Enclosure 2

GI-202 Panel Comments, Results, Conclusions, and Recommendations

Background

The Generic Issues Program (GIP) staff selected three NRC staff experts to perform an independent review of the Generic Issues Program (GIP) staff's screening analysis of generic issue (GI)-202 using a virtual panel approach. The GIP staff opted to use a virtual panel approach to review the GI-202 screening analysis based on successes experienced from the initial use of a virtual panel in review staff's screening analysis for GI-201, "Small Break Loss of Coolant Accident With Loss of Offsite Power." The following paragraphs describe the general basis for using virtual panels in the GIP and their intent.

The Status Report on Proposed Improvements to the Generic Issues Program (GIP) to the Commission in SECY-07-0022 (ML063460239) dated January 30, 2007, describes GIP improvements that will be implemented through a revision to Management Directive 6.4, "Generic Issues Program." The improvements involve several elements that will significantly reduce the time required to resolve Generic Issues (GIs). These elements include enhanced interoffice coordination, increased use of established risk-informed techniques, and revised process requirements to streamline GI assessments. Process improvements will focus assessment resources on the most significant GIs, apply process rigor commensurate with GI importance, and reduce the process burden for assessing GIs of lower risk significance.

Consistent with SECY-07-0022, the GIP staff proposed changes in how the GIP uses GI review panels such that process formality is commensurate with the applicability and complexity of the GI under discussion. When a GI review panel is deemed appropriate, a GIP representative will coordinate individually and collectively with panel members to implement this tailored approach to GI assessment. This is expected to appreciably reduce staff resources and time required to assess GIs of lower risk-significance or complexity.

The GIP staff's screening analysis of GI-202 identified that actions taken by the NRC and affected licensees address the short-term impacts of spent fuel pool leakage and maintain performance within plant license and design bases to ensure adequate protection of public health and safety. On this basis, GIP staff believe the condition described in GI-202 presents relatively low risk. Therefore GIP staff considered the staff's GI-202 screening analysis to be suitable for review using the virtual panel approach.

Process

To facilitate the virtual panel review process, GIP staff prepared for and coordinated the panel's review activities and encouraged panel members to provide suggestions for process improvement. The virtual panel approach includes:

(1) GIP staff provided panel members information, including:
- GIP staff's screening analysis and related documents.
- August 2006 memo from Michael Mayfield to Farouk Eltawila proposing GI-202.
- Background information for virtual panel members as described above.
- Virtual panel process steps as described herein.
- Reference to MD 6.4 and GIP improvements described in SECY-07-0022.

(2) Panel members received and reviewed relevant screening documents.

(3) Panel members provided questions and feedback to the GI-202 project manager regarding the screening analysis and to the Operating Experience and Generic Issues Branch Chief (Jack Foster) regarding the virtual panel process.

(4) Panel members determined whether: (a) GI-202 is suitable for continued review and assessment under the GIP, or (b) GI-202 should be closed out of the GIP based on established screening criteria. Panel members reached their conclusions within a few days and provided an e-mail indicating their decision their rationale, as appropriate.

(5) After panel members reached their consensus determination (not necessarily unanimous), the GI-202 project manager prepared a memorandum (and associated concurrence package) from the GI-202 Screening Panel Chair to the Director of the Office of Nuclear Regulatory Research (RES). This memorandum presents the collective results, conclusions, and recommendations from the virtual panel review. The GIP staff then provided this draft memorandum to panel members for review and comments and then for concurrence.

Virtual Panel Members

Kenneth O'Brien, Panel Chairperson. (Acting Deputy Director, Division of Engineering, NRR. Currently Region III/EICS) 630-810-4373
Ata Istar, Panel Member. (RES/DFERR/ERA/MSEB) 301-415-6601
Gordon Bjorkman, Panel Member. (NMSS/DSFST/TRD/S) 301-492-3298

Summary of Individual Virtual Panel Member's Comments

<u>Kenneth O'Brien Comments</u>

Using the guidance and criteria of Management Directive 6.4, Generic Issues Program, and Appendix G of the MD 6.4 Handbook, I do not believe that this issue meets the criteria for being pursued as a generic issue. Specifically, while the issue has the potential to affect all licensees of pressurized water reactors, it is not clear to me that the regulations governing the design, operation, maintenance, and repair of safety related structures, including spent fuel pools, are insufficient or unnecessary, a criteria for inclusion of the issue in the program.

In discussions with the Branch Chief for DE/EMCB, I also noted that industry standards exist (e.g., American Concrete Institute [ACI] 349, "Concrete Nuclear Structures," 201.1R-92, "Guide

for Making a Condition Survey of Concrete in Service," and American Society of Testing and Material [ASTM] C805, "Standard Test Method for Rebound Number of Hardened Concrete") in addition to the requirements of 10 CFR 50, Appendix A and B, to ensure a proper and timely evaluation of leaks that may develop with spent fuel pools and their impact on the concrete structure. Because these concerns expressed were associated with long term degradation of the structures, the issue appears to be more of a concern with the adequacy of individual licensee corrective actions for a degraded condition than of an unknown interaction phenomenon.

I also reviewed the other aspects of the generic issue screening process and noted that the issue did not appear to meet these criteria.

Therefore, I do not recommend that this issue should be evaluated as a part of the generic issues program.

Gordon Bjorkman Comments

Based on review of the preliminary screening analysis paper and the August 2006 memo from Michael Mayfield to Farouk Eltawila, I have concluded that GI-202, "Spent Fuel Pool Structural Degradation due to Borated Water Leakage," should continue to be reviewed in the Generic Issues program.

It is well known that boric acid corrodes carbon steel reinforcement. Therefore, in considering whether GI-202 should continue to be reviewed, several factors must be evaluated, including:

1. The percent of boric acid in SFPs.
2. The general rate of corrosion of carbon steel subject to this boric acid concentration.
3. Other factors that could enhance or diminish the rate of corrosion.
4. The likelihood that borated water leakage paths in concrete are located in the high stress (high demand) regions of the SFP.
5. The research that has been performed to date to support a conclusion that GI-202 is not a generic issue.

Discussion:

Typical boric acid concentrations in SFPs is about 2.5%. For boric acid concentrations of 5% (the lowest % I could find), carbon steel corrodes at a rate of 0.02 to 0.05 inches per year at any temperature. Even at a rate of 0.01"/year, over a 40 to 60 year plant life, this could amount to ½" of corrosion, which would render a #8 rebar completely corroded. While the concrete itself may lower the acidity of the borated water, cracks and crevasses adjacent to the rebar can attract impurities, such as chlorides and anions that lower the PH and increase corrosion rates. The actual corrosion rate is therefore unknown.

Shrinkage cracks in concrete are small and generally uniformly distributed throughout the SFP, however, the largest cracks are typically structural cracks produced by mechanical loads and thermal radiants and would be expected to occur in the most highly stressed regions of the SFP near the base of the walls and base mat. Thus, the locations where corrosion is likely to be

most prevalent are in the most highly stressed regions of the SFP. We know that leakage in PWR and BWR SFPs has been going on for some time and, no evidence has been presented to show that the corrosion of steel reinforcement from boric acid is not occurring in SFP structures.

Conclusion:

Based on the corrosiveness of boric acid and lack of evidence to show that corrosion is not occurring, one must conclude that boric acid corrosion of steel reinforcement (at some unknown rate) is occurring in SFP structures, and that the problem may only get worse with time. Therefore, research should be initiated as soon as possible to investigate the long term corrosion potential of borated water on SFP rebar.

This conclusion reflects the technical assessment described above without consideration of specific GIP requirements, guidance, and criteria for screening proposed GIs described in MD 6.4.

Kenneth O'Brien's Response to Gordon's Comments

Notwithstanding the information that Gordon provided, I am still not convinced that the issue is one that belongs in the generic issues program based upon the guidance of the management directive and SECY-07-0022.

The information that Gordon presents is of a theoretical nature, would only apply to pressurized water reactors, since I am not aware of any boiling water reactors that use boron in their spent fuel pools, and appears to be extremely conservative since most reactors have a stainless steel liner between the pool water and the concrete structure and have a drain system to remove any leakage that may occur from maintaining constant contact with the concrete structure. Finally, I am not sure that I agree that no evidence to the contrary exists regarding a significantly smaller impact of leakage at existing sites. I think the lack of appreciable leakage from spent fuel pools and operating drainage systems would be two very concrete pieces of evidence that significant corrosion is not presently occurring at most sites.

Ata Istar Comments (summarized from Ata Istar's mark-up of GIP staff screening analysis)

This GI involves the potential for long-term adverse integrity effects on SFP structures from borated water leaking through the stainless steel liner in SFPs at PWRs, then through cracks in the concrete behind the stainless steel liner, and consequently around reinforcing steel (rebar) within the concrete. Licensees are to maintain the integrity of their SFPs and identify and correct the causes of conditions adverse to quality pursuant to existing regulatory requirements. Recent NRC generic communications (i.e., IN 2004-05 and IN 2006-13) informed licensees of some potential adverse impacts from SFP leakage. Previous NRC generic communications (i.e., GL 88-05, IN 2002-11, Bulletin 2002-01, and IN 2003-02) describe conditions in which leakage of borated water has resulted in boric acid degradation of carbon steel components important to safety.

Well-cured concrete has low permeability for elements that can induce corrosion such as chloride ions, carbon dioxide, etc. Furthermore, concrete provides a high alkaline environment for reinforcing steel, which protects the carbon steel rebar against corrosion at ambient temperatures. These inherent protective characteristics of concrete make it unlikely that low acidic sources such as borated water in Spent Fuel Pools at PWRs would corrode reinforcing steel to an extent that could degrade the structural integrity of the SFP structures in the short term. However, long-term effects of corrosion degradation of reinforcing steel at low alkaline or low acidic environments are not well understood. Therefore, if an adverse trend of this condition develops in the industry, then research on the detrimental effects of borated water on the integrity of reinforced concrete in service might be warranted to improve understanding of permeability, impact on concrete strength and bonding, corrosion rates on reinforcing steel, etc. Results from such additional research might contribute to improved analytical structural analyses of the long-term impact on SFP structural integrity.

This issue should be eliminated from further pursuit as a generic issue because it does not satisfy applicable screening criteria of MD 6.4 and SECY-07-0022.

1. The potential for adverse impact on the structural integrity of SFP structures in both the short-term and in the long-term is a matter of regulatory compliance.
2. The potential for adverse impact involving ground water contamination is addressed by recent NRC generic communications.
3. The plant licensees have assessed the potential for adverse impact on structural integrity and determined the design licensing basis remains satisfied.
4. The plant licensees have taken additional measures to improve routine monitoring for detection and correction of the condition, as appropriate.

Virtual Panel Consensus Outcome

Results

The panel member's reviews and evaluations (described above) resulted in the following:

Two panel members recommended against evaluating GI-202 further under the GIP based on the issue not passing the screening criteria described in MD 6.4 and SECY-07-0022.

One panel member recommended that GI-202 continue to be evaluated under the GIP based on the evidence indicating boric acid may have seeped into the SFP concrete and acted on the rebar, the corrosiveness of boric acid on carbon steel rebar and the lack of evidence that rebar corrosion is not occurring. This panel member recommended that research on the long term corrosion potential of borated water on SFP rebar be initiated as soon as possible.

Two panel members also emphasized the large uncertainties associated with boric acid corrosion under the conditions described in GI-202. One of these panel members noted that if the industry experiences an increasing adverse trend of long-term leakage of borated water into SFP structures, then further research of this condition might be warranted to improve

understanding of the phenomena, reduce the uncertainties, and to account for degradation rate in cross-sectional properties in the original SFP structural integrity analyses.

Conclusions

The virtual panel consensus outcome is that this issue should be removed from the GIP because the necessary regulatory tools are already in place and GI-202 does not meet the criteria for the Generic Issues Program based on the following:

1. The exiting regulatory framework of 10 CFR Part 50 Appendix A and B governs the condition described in GI-202, making this a regulatory compliance issue.
2. The plant specific conditions described have been addressed as documented in applicable NRC inspection reports (i.e., per the reactor oversight process).
3. There is no apparent decrease in design license capability or reliability of SFP structures, systems, or components due to leakage of borated water.
4. Maintenance rule requirements would apply if the condition were risk-significant.
5. Recent generic communications inform licensees of the potential for adverse impacts on structural integrity of reinforced concrete due to leaking borated water sources (See Information Notice (IN) 2004-05 and IN 2006-13).

Recommendations

1. The panel recommends the issue described in GI-202 continue to be pursued under the regulatory oversight process (ROP) as a regulatory compliance issue, as appropriate.

2. The panel also recommends continued vigilance by the ROP for possible future instances of SFP leakage to recognize the potential need for further research on the detrimental effects of borated water on the integrity of reinforced concrete in service. If industry trends indicated that further research is warranted to better understand and establish the technical basis and safety impact of borated water on concrete, then NRR could exercise the User Need process to request RES assistance.