability
- ✓ Allowable limits on ingested gas volume to mitigate dynamic pressure pulsation

✓ Development of guidance on the sequence of venting to prevent void formation in high points remote from the vent location
✓ Identification of those portions of systems in which venting is unnecessary (e.g., downstream of the CS spray isolation valve to the spray headers).

Additionally, studies will have to be completed on gas detection techniques and the associated accuracies."

NRC Staff Response to PWR General Comment

This appears to be an initial list of items the PWROG believes should be addressed to adequately resolve the long-standing issues raised in the GL. The NRC staff believes the work necessary to achieve resolution is best approached by an owners group effort that addresses such items in one or more topical reports. Each addressee could then reference topical reports as part of the plant-specific resolutions. This approach would be consistent with the **REQUIRED RESPONSE** Section of the GL that states that "Within 6 months of the date of this generic letter, an addressee is required to submit a written response consistent with the requested actions and information. If an addressee is unable to provide the information or can not meet the requested completion date, the addressee shall provide a response within 45 days and shall describe the alternative course of action that it proposes to take, including the basis for the acceptability of the proposed alternative course of action." Part of the alternative course of action could be an owners group activity. However, the NRC staff notes that there are other aspects to the alternative course of action that may need to be addressed such as consistency with existing TS and FSAR wording and interim actions to ensure subject system operability.

As indicated above, the information from NRC memorandum referenced in the draft GL, ML071030382, is now provided as an updated enclosure to the GL to reflect comments the NRC staff received following publication in the *Federal Register.* A paragraph has been added to the GL enclosure to reflect the insights provided by the **PWR General Comment.**

PWR Comment 1

"The scope of the above activities suggests that a generic program approach be used. In this respect, the Generic Letter should consider the schedule for completing these activities and also add a provision for the use of interim guidance to address these issues until the generic program can be completed. The PWROG also requests that the schedule for the preparation of the TSTF associated with the Generic Letter consider the schedule for completion of the generic program to ensure that the TSTF is consistent with the guidance developed by the program."

NRC Staff Response to PWR Comment 1

Addressees may reference generic documentation, including generic interim guidance, that has been previously provided to the NRC or they may attach generic documentation when responding to the **REQUESTED INFORMATION** and **REQUIRED RESPONSE** Sections. Consequently, no change is necessary to address the first part of **PWR Comment 1.**

In regard to the last sentence of **PWR Comment 1**, the appropriate NRC staff members are communicating to accomplish this request. This is reflected by Hamm[1] in the following discussion that addresses TSTF scheduling:

> Traveler development would involve incorporating elements of acceptable gas intrusion testing into section 5 of the Standard Technical Specifications (STS). The NRC stated the licensee response times for the GL would likely be at least six months. The TSTF stated that it may not be possible to finalize a Traveler until after licensees had time to respond to the GL. This was consistent with NRC expectations that the TSTF use the information and ideas in the GL responses in formulating the Traveler.

This is discussed further in the **NRC Staff Response to PWR Comment 9.**

PWR Comment 2

"In the first paragraph of the Discussion Section, it is stated that 'venting processes sometimes did not ensure that all gas was removed from the venting location'. Use of the word 'all' conflicts with the statement that the piping should be 'sufficiently full of water'."

NRC Staff Response to PWR Comment 2

The rewritten **DISCUSSION** Section no longer contains this statement.

PWR Comment 3

"In the first paragraph of the Discussion Section, it is stated that the issues include Technical Specifications that 'do not adequately address operability of the subject systems prior to surveillance and for the time span until the next surveillance.' An evaluation of various gas intrusion mechanisms (e.g., check valve leakage, degasification in other high points due to venting at a lower elevation, operation alignments, ... etc.), as well as the potential void growth rate would be required to address the operability of the subject systems between surveillances. See General Comment #1."

NRC Staff Response to PWR Comment 3

The NRC staff agrees with this comment. The rewritten **DISCUSSION** Section and inclusion of detail in the GL enclosure cover these topics.

PWR Comment 4

"In item (3) of the Discussion Section, it is stated that 'In some plants, the relief valve reseating pressure is less than the existing RCS pressure, a condition that complicates recovery.' It is not

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[1]Hamm, Matthew, "Summary of March 22, 2007, Category 2 Meeting with the Technical Specifications Task Force (TSTF) to Discuss the Current Status and Administrative Process for TSTF Submissions, and Future TSTF Submissions," NRC Memorandum to Timothy J. Kobetz, ML070990208, April 18, 2007

understood what is intended by this statement, since if the relief valve opens, the DHR system will not be damaged due to over-pressurization."

NRC Staff Response to PWR Comment 4

Item (3) has been rewritten and expanded as follows to clarify the statement:

> Gas accumulation can result in water hammer or a system pressure transient, particularly in pump discharge piping following a pump start, which can cause piping and component damage or failure. Gas accumulation in the DHR system has resulted in pressure transients that have caused DHR system relief valves to open. In some plants, the relief valve reseating pressure is less than the existing RCS pressure, a condition that complicates recovery. This was encountered, for example, during an event at Sequoyah where a pressure pulse due to gas in RHR discharge piping caused a relief valve to open and rendered both RHR trains inoperable for 6 hours because the relief valve failed to reseat.

PWR Comment 5

"In item (6)(1) of the Discussion Section, it is stated that 'associated surveillance procedures, have not reliably precluded gas problems. Use of the word 'precluded' does not acknowledge that the piping only be 'sufficiently full of water.'"

NRC Staff Response to PWR Comment 5

This is a reference to the paragraph that begins with:

> A review of the operating experience has identified the following concerns, which are the focus of this GL:
>
> (1) TS SRs, as implemented by associated surveillance procedures, have not reliably precluded gas problems.

This list has been reorganized and rewritten to better focus on the principal concerns and to provide a foundation for the required responses. It now addresses the following topics:

(1) **Licensing Basis**
(2) **Design**
(3) **Testing**
(4) **Operability**
(5) **Corrective Actions**

The last few sentences of the above Item (1) now reads as follows:

> There may be some parts of these systems where it is not currently possible or practical to verify them to be full of water. Hence, the current TSs and FSARs may establish a standard that may not be realistic to establish system operability. A realistic licensing basis should bound the volume of gas that may impact pump

operability and the volume for which water-hammer-induced stress limits may be exceeded.

PWR Comment 6

"In item (6)(1) of the Discussion Section, it is stated that 'Although the TS and FSAR at many facilities indicate that the subject systems are full of water, in practice it is not uncommon for licensees to vent some gas during periodic surveillances.' Depending upon the type of maintenance and post maintenance testing that is performed; it would not be unexpected for gas to be vented, since the system may be open to the atmosphere (e.g., depressurized or drained to empty high points in other locations, ... etc.), which would introduce air into the system. Post maintenance venting is preventive. Additionally, if a licensee's Tech Specs include a Surveillance to verify that the piping is full of water, venting some gas may be required to satisfy this surveillance. See General Comment #1."

NRC Staff Response to PWR Comment 6

This is now covered in the above identified Item (1) **Licensing Basis**, which starts with the following paragraph:

> The FSARs at many facilities state that the subject systems are full of water and TSs often require periodic surveillances to confirm this condition. Some plant TSs have incomplete SRs that cover only portions of the system. For example, the TSs may require verifying that ECCS discharge piping is full of water but may not include verification of the suction piping or containment spray piping despite the realistic concern that gas in suction piping may be more serious than gas in discharge piping. In addition, since the subject systems may be rendered inoperable or degraded by gas in any section of piping, the regulations require that presence of gas in all piping be assessed to establish operability.

PWR Comment 7

"In item (6)(1) of the Discussion Section, it is stated that 'Hence, the current TS and FSAR may establish a standard that may not be realistic to establish system operability. A realistic standard should bound the volume of gas that may impact pump operability and the volume for which water-hammer-induced stress limits may be exceeded.' Clarification is needed to distinguish between water hammer and dynamic pressure pulsations in the piping downstream of the pump."

NRC Staff Response to PWR Comment 7

The NRC staff uses "water hammer" to describe any transient pressure condition that is caused by or exacerbated by presence of a void in a system regardless of whether the pressure condition was benign or resulted in structural damage. For example, inspection reports have used the term for conditions where no damage occurred and where pipe hanger or system pressure boundary rupture were concerns. In this sense, a benign pressure pulsation due to a system void is simply a mild water hammer. The NRC staff has clarified its use by adding the following footnote in the GL at the location where "water hammer" is first used:

"Water hammer" refers to any transient pressure condition that is caused by or exacerbated by presence of a void in a system regardless of whether the pressure condition was benign or resulted in structural damage.

PWR Comment 8

"In item (6)(2) of the Discussion Section, it is stated that "Based on the as-found volume and location of gas, corrective actions beyond simply refilling a system may be necessary to provide reasonable assurance that the affected system will remain operable until the next surveillance.' See comment 3."

NRC Staff Response to PWR Comment 8

This wording is now contained in the new Item (5) **Corrective Actions**, that reads as follows:

> Some licensees have treated the accumulation of substantial gas quantities as an expected condition rather than a nonconforming condition and have not documented the condition even when it involved a substantial volume of gas that clearly constituted a significant condition adverse to quality. In such cases, Criterion XVI of Appendix B to 10 CFR Part 50 requires that the cause of the condition be determined and corrective action taken to preclude repetition. Based on the as-found volume and location of gas, corrective actions beyond simply refilling a system may be necessary to provide reasonable assurance that the affected system will remain operable until the next surveillance.

In light of the rewritten discussions in the GL, no further clarification is necessary.

PWR Comment 9

"In item (6)(3) of the Discussion Section, it is stated that 'The NRC staff is initiating a Technical Specifications Task Force (TSTF) activity to address the recognized TS weaknesses associated with gas intrusion concerns.' The NRC should clarify what is meant by this statement, specifically whether the TSTF activity will precede the scheduled completion of the development of a generic program as discussed in General Comment #1, or whether the TSTF activity would follow the completion of such a program."

NRC Staff Response to PWR Comment 9

The referenced item has been rewritten as follows:

> The NRC staff is initiating a Technical Specifications Task Force (TSTF) activity to address the recognized TS weaknesses associated with gas intrusion concerns. The information in the GL and GL responses should be useful in formulating the Traveler and the schedule for the TSTF Traveler development will be consistent with the GL response schedule.

PWR Comment 10

"In item (6)(3) of the Discussion Section, it is stated that 'This condition must be shown to be satisfied during the time between surveillances,' See comment 3."

NRC Staff Response to PWR Comment 10

The rewritten **DISCUSSION** Section and inclusion of detail in the GL enclosure clarifies when operability must be satisfied.

PWR Comment 11

"In the last sentence of the last paragraph of the Discussion Section, it is stated that: 'for guidance in the TSTF program to develop improved TSs.' See comment 9."

NRC Staff Response to PWR Comment 11

See the **NRC Staff Response to PWR Comment 9.**

PWR Comment 12

"In the Requested Actions it is stated: 'to assure that gas intrusion is minimized and monitored in order to maintain system operability'. See General Comment #1."

NRC Staff Response to PWR Comment 12

See the **NRC Staff Response to PWR Comment 1.**

PWR Comment 13

"An alternative to a Technical Specification Surveillance Requirement (SR) with a fixed frequency should be considered. For example, monthly venting for three consecutive months could be performed. If no significant gas was found, the frequency could be extended to a quarterly frequency for three performances, then a 6 month frequency, etc. Detailed analysis for how much gas is acceptable for an operable system should be performed on a case by case basis and not for systems that may not have venting problems."

NRC Staff Response to PWR Comment 13

The PWR owners group will have the opportunity to propose such changes the TS SR as part of Technical Specifications Task Force (TSTF) activity that has been initiated.

PWR Comment 14

"The draft Generic Letter does not consider ALARA. For plants that do not perform routine ECCS venting, there will be a significant increase in routine doses. If no safety benefit is demonstrated after an initial testing program, the ALARA principle would indicate that such testing should be discontinued."

NRC Staff Response to PWR Comment 14

The draft GL, near the end of the DISCUSSION Section, states that "an assessment ... that (1) acceptably eliminates other means of introducing gas, (2) establishes acceptable verification that the lines are essentially full following a condition that reduces the discharge line pressure, and (3) establishes an operating history confirming that gas has not accumulated will be adequate justification for not conducting surveillances inside containment or at locations that constitute a hazard to personnel performing the assessment." The NRC staff's intent was to allow consideration of operating history as part of the basis for not performing system venting. However, if venting is necessary in high radiation zones to maintain operability, then measures should be taken to satisfy ALARA principles such as moving vent valves to low radiation areas.

This detail has been moved from the draft GL to a new GL enclosure. In response to **PWR Comment 14**, the GL enclosure now contains the following wording:

> An assessment for such plants that (1) acceptably eliminates other means of introducing gas, (2) establishes acceptable verification that the lines are essentially full following a condition that reduces the discharge line pressure, and (3) establishes an operating history confirming that gas has not accumulated may be adequate justification for not conducting surveillances inside containment or at locations that constitute a hazard to personnel performing the assessment. For example, some three loop plants designed by Westinghouse maintain high pressure safety injection discharge lines at a pressure greater than the RCS operating pressure. This eliminates the potential for leakage from the accumulators or the RCS as a possible means to introduce gas into the discharge lines. If venting from hazardous locations is necessary to maintain operability, measures such as relocating vent valves could be taken in order to address ALARA principles and personnel safety considerations.

STARS Comment

"The 'Requested Information' section in this draft generic letter is very general and may result in a large variation in the detail of responses. Therefore, it is suggested that the 'Requested Information' section be expanded to be more specific, similar to the approach in previous NRC generic letters."

NRC Staff Response to STARS Comment

Several commenters raised similar concerns. In response, the NRC staff has rewritten the **DISCUSSION** Section to better focus on the principal concerns and to provide a foundation for the required responses. It now addresses the following topics:

(1) **Licensing Basis**
(2) **Design**
(3) **Testing**
(4) **Operability**
(5) **Corrective Actions**

In addition, the sections describing required responses have been rewritten as follows:

REQUESTED ACTIONS

Each addressee is requested to evaluate their ECCS, DHR system, and containment spray system licensing basis, design, testing, operability, and corrective actions to assure that gas intrusion is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified. The evaluation should include the issues and considerations identified above and in the enclosure to this GL.

REQUESTED INFORMATION

Each addressee is requested to provide a description of the results of the evaluations done pursuant to the REQUESTED ACTIONS within 6 months of the date of this GL. This description should provide sufficient information to demonstrate compliance with the quality assurance criteria in 10 CFR 50, Appendix B, Sections III, V, XI, XVI, and XVII and the licensing basis and operating license as those requirements apply to the subject systems.

TVA Comment

"TVA believes that casting the 40 events at Sequoyah mentioned in the subject Federal Register Notice as "waterhammer events" is misleading. In common nuclear industry use, the term waterhammer has the connotation of a large pressure transient that causes significant dynamic loads in the associated piping, subsequent pipe movement, and (in many cases) damage to the piping supports and the piping itself. The subject events at Sequoyah varied widely in magnitude and did not involve violent pipe movement. As mentioned in the draft, the events did not result in Residual Heat Removal (RHR) system inoperability. Rather, most of these events occurred when the Sequoyah RHR system was isolated. In this condition, "out gas" pockets formed within system high points and caused less significant gas bubble compressions. If the generic letter continues to reference the 40 Sequoyah events, the description of these events should be modified to provide a proper context."

NRC Staff Response to TVA Comment

The comment applies to the GL sentence that stated "For example, at least 40 RHR water hammer events have occurred at the Sequoyah Nuclear Plant, although none of them rendered the RHR system inoperable."

As discussed in the response to **PWR Comment 7**, the NRC staff has clarified its meaning of "water hammer" by adding a footnote in the GL. The NRC staff also notes that Sequoyah personnel identified RHR pipe movement due to water hammer in discussions with NRC inspectors, hanger damage was identified that might have been caused by water hammer, and that a pressure pulse event at Sequoyah caused a relief valve to open and rendered both RHR trains inoperable for six hours. However, the NRC staff concluded that the GL sentence was not necessary to establish that gas in the systems of concern needs to be addressed and the sentence has been deleted.

In addressing this comment, the NRC staff recognized an inconsistency in the **BACKGROUND** section. The NRC followup actions were identified in some of the gas issue examples but were omitted in others. This has been corrected by identifying followup actions in all examples.

ENCLOSURE 3
Redline/Strikeout Version of Proposed GL Showing Changes Due to Public Comments

OMB Control No.: 3150-0011

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

NRC GENERIC LETTER 2007-XX: MANAGING GAS INTRUSION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SPRAY SYSTEMS

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this generic letter (GL) to address the issue of gas[1] intrusion into the emergency core cooling, decay heat removal[2], and containment spray systems (hereinafter referred to as the "subject systems"). Specifically, the NRC is issuing this GL:

(1) to request addressees to submit information to demonstrate that the subject systems are in compliance with the current licensing and design bases and applicable regulatory requirements, and that suitable design, operational, and testing control measures are in place for maintaining this compliance, and

(2) to collect the requested information to determine if additional regulatory action is required.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.54(f), addressees are required to submit a written response to this GL.

ML053460427

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[1] Gas as used here includes, air, nitrogen, hydrogen, water vapor, or any other void that is not filled with liquid water.

[2] Decay heat removal (DHR), residual heat removal (RHR), and shutdown cooling (SDC) are common names for systems used to cool the reactor coolant system (RCS) during some phases of shutdown operation. The NRC staff generally uses DHR here.

BACKGROUND

Instances of gas intrusion into the subject systems have occurred since the beginning of commercial nuclear power plant operation. The NRC has published 20 information notices (INs), two GLs, and a NUREG[3] that are related to this issue and has interacted with the nuclear industry many times in relation to these publications and in response to gas intrusion events. The following paragraphs summarize a few events to illustrate some of the technical and regulatory requirements issues.

In May 1997, at Oconee Nuclear Station Unit 3, hydrogen ingestion during plant cooldown damaged and rendered nonfunctional two high-pressure injection (HPI) pumps. If the operators had started the remaining HPI pump, it too would have been damaged. The NRC responded with an augmented inspection team (IN 97-38, "Level-Sensing System Initiates Common-Mode Failure of High-Pressure-Injection Pumps," Agencywide Documents Access and Management System (ADAMS) Accession No. ML031050514, June 24, 1997). The NRC team reported that there had been a total lack of HPI capability during power operation, a failure to meet technical specification (TS) HPI operability requirements, design deficiencies, inadequate maintenance practices, operators that were less than attentive to plant parameters, a failure to adequately assess operating experience, and a violation of 10 CFR Part 50, Appendix B, Criterion III ("Notice of Violation and Proposed Imposition of Civil Penalties ~~-$330-~~ $330,000," August 27, 1997, http://www.nrc.gov/reading-rm/doc-collections/enforcement/actions/reactors/ea97297.html).

As a result of this Oconee Unit 3 event, the industry initiated an industry-wide improvement activity to address the gas issue. Based on the industry actions, the NRC concluded that no generic action was necessary. However, significant gas events that jeopardized the operability of the subject systems continued to occur, as illustrated in the following paragraphs.

Dresden Nuclear Power Station Unit 3 experienced a reactor scram on July 5, 2001, that was accompanied by a water hammer[4] as a result of high pressure coolant injection (HPCI) system voids due to inadequate pipe venting. The licensee discovered a damaged pipe support that rendered the HPCI system inoperable on July 19, 2001. On September 28, 2001, NRC inspectors discovered discrepancies in another HPCI hanger that may have been caused by the water hammer. The licensee repaired the hangers on September 30, 2001, and vented the system. An NRC inspector identified a high point that had not been vented and air was removed when the licensee vented that location. The HPCI system was inoperable from July 5, 2001, to September 30, 2001 (NRC Supplemental Inspection Report 50-237,

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[3]GL 88-17, "Loss of Decay Heat Removal," October 17, 1988 (ML031200496); GL 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," October 7, 1997 (ML031110062); and NUREG-0897, Revision 1, "Containment Emergency Sump Performance—Technical Findings Related to USI A-43," October 1985.

[4]"Water hammer" refers to any transient pressure condition that is caused by or exacerbated by presence of a void in a system regardless of whether the pressure condition was benign or resulted in damage.

50-239/2003-012, ML033530204, December 18, 2003). The NRC found violations of 10 CFR 50.9, a TS, and 10 CFR Part 50, Appendix B, Criterion XVI ("Notice of Violation and Proposed Imposition of Civil Penalty - $60,000, and Final Significance Determination for a White Finding," ML031740755, June 23, 2003).

On June 4, 2003, Quad Cities operators performed a monthly TS surveillance to demonstrate that the 1B core spray pump discharge piping was full of water. The piping was vented for 12 minutes before water flow was observed and the NRC inspectors determined the licensee had failed to provide a correct venting procedure that would ensure continued pump operability. The system engineer estimated that the piping was about one-half empty. A water hammer with the potential to cause damage would have occurred if the core spray pump had been started and the core spray system was determined to be inoperable in the as-found condition. The NRC inspectors also determined that the ECCS surveillance procedures were incorrect, that licensee review in response to the excess gas was inadequate, and that TS 3.0.4 had been violated. This was considered to be a licensee-identified violation, the finding was greater than minor because of the pump inoperability, and the finding was considered to be of very low safety significance because it did not result in an actual loss of function. It was dispositioned as a Non-Cited Violation and entered into the corrective action program. (NRC Inspection Report 50-254/03-05, 50-265/03-05, ML031980621, July 17, 2003).

On August 14, 2003, the Perry Nuclear Power Plant scrammed from 100 percent power due to a loss of offsite power. This caused a momentary loss of common water leg pumps[5] and a discharge pressure decrease from 44 psig to 7 psig allowed accumulated gas to completely void a water leg pump and the associated feedwater leakage control system piping. Pump operation was restored by venting the pump casing but a piping high point that was not included in fill and vent procedures was not vented. On September 10, 2003, the licensee vented enough gas from the high point that would have caused the pump to be non-functional if another loss of offsite power would occur. If the RHR and/or the ~~LPCS~~low-pressure core spray pumps had started while the leakage control system piping was voided, the resulting water hammer could have caused the system piping to rupture. The NRC characterized the inspection finding as white; the finding resulted in a TS violation, escalated enforcement action, and a supplemental inspection (NRC Inspection Report 50-440/2003-009, ML032880107, October 10, 2003, and ML040330980, January 30, 2004).

On July 28, 2004, the Palo Verde licensee identified that emergency core cooling system (ECCS) suction piping voids in all three Palo Verde units could have resulted in a loss of the ECCS during transfer to the recirculation mode for some loss-of-coolant accident (LOCA) conditions. The condition had existed since plant startups in 1986, was contrary to the Palo Verde final safety analysis reports (FSARs), and would not be identified during testing because water is not drawn from the containment emergency sumps. The NRC inspectors identified multiple violations of 10 CFR Part 50, Appendix B, Criteria III and V, and violations of ~~10 CFR Part 50~~10 CFR 50.59. The NRC responded with a special inspection, issued a yellow

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[5]These are 40-gpm pumps used to compensate for back-leakage through check valves in RHR and ~~LPCS~~low-pressure core spray piping into the suppression pool. The purpose is to keep piping full of water where the pipe elevation is higher than the suppression pool. The system is often referred to as a "keep-full" system.

finding, and imposed a civil penalty of $50,000 (NRC Special Inspection Report 50-328, 50-329, 50-330/2004-014, ML050050287, January 5, 2005). The Palo Verde licensee identified the ECCS piping suction voids after being contacted by an engineer from another plant where an NRC inspector identified the same problem.

In February 2005, an HPI pump at Indian Point Energy Center Unit 2 was found inoperable because the pump casing was filled with gas. The licensee then found ~~numerous~~several locations in the ECCS piping with gas accumulation. The licensee did not initially understand the implications of the gas condition, and the licensee's early assessments were inadequate, particularly with respect to assessing the operability of the other two HPI pumps. The NRC conducted a special inspection that found one HPI pump was not functional and the other two HPI pumps had a 75 percent failure probability. The NRC found several violations of 10 CFR 50, Appendix B, Criterion XVI, and issued a white finding (NRC Inspection Report 50-247/2005-006, ML051680119, June 17, 2005).

In March 2005, the NRC reported that Diablo Canyon had a sustained history of gas voiding in piping that could possibly result in gas binding or damage to the centrifugal charging pumps or the HPSI pumps during switchover from cold-leg to hot-leg injection.[6] ~~The~~Ten recent gas voiding occurrences were listed in the inspection report and the NRC inspectors concluded that the licensee focused on managing the symptom of the problem rather than finding and eliminating the cause, which is contrary to 10 CFR 50, Appendix B, Criterion XVI. The finding was more than minor in that the voiding could have caused mitigating equipment to fail but was of very low safety significance because the inspectors concluded there was no loss of function. This was a Non-Cited Violation (NRC Inspection Report 50-275, 50-323/2005-006, ML050910120, March 31, 2005).

In September 2005, operators discovered a void in the HPCI pump discharge piping at the Duane Arnold Energy Center due to "turbulent penetration" that caused hot water from the feedwater pipe to penetrate downward into the HPCI discharge pipe. This heated the HPCI pipe on the low pressure side of a closed valve to greater than the saturation temperature and caused steam to be generated in the low pressure pipe as fast as it was vented. The condition had existed since plant startup (Licensee Event Report 50-331/2005-004, ML053360261, November 28, 2005). The NRC opened an unresolved item (URI 05000331/2006002-03) for further NRC review of the licensee's piping analysis that evaluated HPSI system operability with the voided piping. The condition was determined to be adverse to quality since it was not identified by the licensee and was uncorrected. The issue was found to be of very low safety significance and entered into the corrective action program. The violation was treated as a Non-Cited Violation. (NRC Inspection Report 50-331/2006-002, ML061210448, April 27, 2006, and NRC Inspection Report 50-331/2006-008, ML070640515, March 2, 2007).

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[6]A similar gas accumulation problem under closed valves in the recirculation piping from the DHR discharge to the HPSI and charging pump suctions has occurred at several plants. This has the potential to cause loss of all high pressure RCS makeup capability when shifting suction to the emergency containment sump from the refueling water or borated water storage tank following a LOCA.

In October 2005, an NRC inspection team at the Palo Verde Nuclear Generating Station identified that, following a postulated accident when refueling water tank (RWT) level reached the setpoint for containment sump recirculation, the licensee's design basis credited containment pressure for preventing the ECCS pumps from continuing to reduce RWT level and drawing air into the ECCS. However, a recent licensee analysis showed that the minimum containment pressure would be less than needed. The licensee declared the ECCS inoperable at all three units, requiring a shutdown of Units 2 and 3 (Unit 1 was already shut down). The NRC found multiple violations of 10 CFR 50, Appendix B, Criteria III and V (NRC Supplemental Inspection Report 50-528, 50-529, 50-530/2005-012, ML060300193, ~~January 27~~January 27, ~~2006~~ 2006).

These are a few of the more than 60 gas intrusion events reported ~~during recent years involving the subject systems. The number is larger if other similar events at the same plant are counted. Further, many events do not have to be reported to the NRC, and many of them have not been addressed during the NRC's inspections. For example, at least 40 RHR water hammer events have occurred at the Sequoyah Nuclear Plant, although none of them rendered the RHR system inoperable. Additionally, if an ECCS pump has been damaged because of gas but is repaired and tested operable within the TS completion time (typically, 72 hours), the licensee is not required to report the occurrence to the NRC. The frequency and the significance of these events and the likelihood that unidentified gas issues exist require licensee action to ensure compliance with regulatory requirements that will maintain operability of the subject systems.~~

-since the 1997 Oconee Unit 3 event.

APPLICABLE REGULATORY REQUIREMENTS

The regulations in Appendix A to 10 CFR Part 50 ~~Appendix A~~ or similar plant-specific principal design criteria[7] provide design requirements, and Appendix B to 10 CFR Part 50 ~~Appendix B~~, TSs, and licensee quality assurance programs provide operating requirements. Appendix A requirements applicable to gas management in the subject systems include the following:

- General Design Criterion (GDC) 1 requires that the subject systems be designed, fabricated, erected, and tested to quality standards.
- GDC 34 requires an RHR system designed to maintain specified acceptable fuel design limits and to meet design conditions that are not exceeded if a single failure occurs and specified electrical power systems fail.
- GDC 35, 36, and 37 require an ECCS design that meets performance, inspection, and testing requirements. Specified performance criteria are provided in 10 CFR 50.46.
- GDC 38, 39, and 40 require a containment heat removal system design that meets performance, inspection, and testing requirements.

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[7]For facilities with a construction permit issued prior to May 21, 1972, that are not licensed to Appendix A.

Quality assurance criteria provided in Appendix B that apply to gas management in the subject systems include the following:

- Criteria III and V require measures to assure that applicable regulatory requirements and the design basis, as defined in 10 CFR 50.2, "Definitions," and as specified in the license application, are correctly translated into controlled specifications, drawings, procedures, and instructions.

- Criterion XI requires a test program to assure that the subject systems will perform satisfactorily in service. Test results shall be documented and evaluated to assure that test requirements have been satisfied.

- Criterion XVI requires measures to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified, corrected, documented, and reported to management.

- Criterion XVII requires maintenance of records of activities affecting quality.

Further, as part of the licensing basis, licensees have committed to certain quality assurance provisions that are identified in both their TSs and quality assurance programs. Licensees have committed to use the guidance of Regulatory Guide (RG) 1.33, Revision 2 (February 1978), "Quality Assurance Requirements (Operation)," which endorses American National Standards Institute (ANSI) N18.7-1976/American Nuclear Society 3.2, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants," or equivalent licensee-specific guidance. Section 5.3.4.4, "Process Monitoring Procedures," of ANSI N18.7 that states that procedures for monitoring performance of plant systems shall be required to assure that engineered safety features and emergency equipment are in a state of readiness to maintain the plant in a safe condition if needed. The limits (maximum and minimum) for significant process parameters shall be identified. Operating procedures shall address the nature and frequency of this monitoring, as appropriate.

10 CFR 50.36 (c)(3) defines TS surveillance requirements (SRs) as "relating to test, calibration, or inspection to assure" maintenance of quality, operation within safety limits, and operability. Typically, TS Section 5 or 6 requires that licensees establish, implement, and maintain written procedures covering the applicable procedures recommended in Appendix A to RG 1.33, ~~Revision 2 (February 1978)~~. Appendix A to RG 1.33 identifies instructions for filling and venting the ECCS and DHR system, as well as for draining and refilling heat exchangers. Surveillance requirements to verify that at least some of the subject system piping is filled are provided in standard ~~technical specifications (STSs)~~TSs and in most licensee TSs.

DISCUSSION

The events discussed in the BACKGROUND section illustrate that ~~many~~several of the regulatory requirements identified in the APPLICABLE REGULATORY REQUIREMENTS section ~~are~~were not being met. ~~The NRC inspectors often find that the 10 CFR Part 50 Appendix B criteria identified above are not adequately addressed in plant venting procedures.~~

In some cases, venting procedures were almost nonexistent, there were no records of gas quantities that were vented and licensees unsuccessfully attempted to recreate the history by asking operators for their recollections. Consequently, there was no foundation for establishing that the subject systems were operable prior to venting. In addition, the venting processes sometimes did not ensure that all gas was removed from the venting location and often did not adequately establish the quantity of vented gas. Further, examination of ultrasonic test (UT) processes at several licensee sites established that one licensee initially did not know how to acceptably determine liquid level via UT. Additional issues include TSs, which often do not require venting of suction piping despite voids in suction pipes generally being of more concern than in discharge piping, and do not adequately address operability of the subject systems prior to surveillance and for the time span until the next surveillance. This GL and the anticipated NRC followup to this GL are intended to correct such conditionsThose requirements in the operating license and regulations require adequate design, tests, procedures, records and corrective actions whereas operating experience and NRC inspections have revealed inadequate designs, test programs, procedures, test result documentation and corrective actions at licensed facilities. This GL requires licensees to provide information on methods used to comply with these NRC requirements. The NRC will evaluate this information to determine if further regulatory action is necessary to assure compliance.

It is important that the subject systems are sufficiently filled with water to ensure that they can reliably perform their intended functions under all LOCA and non-LOCA conditions that require makeup to the RCS. Portions of these systems and some of the associated pumps are normally in a standby condition while other pumps provide both ECCS and operational functions. For example, some high-pressure pumps are used for normal RCS makeup, and some low-pressure pumps provide a normal DHR capability. The following safety issues are associated with gas intrusion into the subject systems:

The following examples illustrate how inadequate gas control can have safety implications:

(1) The introduction of gas into a pump can cause the pump to become air-bound with little or no flow, rendering the pump inoperable. Air-binding can render more than one pump inoperable when pumps share common discharge or suction headers, or when the gas accumulation process affects more than one train, greatly increasing the risk significance. Such a common-mode failure would result in the inability of the ECCS or the DHR system to provide adequate core cooling and the inability of the containment spray system to maintain the containment pressure and temperature below design limits. An air-bound pump can become damaged quickly, eliminating the possibility of recovering the pump during an event by simply subsequently venting the pump and suction piping.

(2) Gas introduced into a pump can render the pump inoperable, even if the gas does not air bind the pump, because the gas can reduce the pump discharge pressure and flow capacity to the point that the pump cannot perform its design function. For example, an HPI pump that is pumping air-entrained water may not develop sufficient discharge pressure to inject under certain small break LOCA scenarios.

(3) Gas accumulation can result in water hammer or a system pressure transient, particularly in pump discharge piping following a pump start, which can cause piping and component damage or failure. Gas accumulation in the DHR system has resulted in pressure transients that have caused DHR system relief valves to open. In some plants, the relief valve reseating pressure is less than the existing RCS pressure, a condition that complicates recovery.

~~(4)~~ ~~Pump~~ This was encountered, for example, during an event at Sequoyah where a pressure pulse due to gas in RHR discharge piping caused a relief valve to open and rendered both RHR trains inoperable for 6 hours because the relief valve failed to reseat.

(4) Unbalanced loads due to entrained gas and the reduction in inlet pressure at a pump due to gas in a vertical suction line that causes pump cavitation ~~caused by entrained gas~~can result~~s~~ in additional stresses that~~-can~~ lead to premature failure of pump components~~-that can render the pump inoperable~~.

(5) Gas intrusion can result in pumping noncondensible gas into the reactor vessel that may affect core cooling flow.

(6) The time needed to fill voided discharge piping can delay delivery of water beyond the time frame assumed in the accident analysis.

The ~~scope and~~ number of identified gas intrusion problems and their significance at some facilities raise concerns about whether similar unrecognized design, configuration, and operability problems exist at other ~~reactor~~ facilities.

-A review of the operating experience has identified the following principal concerns, which are the focus of this GL:

(1) ~~TS SRs, as implemented by associated surveillance procedures, have not reliably precluded gas problems. Operating experience shows many instances in which substantive gas voiding in the system piping has not been identified. The surveillance procedures may not reliably reveal as-found conditions in which the system may be inoperable or degraded because of gas. Additionally, some plants have no TS SR to verify~~**Licensing Basis.** The FSARs at many facilities state that the subject ~~systems' piping is sufficiently full of water. Still other plants~~systems are full of water and TSs often require periodic surveillances to confirm this condition. Some plant TSs have incomplete~~-TS~~ SRs that cover only portions of the system. For example, the TSs may require verifying that ECCS discharge piping is full of water but may not include verification of the suction piping or containment spray piping~~. Although the TS and FSAR at many facilities indicate that~~ despite the realistic concern that gas in suction piping may be more serious than gas in discharge piping. In addition, since the subject systems ~~are full of water, in practice it is not uncommon for licensees to vent some gas during periodic surveillances. Further, there~~may be rendered inoperable or degraded by gas in any section of piping, the regulations require that presence of gas in all piping be assessed to establish operability. There may be some parts of these systems where it

is not currently possible or practical to verify them to be full of water. Hence, the current TSs and FSARs may establish a standard that may not be realistic to establish system operability. A realistic standardlicensing basis should bound the volume of gas that may impact pump operability and the volume for which water-hammer-induced stress limits may be exceeded.

Criterion(2) **Design.** Criterion III of Appendix B to 10 CFR Part 50 and the operating license identify regulatory requirements for the design of the subject systems. The failure to translate the design basis, such as the system maintained full of water, into drawings, specifications, procedures, and instructions would be contrary to Criterion III of Appendix B of 10 CFR Part 50. Subject system designs vary widely regarding potential gas sources and capability to control gas. Potential gas sources and symptoms of gas leakage from these sources should be identified and potential gas accumulation locations should be known and provisions made to address gas accumulation at these locations. The NRC staff has observed high point vents that were not located at actual high points, non-existent vents where drawings showed vents existed, and failure to provide vents or methods for controlling gas at high points. The NRC staff also notes that drawings and isometric diagrams often show piping as level whereas as-installed piping is sloped.

(3) **Testing.** Criteria V and XI of Appendix B to 10 CFR Part 50 and the operating license requires licensees to perform testing using written test procedures, which include but are not limited to procedures for TS SRs, that incorporate the requirements and acceptance limits contained in applicable design and licensing documents. TSs often require surveillance of discharge piping but do not mention suction piping. Consequently, suction piping surveillances may not be performed. However, since and Criterion XVII requires appropriate records. Testing of all segments of piping and components in the subject systems is necessary to confirm acceptance limits and operability unless it has been acceptability established that some items may be excluded. In practice it is not uncommon for licensees to vent gas during periodic surveillances and then conclude the subject systems may be rendered inoperable or degraded because of gas in suction piping, the regulations require that presence of gas in all piping be assessed to establish operability.

(2) Typically the FSAR describes thatwere and are operable without addressing the pre-venting condition. With the exception of planned draining or maintenance, existence of gas in the system is not consistent with such TSs and FSARs.

(4) **Operability.** The operating license and licensing basis identify regulatory requirements for the operation of the subject systems are filled with water. The wording of TS SRs further confirms that the design-basis configuration calls for the specified piping to be filled with water. Operating experience provides many examples of licensees treating. Operability is required during operational modes defined in TSs when in the specified modes with the exception of allowed outage times. Surveillance and testing that do not

ensure operability prior to a surveillance, at the time of the surveillance, and for the time period until the next surveillance are not consistent with this requirement.

(5) **Corrective Actions.** Some licensees have treated the accumulation of substantial gas quantities as an expected condition (rather than a nonconforming condition) that was and have not documented the condition even when it involved a substantial volume of gas that clearly constituted a significant condition adverse to quality. In such cases, Criterion XVI of Appendix B to 10 CFR Part 50 requires that the cause of the condition be determined and corrective action taken to preclude repetition. Based on the as-found volume and location of gas, corrective actions beyond simply refilling a system may be necessary to provide reasonable assurance that the affected system will remain operable until the next surveillance.

(3) Although the subject systems are often susceptible to gas intrusion, not all plants have vent valves at one or more system high points. Some licensees have installed additional vent valves at system high points after operational events. For example, one licensee installed an additional 21 high-point vent valves. Another licensee, who installed an additional 17 vent valves, determined that the primary cause of the gas voiding problem was that the original design specification did not call for a sufficient number of vent valves. No specific NRC requirement mandates the installation of vent valves on the subject systems. However, failure to translate the design basis of assuring the system is maintained sufficiently full of water to maintain operability into drawings, specifications, procedures, and instructions is a violation of Criterion III in Appendix B of 10 CFR Part 50.

Further, Criterion V requires documented instructions, procedures, or drawings that include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished. This means that each addressee must have suitable documentation and records, including acceptance criteria, to establish that the subject systems have been and are maintained sufficiently full of water to ensure system operability. Vent valves and their use are often a key ingredient for satisfying these requirements.

The NRC staff is initiating a Technical Specifications Task Force (TSTF) activity to address the recognized TS weaknesses associated with gas intrusion concerns. In the interim, until new TSs are developed, the NRC staff will treat a SR that the piping be full of water as satisfied if the piping and pumps of the subject systems are maintained sufficiently full of water to ensure system operability when operability is required. This condition must be shown to be satisfied during the time between surveillances, and either venting or UT surveillances are acceptable means of obtaining void data. Further, the NRC staff will consider justification for not conducting a periodic surveillance or for extending the time between surveillances of certain sections of piping if an addressee considers surveillance to be unnecessary. For example, some three-loop plants designed by Westinghouse maintain HPSI discharge lines at a pressure greater than the RCS operating pressure. This eliminates the potential for leakage from the accumulators or the RCS as a possible means to introduce gas into the discharge lines. An assessment for such plants that (1) acceptably eliminates other means of introducing gas, (2) establishes acceptable verification that the lines are essentially full following a condition that reduces the discharge line pressure, and (3) establishes an operating history confirming that gas has not accumulated will be adequate justification for not conducting surveillances inside containment or at locations that constitute a hazard to personnel performing the assessment.

The NRC memorandumThe information in the GL and GL responses should be useful in formulating the Traveler and the schedule for the TSTF Traveler development will be consistent with the GL response schedule.

The enclosure to this GL, "Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability," ML071030382, April 17, 2007, provides some operating experience insights. Theprovides additional information. Addressees should consider this information when preparing responses to this GL. Further, the NRC staff plans to use this information during inspection activities that are being planned as a followup to this GL and for guidance in the TSTF program to develop improved TSs.

REQUESTED ACTIONS

Each addressee is requested to evaluate their ECCS, DHR system, and containment spray system designslicensing basis, design, testing, operationoperability, and test procedurescorrective actions to assure that gas intrusion is minimized and monitored in order to maintain system operability and compliance with the requirements of Appendix B to 10 CFR 50.

ed less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified. The evaluation should include the issues and considerations identified above and in the enclosure to this GL.

REQUESTED INFORMATION

Each addressee is requested to provide a summary description of howthe results of the evaluations done pursuant to the REQUESTED ACTIONS have been addressed within 6 months of the date of this GL. This summary description should specifically addressprovide sufficient information to demonstrate compliance with the quality assurance criteria in 10 CFR 5010 CFR 50, Appendix B, Sections III, V, XI, XVI, and XVII and the TSs thatlicensing basis and operating license as those requirements apply to the subject systems. This summary should include a general description of: (1) the design, (2) the operating procedures, and (3) the test procedures to assure that gas intrusion does not affect the ability of the subject systems to perform their intended functions.

If an addressee determines that system or procedure modifications are necessary based on the review of the requested actions and these changes cannot be accomplished within 6 months of the date of this GL, then the addressee should also provide a plan and schedule for completion of these actions.

-REQUIRED RESPONSE

In accordance with 10 CFR 50.54(f), in order to determine whether a facility license should be modified, suspended, or revoked, or whether other action should be taken, an addressee is required to respond as described below.

Within 6 months of the date of this generic letter, an addressee is required to submit a written response ~~if they are~~consistent with the requested actions and information. If an addressee is unable to provide the information or ~~they~~ can not meet the requested completion date~~. T~~, the addressee ~~must address in its~~shall provide a response ~~any~~within 45 days and shall describe the alternative course of action that it proposes to take, including the basis for the acceptability of the proposed alternative course of action.

The required written response should be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, 11555 Rockville Pike, Rockville, MD 20852, under oath or affirmation under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f). In addition, submit a copy of the response to the appropriate regional administrator.

REASONS FOR INFORMATION REQUEST

The NRC is requesting this information because a review of operating experience and NRC inspection results shows ~~numerous~~several recent instances of gas intrusion events involving the subject systems that have rendered or potentially rendered these risk-significant systems inoperable.

RELATED GENERIC COMMUNICATIONS

Document Number	Document Name	ADAMS Accession No
GL 88-17	Loss of Decay Heat Removal	ML031200496
GL 97-04	Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps	ML031110062
IN 86-63	Loss of Safety Injection Capability	ML031250058
IN 86-80	Unit Startup with Degraded High Pressure Safety Injection System	ML031250214
IN 87-63	Inadequate Net Positive Suction Head in Low Pressure Safety Systems	ML031180034
IN 88-23 IN 88-23, Supp. 1 IN 88-23, Supp. 2 IN 88-23, Supp. 3 IN 88-23, Supp. 4	Potential for Gas Binding of High-Pressure Safety Injection Pumps During a Loss-of-Coolant Accident	ML031150208 ML881230018 ML900125002 ML901204023 ML921215001
IN 88-74	Potentially Inadequate Performance of ECCS in PWRs during Recirculation Operation Following a LOCA	ML031150118

Document Number	Document Name	ADAMS Accession No
IN 89-67	Loss of Residual Heat Removal Caused by Accumulator Nitrogen Injection	ML031180745
IN 89-80	Potential for Water Hammer, Thermal Stratification, and Steam Binding in High-Pressure Coolant Injection Piping	ML031190089
IN 90-64	Potential for Common-Mode Failure of High Pressure Safety Injection Pumps or Release of Reactor Coolant Outside Containment During a Loss-of-Coolant Accident	ML031103251
IN 91-50	A Review of Water Hammer Events after 1985	ML031190397
IN 94-36	Undetected Accumulation of Gas in Reactor System	ML031060539
IN 94-76	Recent Failures of Charging/Safety Injection Pump Shafts	ML031060430
IN 95-03	Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition	ML031060404
IN 96-55	Inadequate Net Positive Suction Head of Emergency Core Cooling and Containment Heat Removal Pumps under Design Basis Accident Conditions	ML031050598
IN 96-65	Undetected Accumulation of Gas in Reactor Coolant System and Inaccurate Reactor Water Level Indication During Shutdown	ML031050500
IN 97-38	Level-Sensing System Initiates Common-Mode Failure of High Pressure Injection Pumps	ML031050514
IN 97-40	Potential Nitrogen Accumulation Resulting from Back-Leakage from Safety Injection Tanks	ML031050497
IN 98-40	Design Deficiencies Can Lead to Reduced ECCS Pump Net Positive Suction Head During Design-Basis Accidents	ML031040547
IN 02-15 IN 02-15 Supp. 1	Potential Hydrogen Combustion Events in BWR Piping	ML020980466 ML031210054
IN 02-18	Effect of Adding Gas Into Water Storage Tanks on the Net Positive Suction Head for Pumps	ML021570158
IN 06-21	Operating Experience Regarding Entrainment of Air Into Emergency Core Cooling and Containment Spray Systems	ML062570468

-BACKFIT DISCUSSION

Under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, this GL requests a review and appropriate resulting actions for the purpose of assuring compliance with applicable existing requirements. No backfit is either intended or approved by the issuance of this GL. Therefore, the NRC staff has not performed a backfit analysis.

***FEDERAL REGISTER* NOTIFICATION**

~~To be done after the~~A notice of opportunity for public comment ~~period~~on this generic letter was published in the *Federal Register* (72 FR 29010) on May 23, 2007. Seven sets of comments were received, all from the nuclear industry. The NRC staff considered all comments that were received. The NRC staff's evaluation of the comments is publicly available through the NRC's Agencywide Documents Access and Management System (ADAMS) under Accession No. ML072410212.

CONGRESSIONAL REVIEW ACT

In accordance with the Congressional Review Act, the NRC has determined that this GL is not a major rule and the Office of Information and Regulatory Affairs of the Office of Management and Budget has confirmed this determination.

PAPERWORK REDUCTION ACT STATEMENT

This GL contains an information collection that is subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). The Office of Management and Budget approved this information collection under clearance number 3150-0011 which expires on June 30, 2010.

The burden to the public for this mandatory information collection is estimated to average 300 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. ~~The NRC is seeking public comment on the potential impact of the information collection contained in the GL and on the following issues:~~

~~1. Is the proposed information collection necessary for the proper performance of the functions of the NRC, including whether the information will have practical utility?~~

~~2. Is the estimate of burden accurate?~~

~~3. Is there a way to enhance the quality, utility, and clarity of the information collected?~~

~~4. How can the burden of the information collection be minimized, including the use of automated collection techniques?~~

Send comments on any aspect of this information collection, including suggestions for reducing the burden, to the Records and FOIA/Privacy Services Branch (T5-F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by Internet electronic mail to infocollects@nrc.gov; and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0011), Office of Management and Budget, Washington, DC 20503.-

~~**-PUBLIC PROTECTION NOTIFICATION**~~

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.-

-CONTACT

Please direct any questions about this matter to the technical contact or the Lead Project Manager listed below, or to the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Warren C. Lyon, NRR
301-415-2897
e-mail: wcl@nrc.gov

Lead Project Manager: David P. Beaulieu, NRR
301-415-3243
e-mail: dpb@nrc.gov

Enclosure:

"Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability"

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

~~**PUBLIC PROTECTION NOTIFICATION**~~

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CONTACT

Please direct any questions about this matter to the technical contact or the Lead Project Manager listed below, or to the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Warren C. Lyon, NRR
301-415-2897
e-mail: wcl@nrc.gov

Lead Project Manager: David P. Beaulieu, NRR
301-415-3243
e-mail: dpb@nrc.gov

Enclosure:

"Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability"

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*With comments that have been addressed in the report revision.

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Technical Considerations for Reasonably Assuring Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems Operability

Overview

This enclosure provides a discussion of some of the technical issues that should be considered when evaluating the design, operability, testing, and corrective actions for gas intrusion concerns in emergency core cooling, decay heat removal, and containment spray systems.

Gas accumulation in the subject nuclear power plant systems can cause water hammer, gas binding in pumps, and inadvertent relief valve actuation that may damage pumps, valves, piping, and supports and may lead to loss of system operability. Consequently, these systems are equipped with vents, and some of the subject systems have keep-full systems that are intended to avoid these problems by maintaining them full of water. However, as summarized in this generic letter (GL), history has shown that the subject systems, as designed and maintained, have been exposed to gas accumulations sufficient to cause potential and actual loss of operability. This enclosure provides insights that addressees should consider when responding to the GL.

The root causes of gas accumulation include poor designs that allow gas introduction and accumulation, licensees failing to properly fill and vent the system following drain-down or maintenance, ineffective controls on gas accumulation during operation, inappropriate technical specifications (TSs), and, in some cases, unanticipated problems with keep-full systems.

The correct objective of gas control measures is to limit the volume of gas accumulation to a quantity that does not jeopardize system operability. An acceptable volume depends on a variety of factors including, but not necessarily limited to, the location, the type of pump, the net positive suction head (NPSH) margin, the gas volume fraction at the pump impeller, and the flow rate. A gas volume downstream of an emergency core cooling system (ECCS) pump that would not cause a loss of system function might cause a pump failure if located upstream of the pump.

The amount and location of gas are important in addressing system operability. Additional work is necessary to develop realistic criteria to determine the amount of gas that could impact operability including:

- Characterizations of the sources and rate of generation of gases in systems,
- Ingestion of gas from tanks and recirculation sumps[8] (vortexing),
- Characterization of gas transport in the subject system piping as a function of system flow requirements,

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[8]This includes potential gas accumulation downstream of containment emergency sump screens and post-accumulation transport.

- Allowable limits on ingested gas volume in pump suction piping to ensure pump operability, as well as for the pump discharge piping to alleviate water hammer concerns such as slamming check valves or a water cannon effect on the piping,

- Allowable limits on ingested gas volume to mitigate dynamic pressure pulsation,

- Development of guidance on the sequence of venting to prevent void formation in high points remote from the vent location,

- Identification of those portions of systems in which venting is unnecessary such as downstream of the CS spray isolation valve to the spray headers,

- Evaluation of gas detection techniques and the associated accuracies.

This GL enclosure addresses the following six topics:

(1) sources of gas
(2) gas accumulation locations
(3) determination of gas quantity
(4) water hammer and acceptable gas quantity
(5) pump operation and acceptable gas quantity
(6) control of gas

(1) Sources of Gas

Some sources of gas include:

- leakage from accumulators;

- leakage from the reactor coolant system (RCS);

- outgassing of dissolved gas because of a pressure reduction such as through control valves, orifices, and emergency sump screens, or due to elevation changes or venting;

- draining, system realignments, incorrect maintenance procedures, and failure to follow procedures;

- failure of level instruments to indicate correct level;

- leakage through test header valves;

- leakage through faulty vent system components when local pressure is less than the nominal downstream pressure;

- temperatures at or above saturation temperature; and

- vortexing in suction sources or gas introduced from suction sources.

Gas in discharge piping can be an indicator of potential backleakage from high-pressure sources such as accumulators or the RCS, and the gas may have moved into the pumps and the pump suction piping. Such gas may have flowed through multiple closed in-series valves. For this reason, it is important to reassess gas accumulation conditions following system operations and valve manipulations. In addition, many plants have a dozen or more test valves that connect to a common header and provide multiple potential leak paths. For example, the gas accumulation rates at the Sequoyah Nuclear Plant were significantly reduced in 2002 by test header valve maintenance and, at Indian Point Energy Center Unit 2, the test header provided a leakage pathway through multiple closed valves into both high-pressure injection (HPI) lines in January 2005.

Some pressurized-water reactors (PWRs) have experienced gas accumulation due to outgassing in charging pump bypass orifices. Installing multiple-stage orifices essentially eliminated the problem by reducing the pressure drop at each orifice to reduce or eliminate non-equilibrium conditions that caused local gas generation.

(2) Gas Accumulation Locations

Some locations where gas can accumulate include:

- in high points in pipe runs, including elevation variation in nominally horizontal pipes;
- under closed valves;
- in decay heat removal (DHR)[9] system heat exchanger U-tubes;
- in horizontal pipe diameter transitions that introduce traps at the top of the larger pipe;
- in tees where gas in flowing water can pass into a stagnant pipe where it accumulates;
- in valve bonnets
- in pump casings; and
- in piping when the temperature is at or above the saturation temperature.

Some locations, such as tees, horizontal pipes, and valve bonnets, are commonly overlooked. Gas accumulation due to separation of liquid and gas at a tee has caused significant problems. In some PWRs, gas accumulates under the isolation valve in the crossover piping between the DHR pump discharge to the suction of the HPI pumps where there are no vents. The crossover piping is especially vulnerable because system testing usually does not involve flow through that location and licensees may not have correctly determined the acceptable gas volume.

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[9]DHR, residual heat removal (RHR), and shutdown cooling (SDC) are common names for systems used to cool the reactor coolant system (RCS) during some phases of shutdown operation.

Further, some TS surveillance requirements (SRs) do not specify suction piping. Often, licensees consider the crossover piping to be suction piping that does not have to be checked for gas.

Gas accumulation can be exacerbated by failure to adequately determine actual system high points and failure to have vents where gas accumulates. For example, plant isometric drawings sometimes indicate that a length of pipe is horizontal, but an in-plant examination may reveal that the pipe is sloped, sometimes by several inches. This is an important consideration for vent locations and for using ultrasonic testing (UT) to determine gas volume.

(3) Determination of Gas Quantity

Some common methods to determine gas quantity in the subject systems are to measure the volume of gas released through vents or to determine the gas volume by UT.

Some hard-piped vents exhaust at a remote location or into a vent manifold where it is difficult to determine whether any gas was released. Closed systems may have sight glasses for observing bubbles. When the flow rate is adequate to force the gas from the high point down through the vent line to a clean sight glass, and the venting period is long enough for the gas to have traveled through the sight glass, personnel can tell if all gas has been removed. However, it is difficult to accurately determine the volume of gas removed. In some cases, vent flow is passed into a test header with a flow meter, but the accuracy of this method of determining gas quantity is difficult to establish. Vents consisting of a valve with a removable blind flange immediately downstream of the valve allow the effluent to be observed and are often used in conjunction with other means to determine the vented volume. Procedures should cover venting and post-venting actions such as recording observations and/or gas volumes and should ensure a followup if specified criteria related to the gas volume are not met.

Several conditions may effect the accuracy of a vented volume determination. In some locations, venting changes the pressure, and a volume estimate based on venting time may therefore be in error because the venting rate is not constant. In some cases, opening and closing or repositioning the throttle valve during venting may affect timing. Gas and water vapor released from the liquid during depressurization may also affect volume determinations. Saturated water vapor will superheat when pressure decreases and will condense if exposed to a temperature below the saturation temperature. Saturated water may boil during venting when pressure is decreased. These conditions may result in a misleading assessment of gas quantity if the behavior is not recognized.

Other methods of determining gas volume are available. UT can provide accurate gas volumes regardless of vent locations. A known volume of water can be injected into an isolated section of piping (or a heat exchanger) and the void can then be calculated from the known pressures and injected volume. Another method is to record DHR system flow rate behavior immediately following pump start to estimate gas volume in the DHR system discharge piping. NRC Special Inspection Report 50-400/02-06 stated that this method is useful in determining whether the DHR heat exchangers are void free. This has been used at Sequoyah. When a DHR pump was started for testing with the DHR system configured for injection into the RCS, the flow rate indicated on a local gauge immediately downstream of the DHR pump should increase approximately linearly for the first 8 seconds as the minimum flow line flow control valve opens and should then level off at approximately 550 gallons per minute (gpm) if there is no gas volume downstream of the pump. In this case, there is no actual injection since the RCS pressure is higher than the DHR system pump discharge pressure and the flow is through the minimum flow line. With gas present, the flow rate typically increases more rapidly to a value greater than approximately 550 gpm and then decreases to approximately 550 gpm within roughly 20 seconds.

The accuracy necessary for void determination is also of interest. An approximate void determination method will be adequate when the anticipated void is significantly removed from an operability concern based on the historical record and, in that case, recording a parameter that is indicative of the void quantity would be sufficient. Anticipation of more significant voids, sudden increases in void accumulation rate, or observation of other plant behavior such as decreasing accumulator level may require more accurate means to obtain the void size and/or a reduction in time between surveillances[10].

With respect to accuracy, UT can provide a quantitative datum that, when considered in combination with temperature and pressure within a pipe, will yield an accurate void volume. Use of vent valves to obtain a pre-test void volume is more difficult and is often more qualitative. Time to vent to obtain a clear liquid stream, with an acceptance criterion conservatively determined from a correlation of vent time to an acceptable volume for each vent location, may be adequate for trending purposes when anticipated vented volumes are clearly well removed from a region of concern. Volumes that are close to impacting operability may require more sophisticated measurement.

(4) Water Hammer and Acceptable Gas Quantity

A principal water-hammer concern is the sudden pressure increase in the pump discharge piping and associated components when systems are put into service. Another concern is pressurization of the DHR system when it is initially connected to the RCS when the RCS pressure is near the DHR system relief valve set pressure. A small pressure perturbation because of a minor water hammer can open DHR system relief valves, which then might fail to close. The relief valve reseating pressure could be less than the RCS pressure, which complicates recovery. Therefore, it is particularly important to initiate DHR system operation by a process that minimizes the potential to cause a pressure pulse. However, application of such techniques must be carefully considered if used for performing surveillances to assess operability. During testing, any proceduralized deviation from normal system operation must be evaluated for the potential to cause unacceptable preconditioning. If the ECCS must start and operate under accident conditions without benefit of pressure-pulse-reducing techniques, then it should be tested in a manner that demonstrates it is capable of doing so without those techniques.

(5) Pump Operation and Acceptable Gas Quantity

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[10]Variation of time between surveillances is discussed in Item (6).

The amount of gas that can be ingested without a significant impact on pump operability and reliability is not well established. It is known to depend on pump design, gas dispersion, and flow rate. The presence of gas is undesirable because gas may initiate a long-term failure mechanism such as shaft fatigue, wear ring degradation, bearing wear, or seal wear. Unfortunately, a no-gas condition during initial pump operation or following alignment changes cannot be assured in practice, and the operational goal should be to minimize the amount of gas consistent with the requirement that operability must be reasonably assured.

A single-stage pump, such as a DHR system pump with significant clearances between moving parts, can often withstand a large slug of gas that completely stops flow, and the pump may be restored to operation when the gas is removed. However, in some cases, physical pump failure has occurred after ingesting gas. A similar no-flow or reduced-flow condition with a multistage pump that has close tolerances between moving parts, such as the multi-stage pumps used in the ECCS, will likely cause permanent damage.

All pumps will exhibit a loss of developed head when exposed to gas at the pump impeller. The following general conclusions appear reasonable for single-stage pumps that are operating at close to rated flow rate:

- Less than about 0.5 to 1 percent gas by volume at the impeller may not have a significant effect on pump head.
- Pump head may be degraded with 1 to 2 percent gas by volume.
- Some pumps may fail to provide significant head at 5 percent gas by volume.
- Most pumps may fail to provide significant head at 10 percent gas by volume.

However, these percentages are a function of flow rate. With respect to developed head, NUREG/CR-2792[11] states that expert opinions on the level of gas ingestion giving negligible degradation ranged from 1 to 3 percent. These experts generally agreed that for flow rates less than 50 percent at best efficiency, the presence of gas might cause gas binding that would not occur at full flow in some pump designs. The experts apparently agreed that gas in the suction lines increased NPSH requirements, but no quantitative data were found. NUREG/CR-2792 also identified a problem that does not appear to be widely recognized. At reduced flow rates with gas ingestion rates that are not normally a problem, gas can accumulate with time and the pump can eventually become gas bound. According to NUREG/CR-2792, this is possible with less than 2 percent gas by volume at low flow rates. Gas binding because of this effect is a potential concern since ECCS pumps are often initially operated at low flow rates when the gas volume passing through the pump may be at a maximum.

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[11] Kamath, P. S., et al., "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions," Creare, Inc., NUREG/CR-2792.

There is some evidence that a multistage pump can tolerate a higher fraction of incoming gas than a single-stage pump without completely losing developed head. This characteristic is attributed to compression of the gas in the early stages so that later stages are exposed to a lower void fraction and consequently continue to develop head. However, this is only true if the flow rate remains a substantial fraction of the best-efficiency flow rate. A significantly reduced flow rate may result in pump damage that makes the pump non-functional. For example, in large break loss-of-coolant accidents (LOCAs) where there is little backpressure, the high-pressure ECCS pumps may continue to function with a substantial void fraction at the first stage impeller, but the high backpressure associated with small LOCAs could cause pump damage at the same void fraction.

There is concern that more than 5 percent gas passing through a multistage pump may result in impeller load imbalance that could bend the shaft or initiate shaft cracks, although this did not occur in tests conducted by Palo Verde Nuclear Generating Station in 2004, where flow rates remained high. If such damage occurred, it is not clear how long the pump would continue to operate. Moreover, such damage may not be evident from developed head tests or pump vibration observation. On the other hand, a few cubic feet of finely dispersed 2 percent gas by volume, although undesirable in a multistage pump, may not cause immediately evident pump damage if the exposure time was short, pump flow rate remained high, and the exposure did not occur repeatedly.

These considerations lead to the conclusion that the commonly used limit of 5 percent gas into pumps may be reasonable only if a substantial flow rate can be assured. For low flow rates, it may be a nonconservative limit. Further, such gas percentages are undesirable due to the potential to cause damage to the pump.

(6) Control of Gas

Venting for a fixed time at what are perceived as local high points is often performed to satisfy TS surveillance requirements (SRs) to assure that gas accumulation in the ECCS and DHR system will not jeopardize operation. However, the SR should reasonably assure that gas has not affected operability will not likely accumulate in sufficient quantity to jeopardize operability before the next surveillance. Venting is sometimes performed where the effluent cannot be directly observed. The venting times are sometimes specified, but they may be too short for an unexpectedly large gas accumulation. In such cases, effective corrective actions may include modifying vents to accommodate direct observation and to provide actions keyed to the observed venting results.

Although the subject systems are often susceptible to gas intrusion, all plants may not have vent valves at one or more system high points. Further, vents in long, nominally horizontal pipes might not be completely effective in eliminating gas. Licensees have also found vents that were supposed to be installed at a high point but were actually installed at a different location. Where high points are not vented, the important questions are whether the licensee is aware of the potential problems, whether the licensee's controls and practices sufficiently reflect this awareness, and whether modifications should be accomplished. For example, where vents are not installed at high points, UT measurements can provide a check for gas, and a high flow rate may be useful to assure gas has been swept from high points. In other cases, design modifications, such as adding vent valves, may be a reasonable approach to problem resolution. For example, one licensee found it needed to install an additional 21 high-point vent valves. Another licensee, who installed an additional 17 vent valves, determined that the primary cause of the gas voiding problem was that the original design specification did not call for a sufficient number of vent valves. No specific NRC requirement mandates the installation of vent valves on the subject systems. However, failure to translate the design basis of assuring the system is maintained sufficiently full of water to maintain operability into drawings, specifications, procedures, and instructions is a violation of Criterion III in Appendix B of 10 CFR Part 50.

In some cases, it may not be necessary to conduct a surveillance to assure operability. An assessment for such plants that (1) acceptably eliminates other means of introducing gas, (2) establishes acceptable verification that the lines are essentially full following a condition that reduces the discharge line pressure, and (3) establishes an operating history confirming that gas has not accumulated may be adequate justification for not conducting surveillances inside containment or at locations that constitute a hazard to personnel performing the assessment. For example, some three loop plants designed by Westinghouse maintain high pressure safety injection discharge lines at a pressure greater than the RCS operating pressure. This eliminates the potential for leakage from the accumulators or the RCS as a possible means to introduce gas into the discharge lines.

If venting from hazardous locations is necessary to maintain operability, measures such as relocating vent valves could be taken in order to address ALARA principles and personnel safety considerations.

With similar justifications and additional considerations, extending the time between surveillances of certain sections of piping may be reasonable. For example, consideration should be given to such conditions as changes in accumulator level and pressure or other indicators of potential gas problems. In regard to significant extension of surveillance times, consideration should be given to the possibility of a previous surveillance, such as a pump test, causing a change in gas behavior, such as a check valve failing to close as tightly as prior to the surveillance, a change that appears to have contributed to the Indian Point Unit 2 event described in the GL. Finally, although not covered by existing TSs, some addressees have correctly increased selected surveillance rates when problems were observed.

Hydrogen is sometimes vented and ignition may be a concern if the area to which the hydrogen is vented is small and not well ventilated. The source of the gas to be vented should be determined and, if the gas is hydrogen, steps to monitor and control the effluent should be considered.

INPO Overview

Clair Goddard
Vice President
Assistance

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Institute of Nuclear Power Operations

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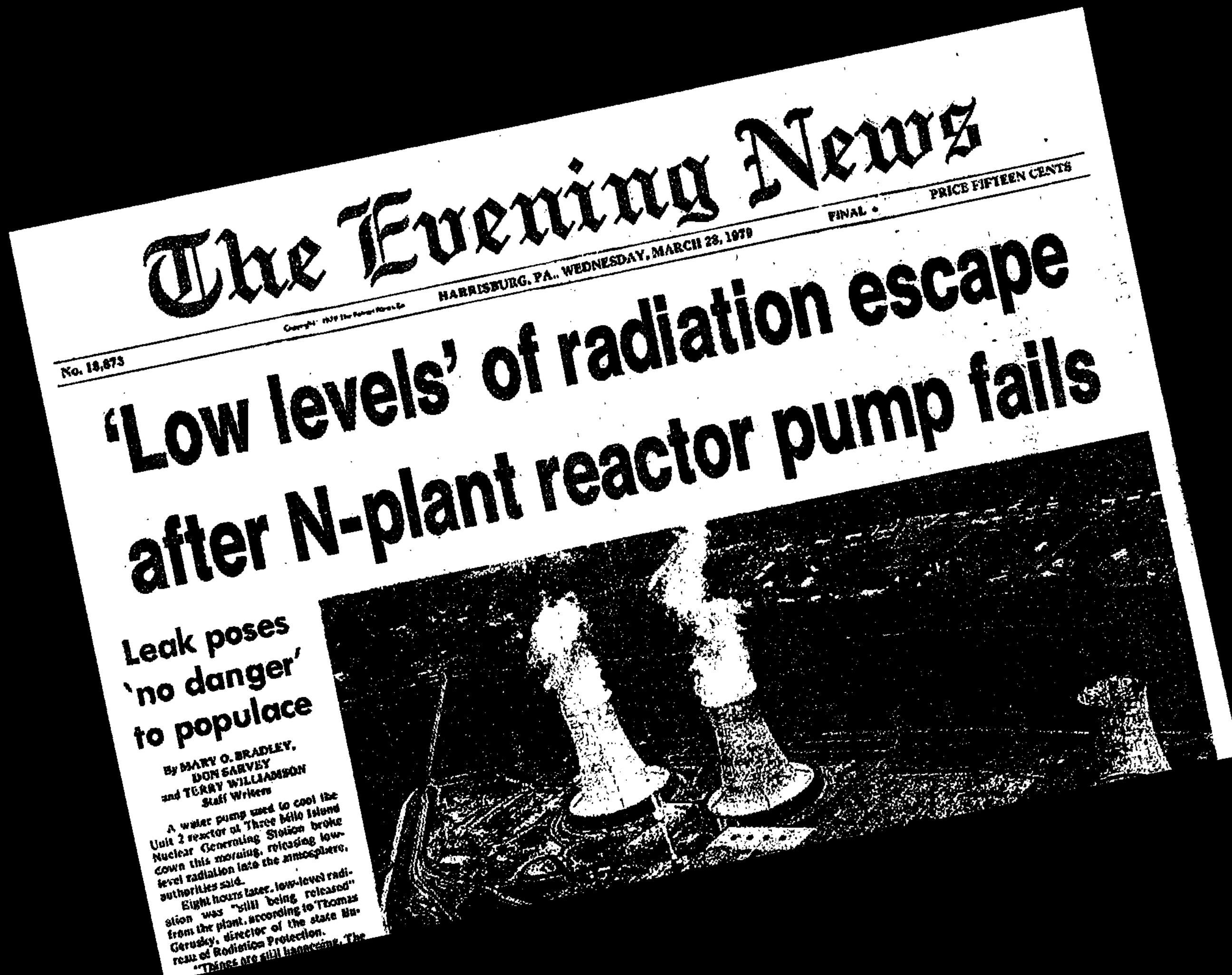
Birth of *INPO*®



The Evening News

No. 18,873 · HARRISBURG, PA., WEDNESDAY, MARCH 28, 1979 · FINAL · PRICE FIFTEEN CENTS

'Low levels' of radiation escape after N-plant reactor pump fails

Leak poses 'no danger' to populace

By MARY O. BRADLEY, DON SARVEY and TERRY WILLIAMSON
Staff Writers

A water pump used to cool the Unit 2 reactor at Three Mile Island Nuclear Generating Station broke down this morning, releasing low-level radiation into the atmosphere, authorities said.

Eight hours later, low-level radiation was "still being released" from the plant, according to Thomas Gerusky, director of the state Bureau of Radiation Protection.

"Things are still happening. The

President's Commission on the Accident at Three Mile Island

- Set and police its own standards of excellence
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- Operator continuing training & plant simulators
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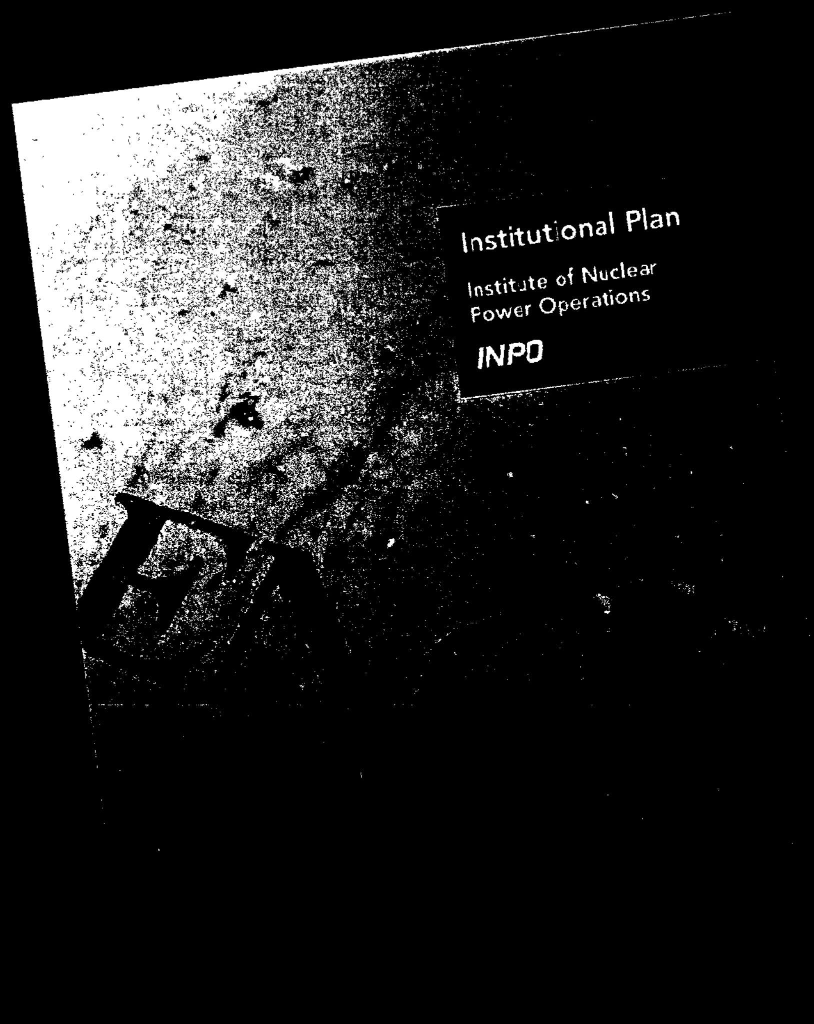

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of safety and reliability
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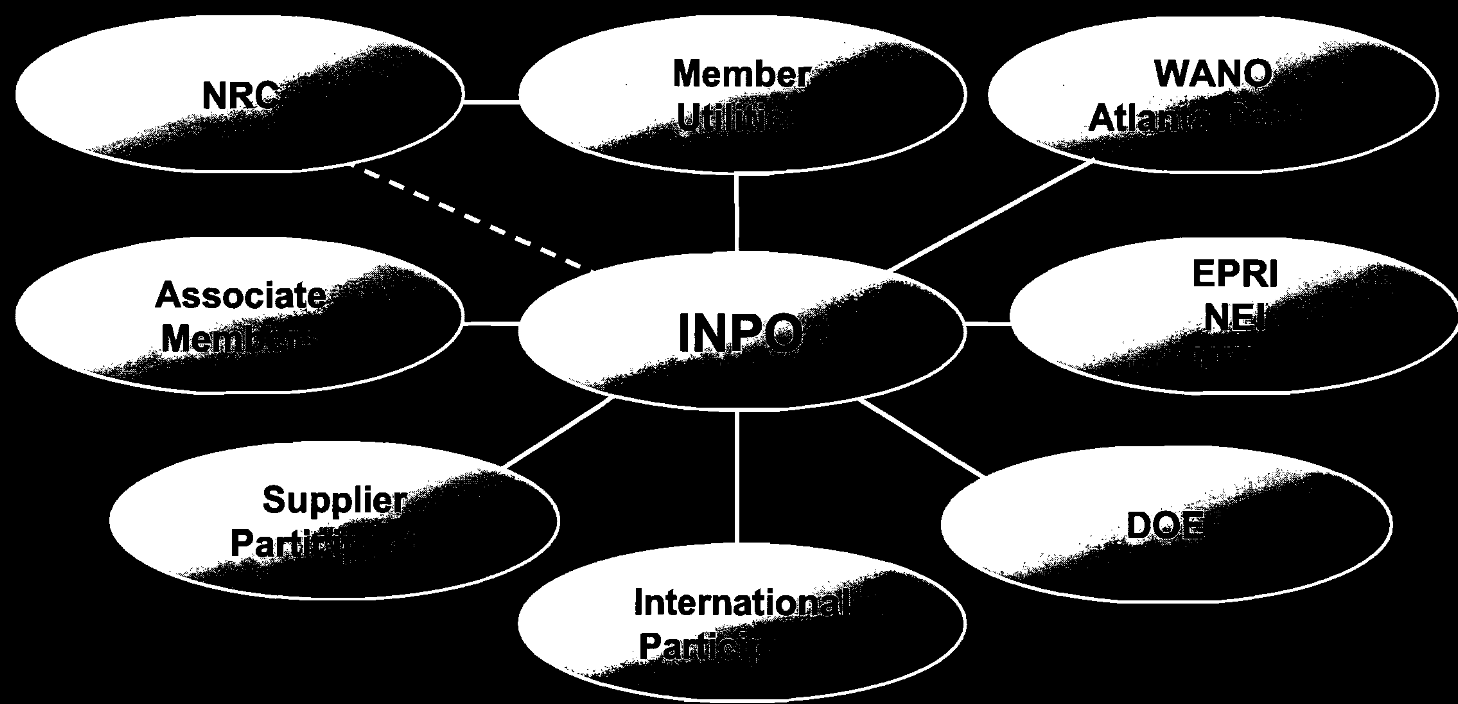

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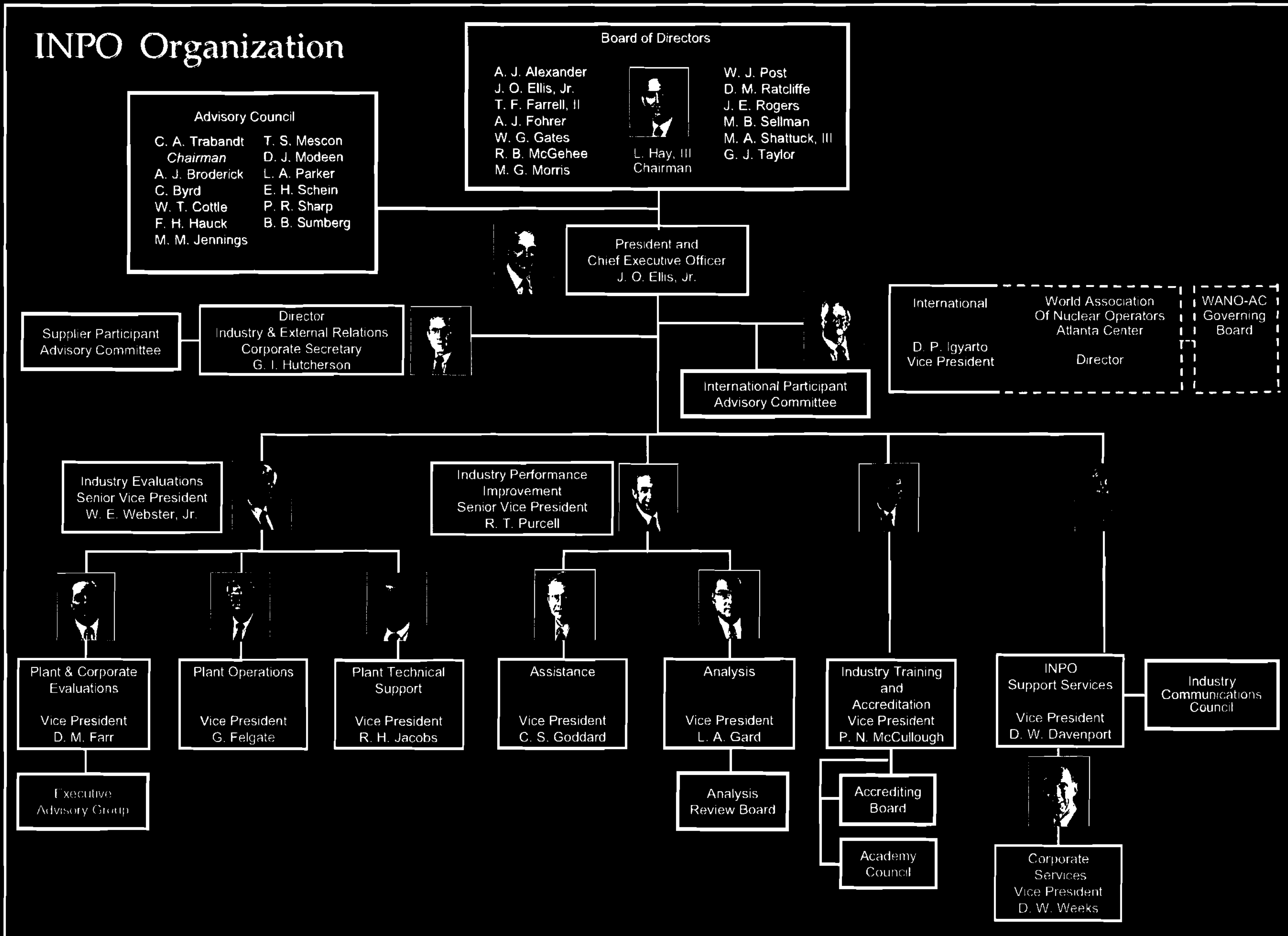

October 1, 2007

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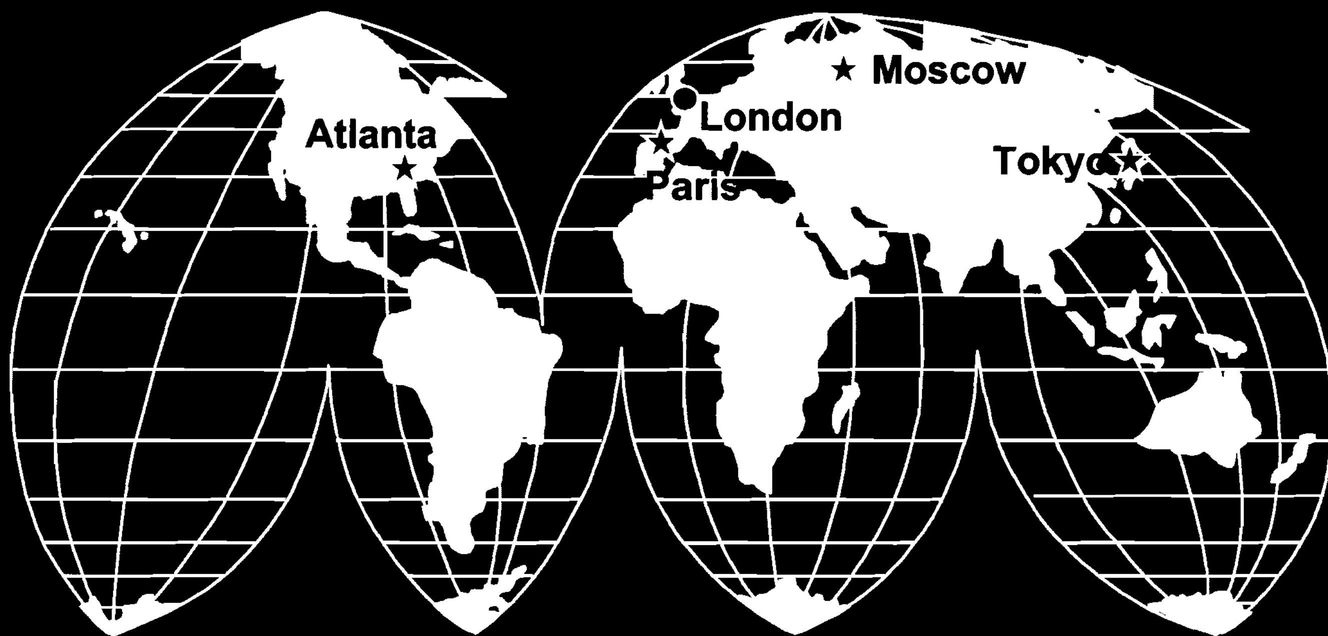

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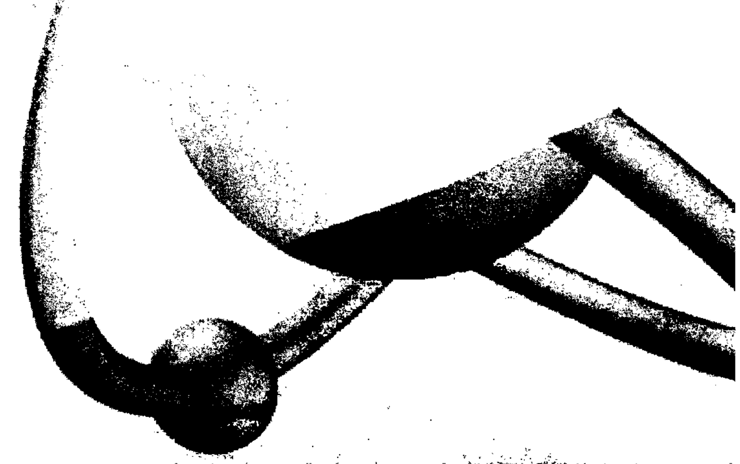
Nuclear Energy Institute: Mission, Goals and Issues

Anthony R. Pietrangelo

Vice President, Regulatory Affairs

October 5, 2007



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Discussion Topics

- Organization and Governance
- Mission
- How NEI accomplishes the Mission
- Business Plan Goals and Activities
- NEI integration with other industry organizations

NEI's Members
284 Member Companies

- All U.S. nuclear utilities
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- Architect/engineering firms
- Radiopharmaceutical manufacturers
- Fuel suppliers
- Universities
- Labor unions
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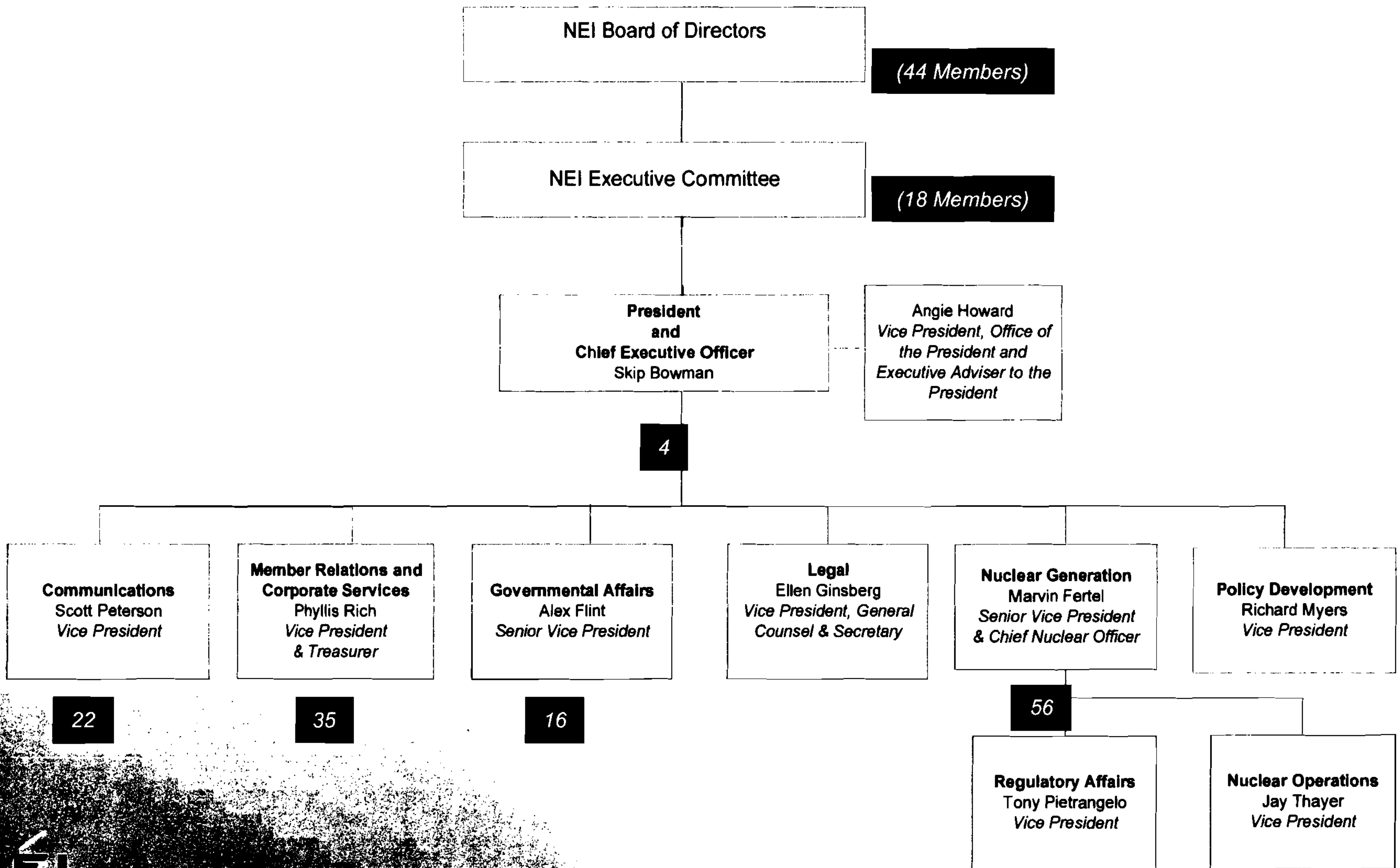
NEI Organization



NEI Committees, Working Groups and Task Forces

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- Standing Committees
- Executive Task Forces
- Working Groups
- Issue Task Forces

Nuclear Strategic Issues Advisory Committee (NSIAC)

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- Steering Committee
  - Operating utility CNOs
- Formal Initiatives
  - 80% vote of utility CNOs on an issue commits the industry

Most Recent Formal Initiatives

- Management of Materials Issues
- Standardized Security Plans
- Industry Composite Adversary Force To Support NRC Force-on-force Exercises
- Portable Qualifications
- Cyber Security
- Groundwater Protection
- Fuel Reliability
- Heavy Load Lifts

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Topics Covered in 8/30 NSIAC

- Materials Initiative
- Risk-Informed Regulation
- Security
- Seismic Issues
- Used Nuclear Fuel
- Fuel Supply
- Workforce Issues
- NEI Litigation
- FirstEnergy-NEIL Lessons Learned
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- GSI 191 PWR Sumps
- Regulatory Issues
- INES Reporting System
- GL on Medium Voltage Underground Power Cable
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- GL on Gas Intrusion in ECCS, DHR & CS
- Fire Protection/NFPA-805

NEI Mission

- Ensure the formation of policies that promote beneficial uses of nuclear energy and technologies
- Provide a forum to resolve technical, regulatory and business issues for the nuclear business

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Accomplishing the Mission

- Policy direction on critical issues
- A unified nuclear energy industry approach to address and resolve nuclear regulatory issues and related technical matters
- Advocacy and representation before the Congress, Executive Branch agencies, regulatory bodies, media and state policy forums

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Accomplishing the Mission

- Accurate and timely information to policy makers, the public and other constituencies
- Assistance to the nuclear energy industry with regard to state issues such as environmental considerations
- Encouragement to educational institutions to promote education in nuclear energy disciplines

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2007 Business Plan

CORE ACTIVITY 1
Enhancing the Business Environment for the Safe and Reliable Operation of Existing Plants

CORE ACTIVITY 2
Creating the Business Environment for New-Plant Deployment

ESSENTIAL ACTIVITIES

Enhancing the Regulatory Environment
- Regulatory Oversight
- Safety-Focused, Risk-Informed Regulation
- Security & EP
- New-Plant Deployment
- Fuel Cycle
- Radiation Protection

Managing Used Nuclear Fuel
- Fuel Acceptance
- Waste Confidence
- Funding
- Licensing
- EPA Standard
- Nevada
- Standard Canister
- Advanced Technologies

Advancing a National Energy Policy
- Implementation of EPACT 2005
- Funding For DOE Nuclear Activities
- Recognition Of Environmental Benefits
- Long-range Policies

Sustaining the Nuclear Infrastructure
- Work Force
- Fuel Supply
- Physical Infrastructure
- Financial Community Outreach

Branding & Building Public Support
- Coordination With Member Efforts
- Targeted Advertising
- Outreach to Media, Policy Makers
- Outreach to State, Labor

Enhancing Community Relations & Incident Response
- Industry Community Relations Programs
- Benchmarking Against Other Industries
- Community Relations "Tools"
- NEI Emergency Plan / Improved Coordination

MISSION-CRITICAL FUNCTIONS

- Influencing Public Policy & Policymakers
- Influencing the Political Process
- Relationship Development
- Member Support: Policy Coordination
- Member Support: Information & Technology
- Internal Operations

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New Executive Task Forces

- Improving the Regulatory Process
- Community Relations and Incident Response
- Competitive and Reliable Fuel Supply
- Immigration and the Work Force

Improving the Regulatory Process Executive Task Force

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▪ Mike Sellman	President and CEO, NMC
▪ Joe Sheppard	President and CEO, STPNOC
▪ Mike Kansler	President, Entergy Nuclear Operations
▪ Dave Christian	Sr. VP Nuclear and CNO, Dominion
▪ Tom O'Neill	VP Regulatory and Legal Affairs, Exelon
▪ Mano Nazar	Sr. VP and CNO, AEP
▪ Marv Fertel	Sr. VP and CNO, NEI

Improving the Regulatory Process

- **Regulatory actions directly impact industry**
- **NRC critical to present and future**
- **NRC entering a challenging period**
- **Problem:**
  - Overall industry performance high, however...
  - Regulatory environment less stable, less transparent and less predictable
  - Formal regulatory processes not being followed

NEI

Objectives

- Increase safety focus in regulations, reviews and oversight
- Achieve formal promulgation and consistent interpretation of regulatory requirements
- Enhance public understanding of, and confidence in, the NRC
- Improve industry's communication of regulatory concerns in a timely and factual manner

Activities

- Initiated discussion with NRC
- Established industry clearinghouse (web board) for regulatory process issues
- Conducted industry self assessment
- Ongoing activities:
  - Implement recommendations from assessment
  - Met with EDO to discuss assessment
  - White paper on the regulatory process
  - Re-energize the Committee to Review Generic Requirements

NEI

Expected Results

- NRC using formal rulemaking process for new requirements
- NRC more focused on risk significant issues
- Congressional oversight well informed
- Industry meeting its commitments
- NRC and industry priorities well understood

NEI's Mission Critical Functions

- Influencing public policy/policymakers
- Influencing the political process
- Relationship development with outside organizations, institutions, agencies and individuals
- Direct member support

NEI Member Communications

- **Administrative Point of Contact (APC)**
- **NEI sends several letters per month to the APCs and others.**
  - Requests for review/comments on proposed rulemaking and generic communications
  - Format and content for generic responses to NRC
  - Status of key generic issues

NEI Web Pages

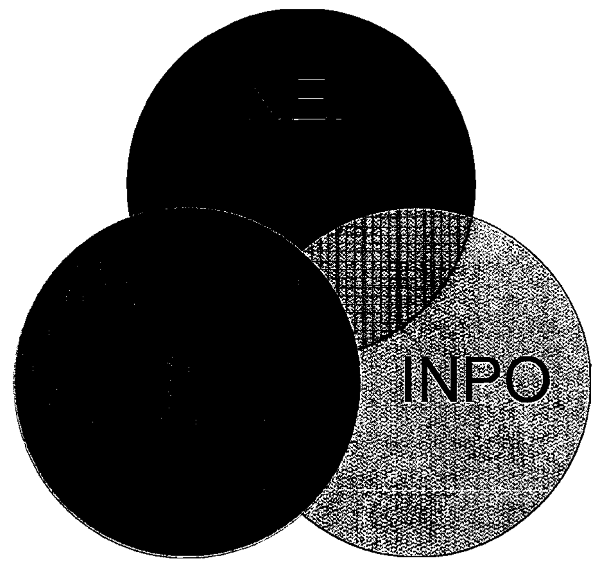
- **Public site**
  - http://www.nei.org
- **Member Site**
  - http://member.nei.org
  - For password contact Suzanne Stuart 202.739.8005
- **Clean and Safe Energy Coalition**
  - http://www.cleansafeenergy.org/

NEI

NEI as a Resource

- NEI Directors and Project Managers
- Matrixed team approach to issue resolution
- NEI guidance documents
- Emerging generic issues
- Help on inspection, engineering or licensing issues
- Relationships with the federal government, agencies, Congress and media
- Loaned executives and employees

Partners in Supporting the Nuclear Industry



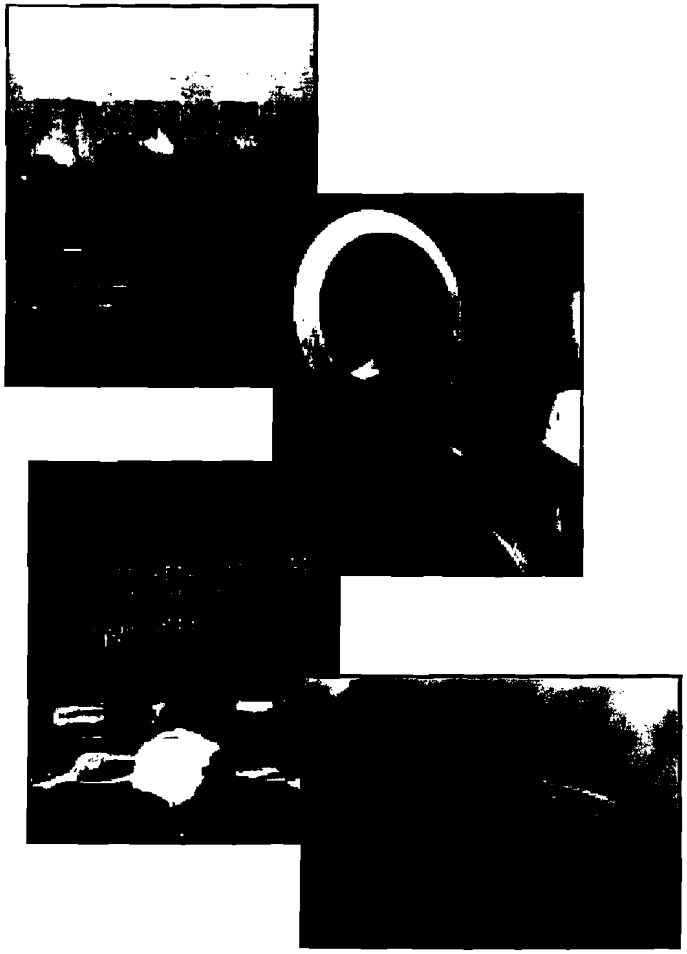
ELECTRIC POWER RESEARCH INSTITUTE

Overview of the Nuclear Power Sector at EPRI

John Gaertner
Sr. Business Operations Manager
EPRI Nuclear Sector

October 5, 2007

EPRI Background



- Founded in 1973
- Unbiased, non-profit energy research consortium
- Voluntary funding from energy industry participants
- Collaborative research benefits members, their customers, and society
- Over 700 North American members (represents over 90% of U.S. electricity generated)
- Over 130 International participants

Power Industry Technology Areas

Generation & Distributed Resources

- Environmental Controls
- Major Component Reliability
- Combustion Turbines
- Maintenance, Operations and Workforce
- Advanced Coal Plant Portfolio
- Distributed and Renewable Generation Resources
- Generation Planning: Economics and Fuels

Nuclear Power

- Material Degradation/Aging and Chemistry
- High Performance Fuel
- Radioactive High-Level Waste & Spent Fuel Management
- NDE & Material Characterization
- Equipment Reliability
- Instrumentation & Control Hardware and Systems
- Nuclear Asset-Risk Management
- Safety/Risk Technology & Application
- New Nuclear Plant Deployment
- Low-Level Waste & Radiation Management

Power Delivery & Markets

- Strategic Initiatives
- Security
- Power Markets & Risk
- Assets, Planning & Operations
- Power Quality
- Transmission Reliability & Performance
- Distribution Reliability & Performance
- Electric Transportation and Energy Utilization
- Enterprise Asset Management

Environment

- Air Quality
- Global Climate Change
- Land & Groundwater
- Water and Ecosystems
- EMF Health Assessment and RF Safety
- Occupational Health and Safety

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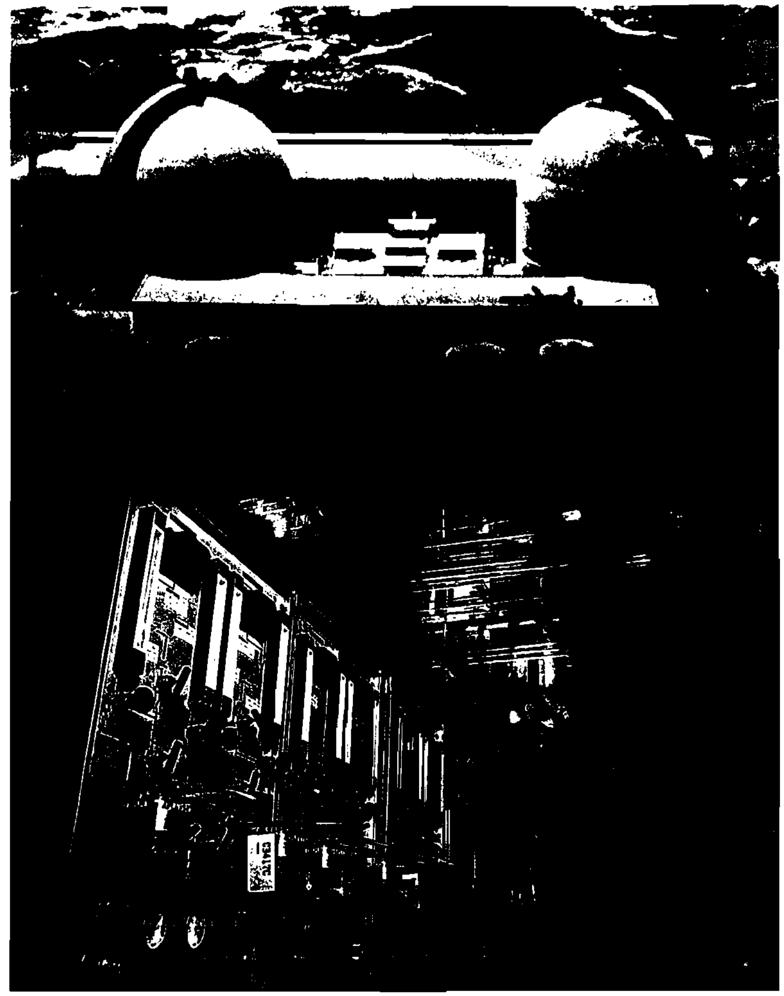
EPRI Nuclear Power Sector Mission

Develop cost-[illegible]
[illegible]

to

Maximizes the utilization of existing nuclear asset

Supports the deployment of new nuclear technology



EPRI ELECTRIC POWER RESEARCH INSTITUTE

EPRI Worldwide Nuclear Participation

Full Members

All 26 U.S. Utilities

Electricité de France (France)

British Energy (U.K.)

CANDU Owners Group (Canada and Romania)

TEPCO (Japan)

UNESA (Spain)

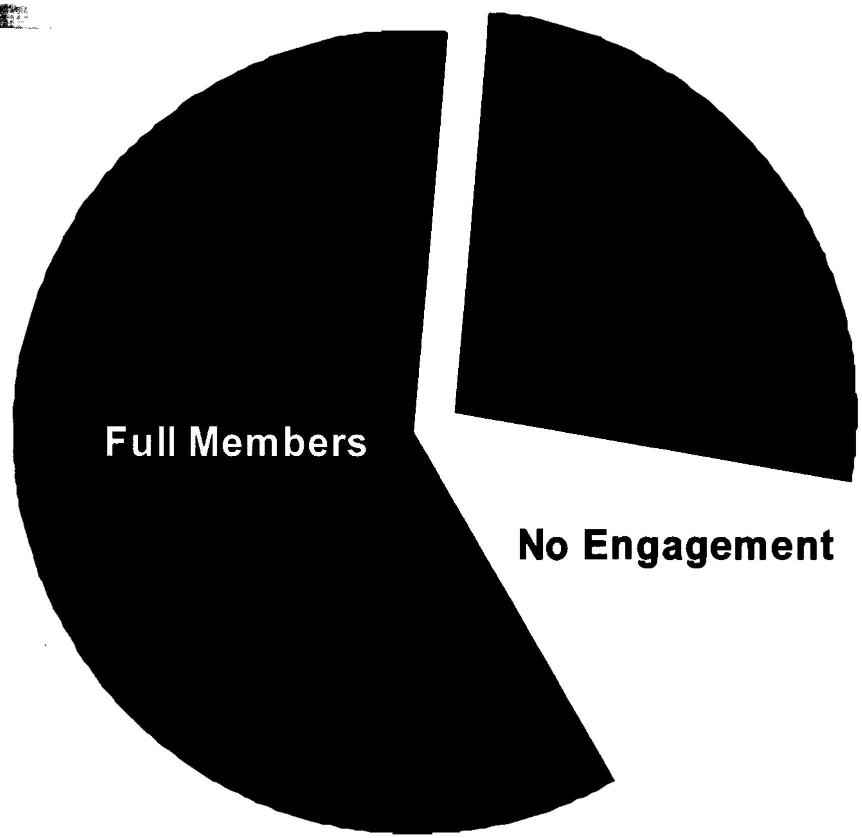
Rolls Royce (U.K.)

Eletronuclear (Brazil)

CFE (Mexico)

Chubu (Japan)

Eskom (S. Africa)



Membership and Program Participants Include Over 80% of the World's 443 Operating Commercial Units.

EPRI's Key Interfaces in the Nuclear Industry

EPRI
Technology

INPO
Operational Excellence

NEI
Regulatory/ Public/ Government

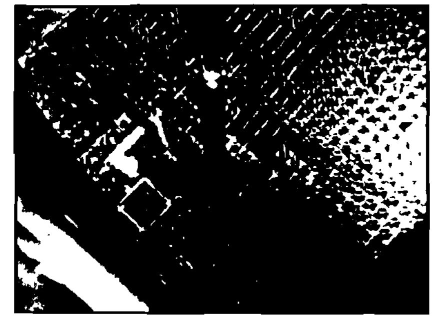
- Relationships with DOE, NRC Office of Research, and Idaho National Laboratory
- Global relationships with other research agencies
- Cooperation with vendors, NSSS Owners Groups and universities

Collaboration is key to EPRI mission

EPRI Nuclear Strategic Plan

- Vision and Strategic Goals
  - Developed with NEI and INPO
- Strategic Technical Areas Identified
- Action Plan developed for each Technical Area
  - 3-Year Budgets and Portfolios developed from Action Plan
  - Change Initiatives identified to keep strategic focus
- Advisory structure parallels Strategic Plan structure
- Action Plans updated annually
- Nuclear Strategic Plan Updated every 2 years

Nuclear "Action Plans" Address Key Industry Issues



The Nuclear Program's 10 Strategic Action Plans:

- Materials Degradation/Aging (including Chemistry)
- Fuel Reliability
- High-Level Waste and Spent Fuel Management
- Low-Level Waste and Radiation Exposure Management
- Non-Destructive Evaluation and Materials Characterization
- Equipment Reliability
- Instrumentation & Control Modernization
- Nuclear Asset/Risk Management
- Safety Risk Technology and Applications
- Advanced Nuclear Technology

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Nuclear Power Sector Leadership Team

Steve Specker
President & CEO

Mike Howard
SVP R&D

Chris Larsen*
VP and CNO

* **Dave Modeen** transitions from VP/CNO 10/1/07

Support Team

- Ken Barry, Technology Transfer
- Christian Brutzman, HR Mgr
- Maureen Costello, Sr. Corp. Counsel
- Harry Jones, Finance / Controller
- Tuan Nguyen, Tech Advisory Services
- Brian Schimmoller, Communications

Tracy Wilson
Executive Admin Assistant

Greg Selby	**Tom Mulford**	**Ken Huffman**	**Rosa Yang**	**John Gaertner**	**Gary Vine**	**Richard Oehlberg**
NDE	Adv. Nuclear Technology	Plant Technology	Materials & Chemistry	Business Operations	Federal & Industry Activities	Quality Assurance

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Nuclear Power Advisory Structure with Committees

Nuclear Power Council

Executive Committee

QA Committee

Material Degradation/Aging

BWRVIP
- Exec. Oversight Comm.
- Exec. Comm.
- Integration Comm.
- Assessment Comm.
- Mitigation Comm.

PWR Materials Reliability Prog. (MRP)
- PMMP Exec. Oversight Comm
- PMMP Exec. Comm.
- Integration & Impl. Grp
- Issues Integration Group (IIG)
- Technical Support Comm.
- Mitigation and Testing
- ITG Assessment ITG
- Inspection ITG
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- Eng. & Reg. IRG.
- ISI/NDE IRG.

Water Chem. Program
- PWR Primary Water Chem. Guidelines
- PWR Secondary W. Chem Guidelines
- BWR Water Chem. Guide.
- BWR Condens. Filter UG
- ChemWORKS UG
- SMARTChemWorks UG

Primary Systems Corrosion Research
- Primary System Corrosion S/C

NDE

NDE Center S/C
- Risk-Informed Inspection WG
- BOP Inspection WG
- Perf. Demonstration Initiative
- Remote Visual Exam. WG
- Aging Plant NDE WG
- PWR Stainless Steel NDE
- NDE Workforce WG
- Filmless Radiography WG
- Groundwater Protection WG
- Training WG

Equipment Reliability/I&C

Nuc. Maint. Application Center (NMAC) S/C
- Circuit Breaker UG
- Large Electric Motor UG
- Press. Relief Device UG
- Pump UG
- Terry Turbine UG
- Rod Control System UG
- Hoisting/Rigging/Crane UG
- Transformer/Switchyard UG
- Work Planning UG (WPUG)

BOP Corrosion S/C
- CHECWORKS UG

Plant Support Engineering (PSE) S/C
- Seismic Qual. (SQURTS)
- EQ Mg. System UG
- Cable UG
- Heat Exchanger Perf. UG
- Joint Utility Task Group
- Plant Performance Enhancement Prog. UG
- Service Water Assist. UG
- Task Proficiency Eval. & Task Qual. Registry S/C
- Nuclear Utility Coating Council

Operations & Maint. Development (O&MD) S/C
- MOV Perf. Pred. Meth. UG
- Maintenance Rule UG
- Infrared Thermography UG
- Vibration Technology UG
- Predictive Maintenance UG
- Preventive Maint. Info Repository TAG

I&C-Nuclear S/C
- Impl. Issues—PLC-based Digital Platforms-Nuc. WG
- Hybrid Control Room WG
- EMI WG

Nuclear Steam Turbine Initiative S/C
- Turbine Generator UG

Repair Replacement Appl. Ctr. (RRAC) S/C

Fuel Reliability

Fuel Reliability Program
- Executive Comm.
- Integration Group
- PWR Corrosion & Crud Control
- BWR Corrosion & Crud Control
- Fuel Performance & Reliability
- Fuel Regulatory Issues

NFIR -V

Risk & Asset Mgmt.

Nuclear Asset Mgmt. (NAM)
- NAM Users Group

Risk & Safety Mgmt. (RSM)
- PRA Scope & Quality Committee
- Fire PRA Users Group
- Risk & Reliability UG
- HRA / PRA Tools UG
- ORAM UG
- GOTHIC UG
- MAAP UG
- Retran / VIPRE
- Structural Reliability & Integrity
- Seismic Qualification UG (SQUG)
- Configuration Risk Mngt. Forum

High Level Waste & Spent Fuel Mgmt.

HLW & Spent Fuel Mgmt.
- Neutron Absorber UG
- Cask Loader UG

LLW & Radiation Exp. Mgmt.

LLW Management Tech. A/C
- Waste Logic Software UG
- Chemistry, LLW, & RM Technical A/C
- Groundwater Protection UG

Rad. Mgmt.Tech
- ALARA UG

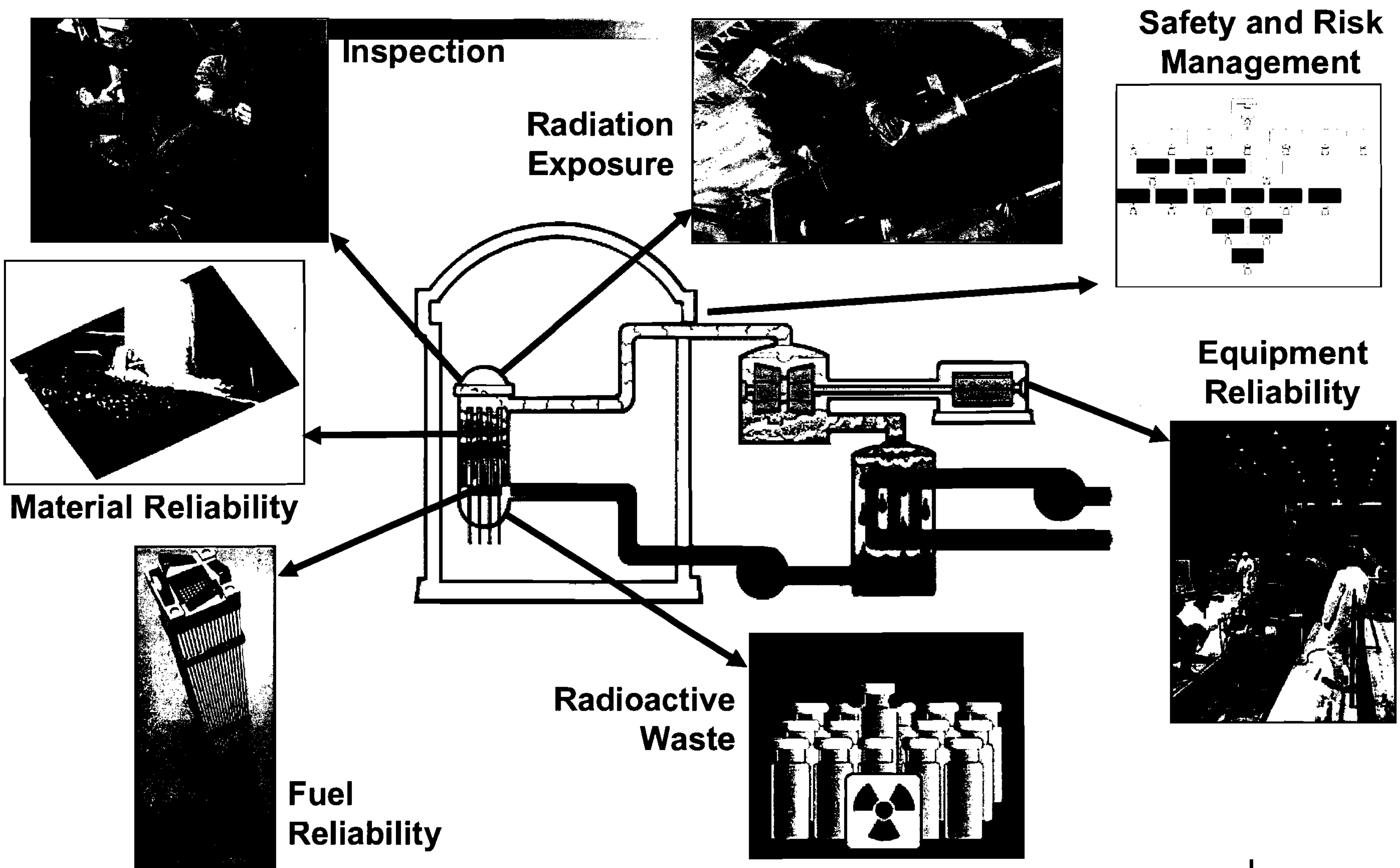
Decommissioning A/G

Advanced Nuclear Technology (ANT)

- Executive Oversight Comm.
- Topical TAG (Various)
- International Utility Coordinating Comm.

A/C=Advisory Committee, TAG= Technical Advisory Committee, S/C= Steering Committee, A/G=Advisory Group, UG = User Group WG =Working Group, ITG=Issues Technical Group IRG=Issue Resolution Group

Integrated Approach to Improve Plant Performance



Recent Technical Support for Regulatory Issues

- Digital I&C
- Inspections of Dissimilar Metal Welds
- Risk Informed Regulations
  - Risk Managed Tech Specs
  - 50.69
  - Risk Informed Fire Protection
- Containment Coatings
- Emergency Planning
- BWR Steam Dryers
- Alpha Radiation Guidelines

Other Key Technical Support for Issues with NEI and INPO

- Management of Materials Issues
- Fuel reliability
- Aircraft impact
- Seismic hazard and K-K response
- Grid reliability
- Rigging, lifting and moving
- LNT models & data; improved radiation threshold
- Medium Voltage Power Cables
- Burnup credit for spent fuel transportation
- Groundwater protection

NRC/EPRI R&D Collaboration -- Perspective

- Extensive collaboration among NRC, DOE, EPRI, NSSS Vendors on nuclear R&D in 1970s and 80s
- R&D collaboration rare during 1990s
  - Legal concerns with "independence" became obstacle to issue closure
- What has changed since late 1990s?
  - Greater appreciation of common R&D goals
  - Diminished resources for R&D suggests leveraging
  - Risk-informed regulation encourages convergence on R&D assumptions, data, models, etc.
- RES and EPRI both encouraged to increase collaboration

NRC/EPRI R&D Collaboration – Without Compromising Regulatory Independence

- RES-EPRI MOU focuses on data needs and joint efforts to collect the data needed to support issue resolution.
  - Collaboration includes:
    - Defining issue & data needs, joint collection of data and review for completeness and accuracy, data validation, reporting to decision-makers.
  - Collaboration does not include:
    - regulatory analysis or specific solutions to regulatory issues.
- Issue resolution enhanced -- NRC and industry are starting with the same technical basis for resolution

Active Topics in EPRI/RES MOU

- PRA, including Scope and Quality
- Fire Risk, including PRA methods, training
- PWR Materials and NDE
- MAAP Applications
- Digital I&C
- Dry Cask Storage and Transport Risk
- Fuel Failure Analysis

- Potential Future Topics:
  - HBU Fuel, Seismic, License Renewal to 80 Years

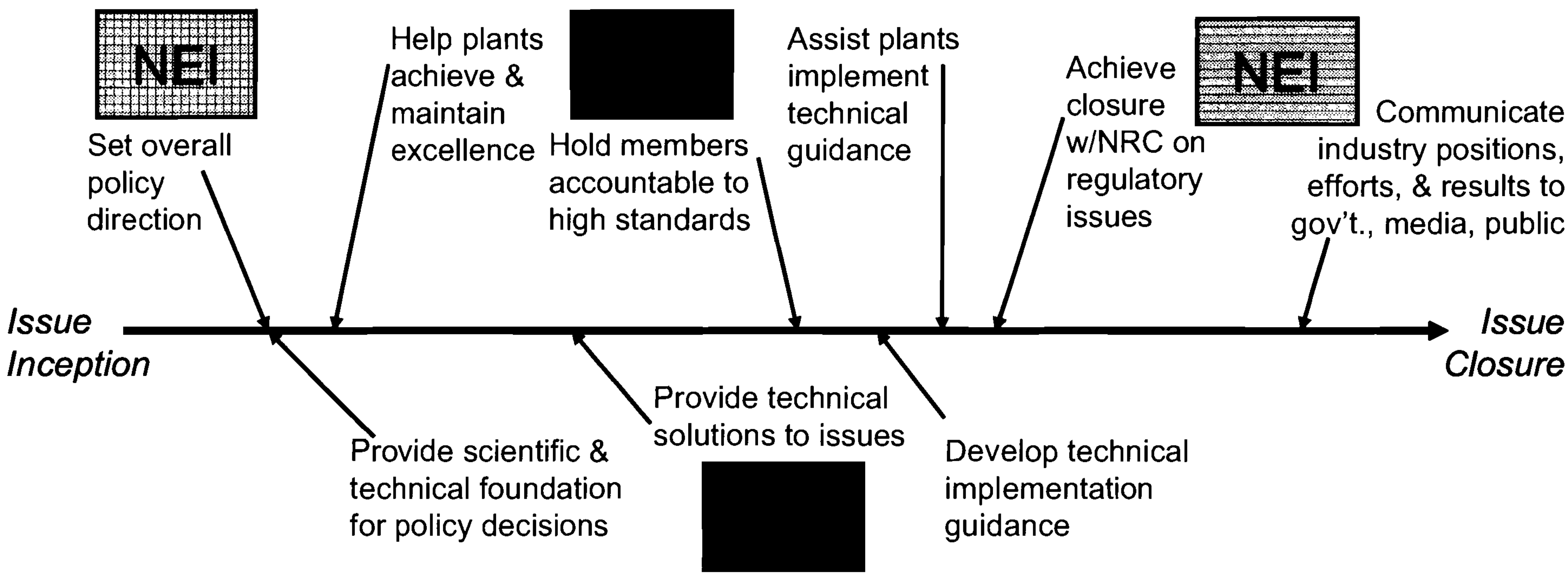
Additional R&D Areas

- Integrated Spent Fuel Management
  - Geologic repository
  - Advanced fuel cycle planning and demonstration
- New Plant Deployment
  - Reflect lessons learned in design
  - Anticipate obstacles to construction, testing, operation
  - Technical analysis to support ESP and licensing

EPRI-INPO-NEI Memorandum of Agreement

Goal: Effective coordination, efficient use of utility resources, teamwork, minimizing duplication, integrated support to plant owner/operator needs

Typical process for addressing a technical issue:



INPO Overview

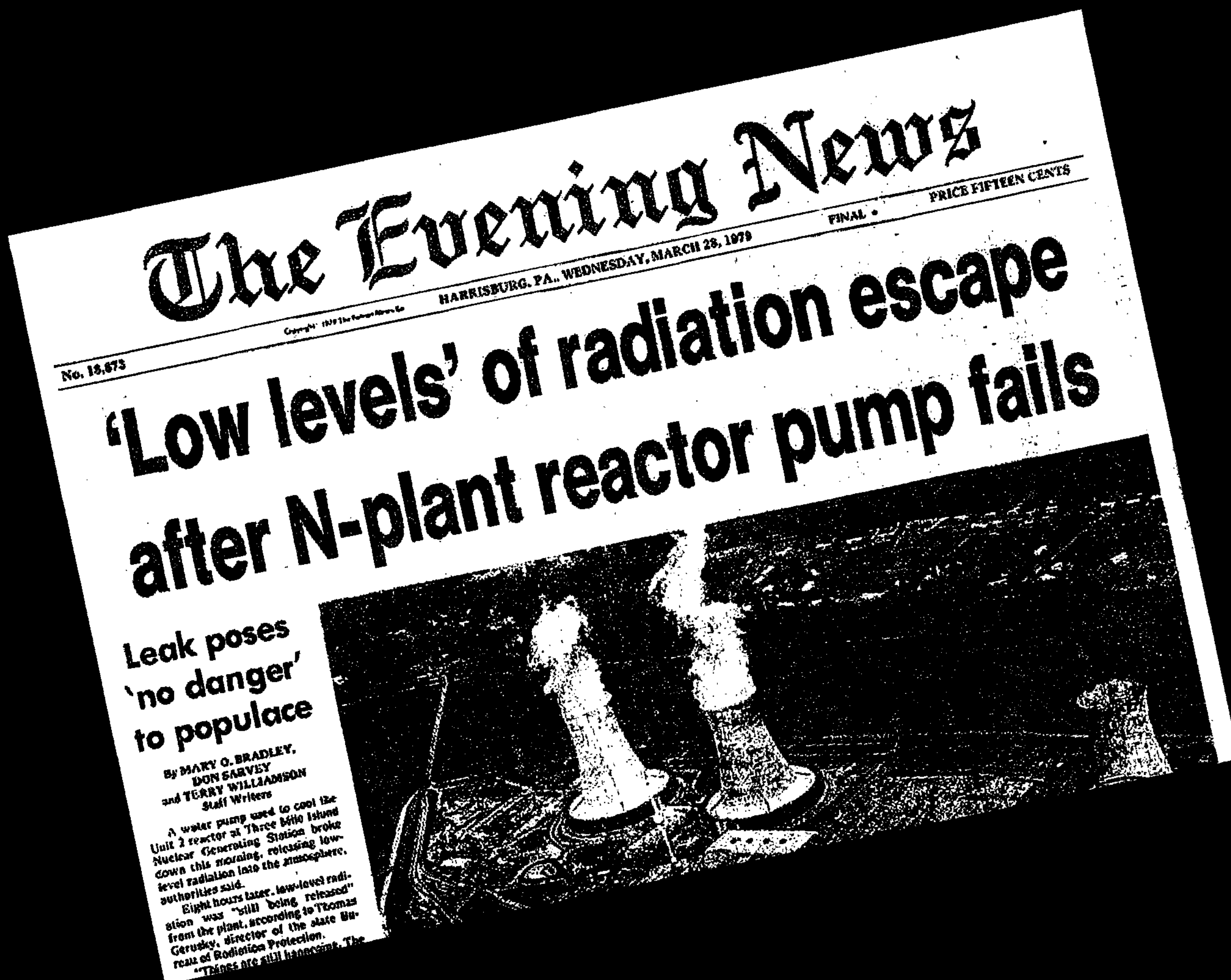
Clair Goddard
Vice President
Assistance

Institute of
Nuclear Power
Operations

National Academy
for Nuclear Training

World Association
of Nuclear
Operators

Birth of *INPO*®



The Evening News

No. 18,873 Copyright 1979 The Evening News Co. HARRISBURG, PA., WEDNESDAY, MARCH 28, 1979 FINAL • PRICE FIFTEEN CENTS

'Low levels' of radiation escape after N-plant reactor pump fails

Leak poses 'no danger' to populace

By MARY O. BRADLEY,
DON SARVEY
and TERRY WILLIAMSON
Staff Writers

A water pump used to cool the Unit 2 reactor at Three Mile Island Nuclear Generating Station broke down this morning, releasing low-level radiation into the atmosphere, authorities said.

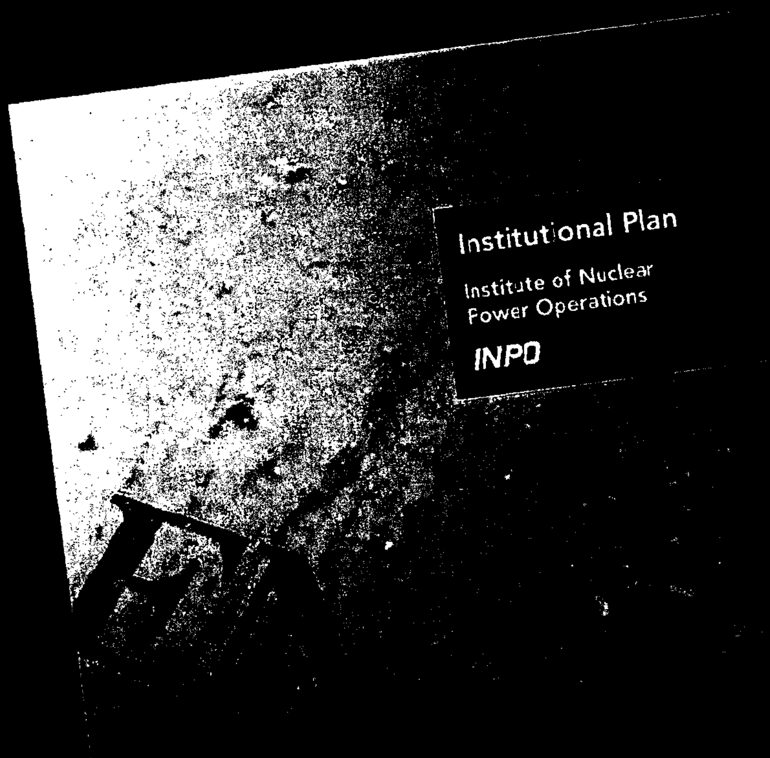
Eight hours later, low-level radiation was "still being released" from the plant, according to Thomas Gerusky, director of the state Bureau of Radiation Protection. The

"Things are still happening...

President's Commission on the Accident at Three Mile Island

- Set and police its own standards of excellence
- Integration of management responsibility
- Systematic gathering & analysis of operating experience
- Agency-accredited training institutions
- Operator continuing training & plant simulators
- Dramatic change in attitude toward safety (safety culture)

INPO's Mission



To promote
the highest levels
of safety and reliability
– to promote
excellence –
in the operation of
nuclear electric
generating plants

INPO® Members and Participants

Members

27 U.S. Utility Members who operate nuclear power plants and 38 Utility Associate Member co-owners

International Participants (12)

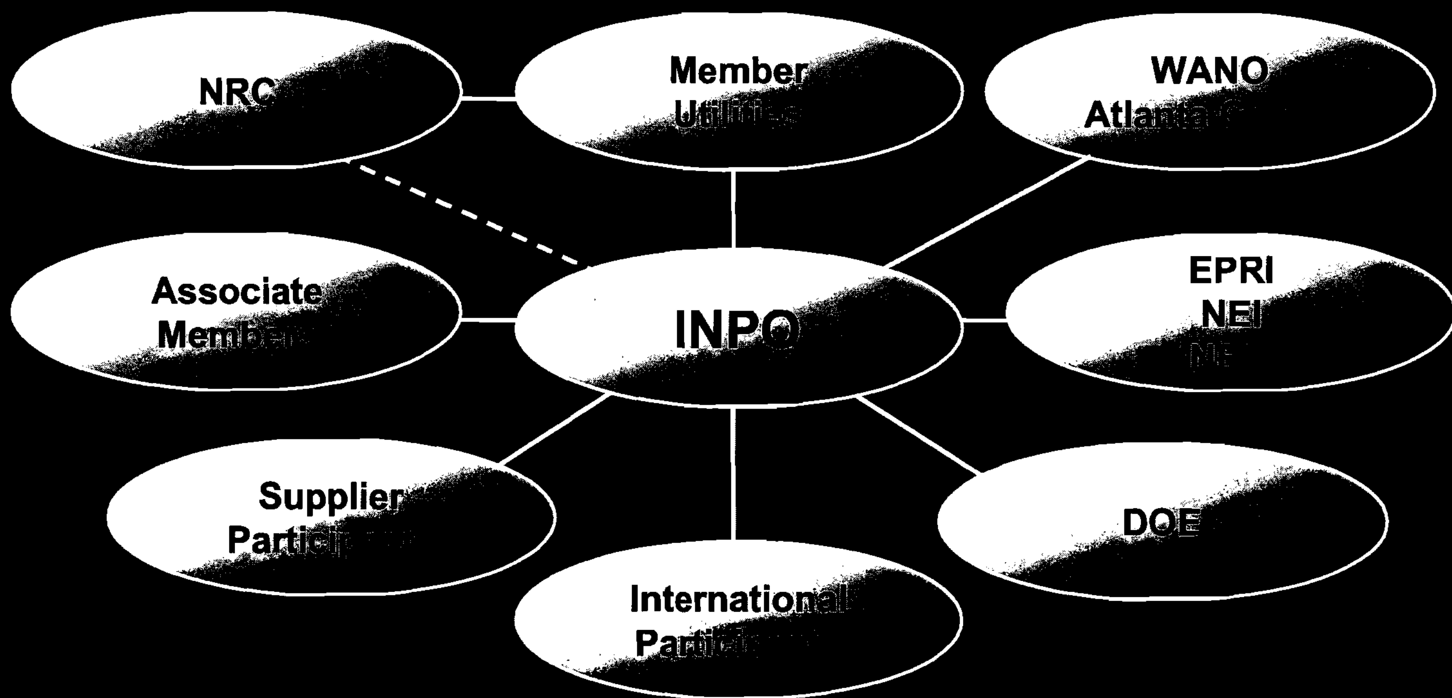
Brazil, Canada, France, Japan, South Korea, Mexico

Romania, Slovenia, South Africa, Spain, Taiwan, United Kingdom

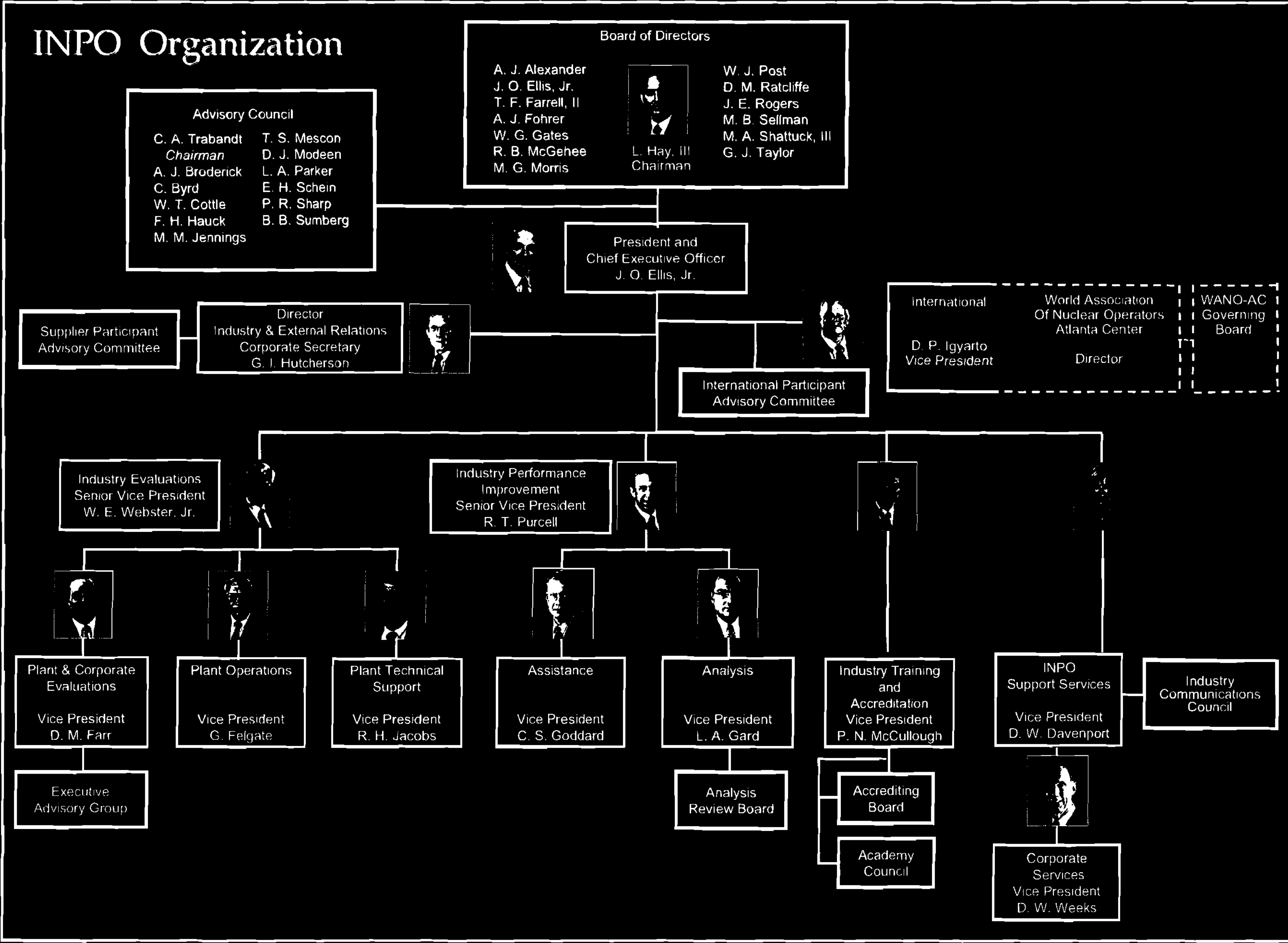
Supplier Participants (18)

AREVA
Bechtel
BHP Billiton
Black & Veatch
Day & Zimmermann
General Electric
Hitachi
Honeywell
Louisiana Energy Services
Mitsubishi
Nuclear Fuel Services
PBMR
Sargent & Lundy
Scientech
The Shaw Group
Toshiba
Washington Group
Westinghouse

INPO® Relationships



INPO Organization



October 1, 2007

Core Values

Excellence... Make it better.
We are committed to learning, improvement and personal growth.

Perseverance... There is no finish line.
We are relentless and vigilant about nuclear safety and reliability.

Leadership... Make things happen.
We work with the industry to identify needs and aggressively stimulate industrywide progress.

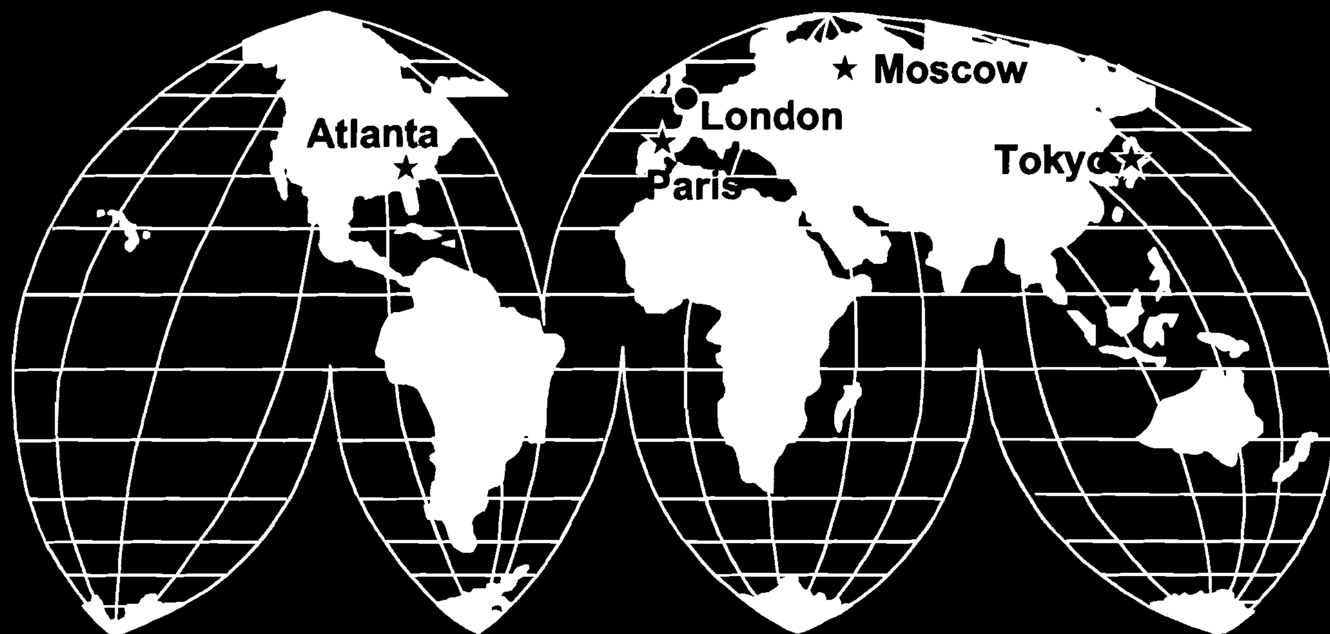
Relationships... Knock down walls. Build bridges.
We respect each other. We work as a team and build a community that shares, compares and improves.

Integrity... We are what we say and do.
We are accountable for our words and actions. Honesty and sincerity are fundamental to our credibility.

INPO® Cornerstone Programs

Evaluations	Training & Accreditation
Analysis & Information Exchange	Assistance

WANO Organization



○ Coordinating Center ☆ Regional Centers

INPO® Focus Areas

Fuel Performance

Transformer, Switchyard and Grid Issues

Emergency Preparedness

Knowledge Retention

INPO®

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

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Sr. Business Operations Manager

EPRI Nuclear Sector

October 5, 2007

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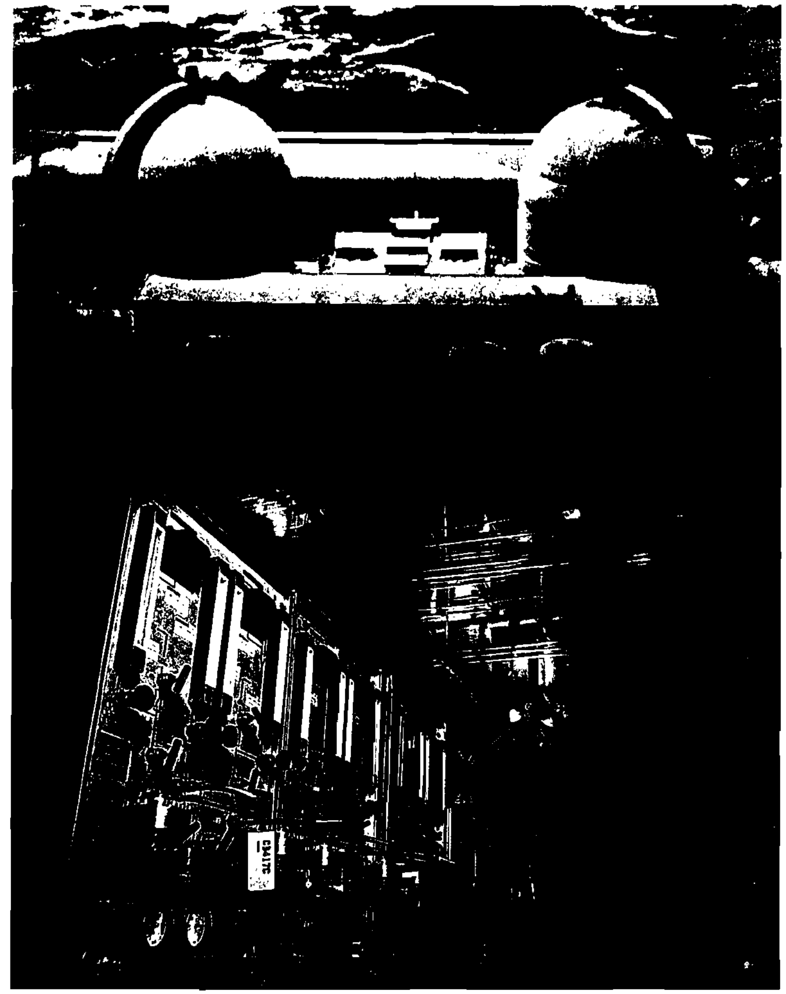

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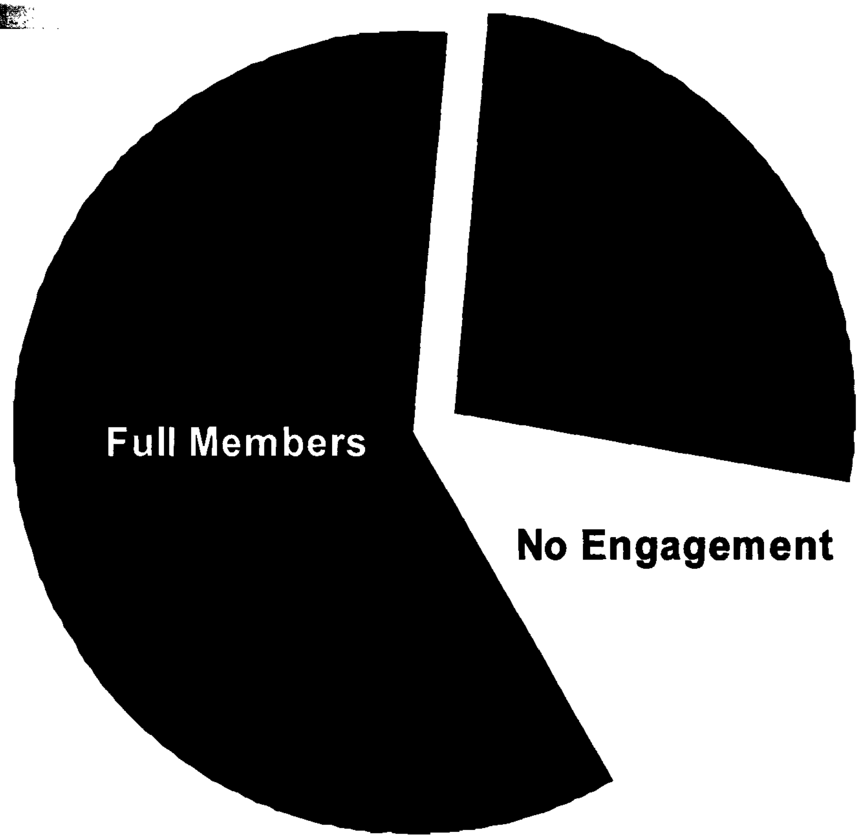

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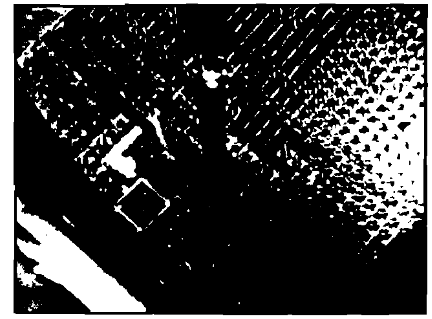
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Nuclear "Action Plans" Address Key Industry Issues



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NDE

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- Predictive Maintenance UG
- Preventive Maint. Info Repository TAG

I&C-Nuclear S/C
- Impl. Issues—PLC-based Digital Platforms-Nuc. WG
- Hybrid Control Room WG
- EMI WG

Nuclear Steam Turbine Initiative S/C
- Turbine Generator UG

Repair Replacement Appl. Ctr. (RRAC) S/C

Fuel Reliability

Fuel Reliability Program
- Executive Comm.
- Integration Group
- PWR Corrosion & Crud Control
- BWR Corrosion & Crud Control
- Fuel Performance & Reliability
- Fuel Regulatory Issues

NFIR -V

Risk & Asset Mgmt.

Nuclear Asset Mgmt. (NAM)
- NAM Users Group

Risk & Safety Mgmt. (RSM)
- PRA Scope & Quality Committee
- Fire PRA Users Group
- Risk & Reliability UG
- HRA / PRA Tools UG
- ORAM UG
- GOTHIC UG
- MAAP UG
- Retran / VIPRE
- Structural Reliability & Integrity
- Seismic Qualification UG (SQUG)
- Configuration Risk Mngt. Forum

High Level Waste & Spent Fuel Mgmt.

HLW & Spent Fuel Mgmt.
- Neutron Absorber UG
- Cask Loader UG

LLW & Radiation Exp. Mgmt.

LLW Management Tech. A/C
- Waste Logic Software UG
- Chemistry, LLW, & RM Technical A/C
- Groundwater Protection UG

Rad. Mgmt.Tech
- ALARA UG

Decommissioning A/G

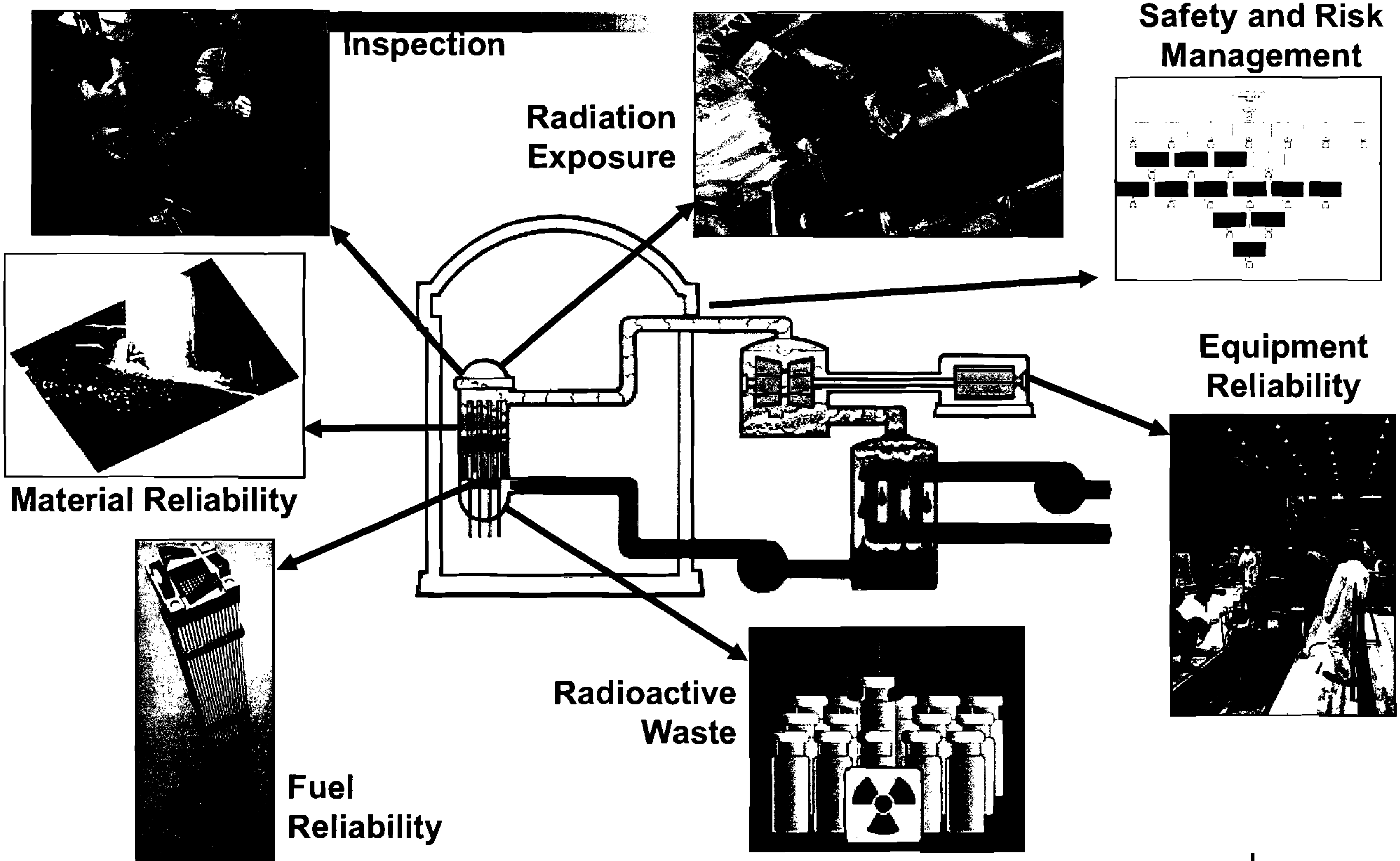
Advanced Nuclear Technology (ANT)

- Executive Oversight Comm.
- Topical TAG (Various)
- International Utility Coordinating Comm.

A/C=Advisory Committee, TAG= Technical Advisory Committee, S/C= Steering Committee, A/G=Advisory Group, UG = User Group WG =Working Group, ITG=Issues Technical Group IRG=Issue Resolution Group

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Integrated Approach to Improve Plant Performance



Recent Technical Support for Regulatory Issues

- Digital I&C
- Inspections of Dissimilar Metal Welds
- Risk Informed Regulations
  - Risk Managed Tech Specs
  - 50.69
  - Risk Informed Fire Protection
- Containment Coatings
- Emergency Planning
- BWR Steam Dryers
- Alpha Radiation Guidelines

Other Key Technical Support for Issues with NEI and INPO

- Management of Materials Issues
- Fuel reliability
- Aircraft impact
- Seismic hazard and K-K response
- Grid reliability
- Rigging, lifting and moving
- LNT models & data; improved radiation threshold
- Medium Voltage Power Cables
- Burnup credit for spent fuel transportation
- Groundwater protection

NRC/EPRI R&D Collaboration -- Perspective

- Extensive collaboration among NRC, DOE, EPRI, NSSS Vendors on nuclear R&D in 1970s and 80s
- R&D collaboration rare during 1990s
  - Legal concerns with "independence" became obstacle to issue closure
- What has changed since late 1990s?
  - Greater appreciation of common R&D goals
  - Diminished resources for R&D suggests leveraging
  - Risk-informed regulation encourages convergence on R&D assumptions, data, models, etc.
- RES and EPRI both encouraged to increase collaboration

NRC/EPRI R&D Collaboration – Without Compromising Regulatory Independence

- RES-EPRI MOU focuses on data needs and joint efforts to collect the data needed to support issue resolution.
  - Collaboration includes:
    - Defining issue & data needs, joint collection of data and review for completeness and accuracy, data validation, reporting to decision-makers.
  - Collaboration does not include:
    - regulatory analysis or specific solutions to regulatory issues.
- Issue resolution enhanced -- NRC and industry are starting with the same technical basis for resolution

Active Topics in EPRI/RES MOU

- PRA, including Scope and Quality
- Fire Risk, including PRA methods, training
- PWR Materials and NDE
- MAAP Applications
- Digital I&C
- Dry Cask Storage and Transport Risk
- Fuel Failure Analysis

- Potential Future Topics:
  - HBU Fuel, Seismic, License Renewal to 80 Years

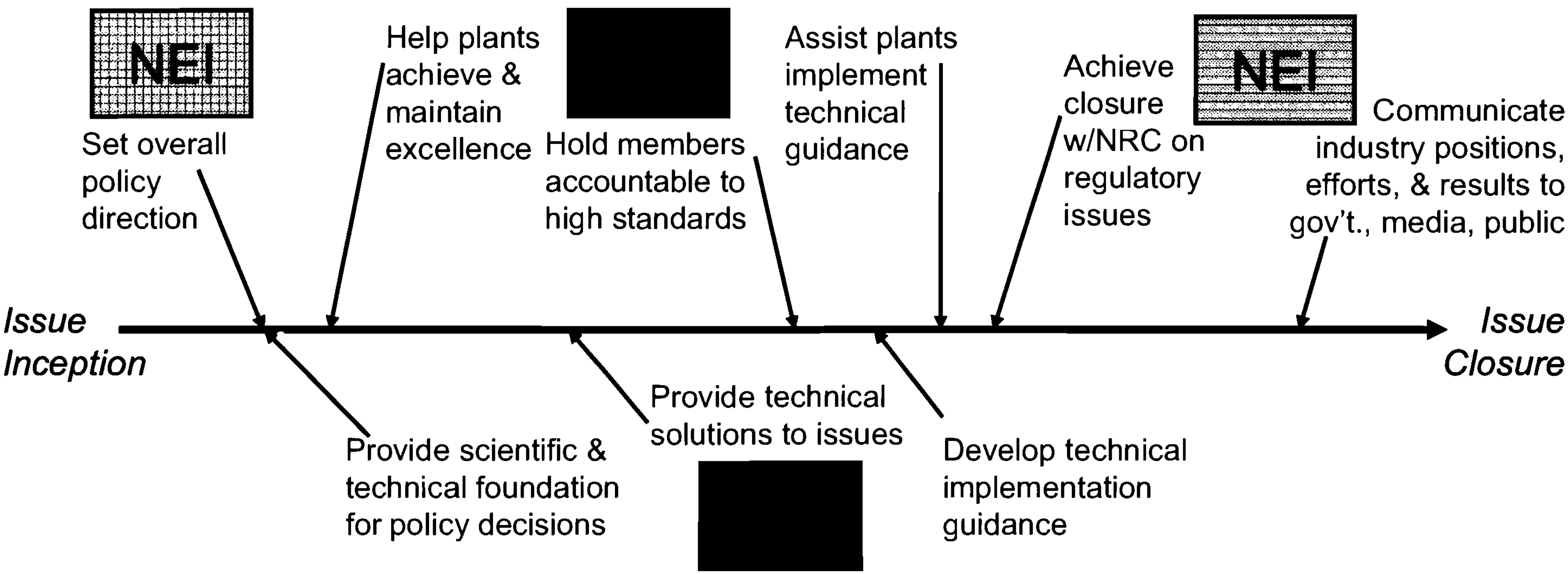
Additional R&D Areas

- Integrated Spent Fuel Management
  - Geologic repository
  - Advanced fuel cycle planning and demonstration
- New Plant Deployment
  - Reflect lessons learned in design
  - Anticipate obstacles to construction, testing, operation
  - Technical analysis to support ESP and licensing

EPRI-INPO-NEI Memorandum of Agreement

Goal: Effective coordination, efficient use of utility resources, teamwork, minimizing duplication, integrated support to plant owner/operator needs

Typical process for addressing a technical issue:



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