DAVIS-BESSE LESSONS LEARNED TASK FORCE RECOMMENDATIONS REGARDING STRESS CORROSION CRACKING

TAC No.	Description
MB2916	Non plant-specific activities for Bulletin 2001-01
MB3567	VHP Action Plan (Coordination and Administration)
MB3954	Development of CRDM NUREGs (Bulletin 2001-01)
MB4495	Lead PM Activities for Bulletin 2002-01
MB4603	Non plant-specific activities for Bulletin 2002-01
MB5465	Lead PM Activities for Bulletin 2002-02
MB6218	Inspection TI for Bulletin 2002-02
MB6220	Review of NEI/MRP Crack Growth Rate Report (MRP-55)
MB6221	Development of Alternate (to ASME Code) RPV Head and VHP Inspection Requirements
MB6222	Review of NEI/MRP RPV Head and VHP Inspection Plan (MRP-75)
MB7182	Orders for Interim Inspection Guidelines
MB9522	Review of Bulletin 2002-01 Responses
MB8915	Generic Activities for Lower Head Inspection
MB9891	Develop Bulletin 2003-02
MC0590	Develop Technical Issues Related to Incorporating RCPB Inspection Requirements into 50.55a
MC1036	Develop/Revise Inspection Guidance for ISI and BACC

Last Update: 09/30/05
Lead Division: DLPM
Supporting Divisions: DE, DSSA, DIPM, & DRIP
Supporting Offices: RES & Regions

	Milestone	Date (T=Target) (C=Complete)	Lead	Support
Part I - Reactor Pressure Vessel Head Inspection Requirements				
1.	Collect and summarize information available worldwide on Alloy 600, Alloy 690 and other nickel based alloy nozzle cracking for use in evaluation of revised inspection requirements. [LLTF 3.1.1(1)-High]	03/04 (C) ML040920026	RES/DET	DE
2.	Critically evaluate existing SCC models with respect to their continuing use in the susceptibility index. [LLTF 3.1.4(1)-Medium]	07/03 (C) ML032461221	RES/DET	DE

	Milestone	Date (T=Target) (C=Complete)	Lead	Support
3.	a. Complete initial evaluation of individual plant inspections in response to Bulletins and Orders. b. Continue to review future inspection results until permanent guidelines are issued.	05/04 (C) ML041560306 Ongoing	DE DE	DLPM Regions DLPM Regions
4.	Incorporate Order EA-03-009 requirements into 10 CFR 50.55a 1. Develop technical basis 2. Develop rulemaking plan 3. Commission decision	Note (2) 04/04 (C) ML040920628 ML040920638 07/04 (C) 08/04 (C) ML042190072	 DE DRIP	 DRIP DE
5.	Monitor and provide input to industry efforts to develop revised RPV Head inspection requirements (ASME Code Section XI). [LLTF 3.3.4(8)-High	06/05 (C) Note (1)	DE	RES/DET DSSA Regions Industry
6.	Participate in meetings and establish communications with appropriate stakeholders (e.g., MRP, ASME). [LLTF 3.3.4(8)-High]	Ongoing	DE	RES/DET DLPM DRIP DSSA industry
7.	Review and evaluate revised ASME Code requirements when issued. [LLTF 3.3.4(8)-High]	TBD Note (1)	DE	RES/DET
8.	If revised ASME Code requirements are acceptable, establish schedule to incorporate by reference into 10 CFR 50.55a. [LLTF 3.3.4(8)-High]	TBD Note (1)	DE	DRIP DIPM DSSA RES/DET industry public
9.	Publish a NUREG report summarizing findings from Part I, Items 1 and 2, and Part II, Item 1.	03/05 (C) NUREG-1823 ML050690012	RES/DET	DE
10.	Propose a course of action and implementation schedule to address the results of the analysis of Part I, item 1, and Part II, item 1 [LLTF 3.1.1(1)-High]	10/04 (C) ML043010675	DE	RES/DET

	Milestone	Date (T=Target) (C=Complete)	Lead	Support
Part II - Boric Acid Control				
1.	Collect and summarize information available worldwide on boric acid corrosion of pressure boundary materials for use in evaluation of revised inspection requirements. [LLTF 3.1.1(1)-High]	10/04 (C) ML043000274	RES/DET	DE
2.	a. Evaluate individual plant responses to Bulletin 2002-01 regarding Boric Acid Inspection Programs (60-day responses and necessary follow-up)	06/03 (C) ML031760568	DE	DLPM
	b. Issue public document to summarize evaluation of plant responses.	07/03 (C) ML032100653	DE	DLPM DRIP
3.	Participate in meetings and establish communications with appropriate stakeholders (e.g.,MRP, ASME).	Ongoing	DE	RES/DET DLPM DRIP DSSA industry
4.	Evaluate need to take additional regulatory actions and determine appropriate regulatory tool(s).	06/03 (C) ML031760568	DE	DLPM DRIP DIPM DSSA Regions
5.	Issue Bulletin 2003-02 on Reactor Vessel Lower Head inspection	08/03 (C) ML032320153	DE	DLPM
6.	Develop milestones for additional regulatory actions, as necessary.	07/03 (C)	DE	DLPM DSSA DRIP
7.	Complete and evaluate the results of ongoing research on materials degradation, engage external stakeholders and develop a plan to implement a proactive approach to manage degradation of the RCPB.	06/06 (T)	DE	RES
8.	Review and evaluate the adequacy of revised ASME Code Requirements for Pressure Testing/Leakage Evaluation being developed by the ASME Code, Section XI, Task Group on Boric Acid .	12/05 (T) Note (1)	DE	RES/DET
Part III - Inspection Programs				
1.	Develop inspection guidance or revise existing guidance to ensure that VHP	06/04 (C)	DIPM	DE Regions

Milestone	Date (T=Target) (C=Complete)	Lead	Support
nozzles and the RPV head area are periodically reviewed by the NRC during licensee ISI activities. [LLTF 3.3.4(3)-High]			
2. Develop inspection guidance that provides for timely, periodic inspection of PWR plant BACC programs. [LLTF3.3.2(1)-High]	06/04 (C)	DIPM	DE Regions
3. a. Develop inspection guidance for assessing the adequacy of PWR plant BACC programs (implementation effectiveness, ability to identify leakage, adequacy of evaluation of leaks). [LLTF 3.2.2(1)-High]	06/04 (C)	DIPM	DE RES/DET Regions
b. Perform follow-up evaluation of inspection guidance and licensee program acceptability after conducting inspections for approximately one year.	05/05 (C) ML051360392	DIPM	DE RES/DET Regions

Notes: (1) Milestone dates are dependent upon issuance of industry proposals.

(2) Requirements for inspection of only the upper head will be the subject of this rulemaking.

Description: The reactor vessel head (RVH) degradation found at Davis-Besse, along with other documented incidences of circumferential cracking of vessel head penetration (VHP) nozzles, have prompted the staff to question the adequacy of current RVH and VHP inspection programs that rely on visual examinations as the primary inspection method. Also, the failure to adequately address indications of boric acid leakage at Davis-Besse raised questions as to the efficacy of industry boric acid control (BACC) programs. Finally, review of the Davis-Besse event identified deficiencies in the NRC inspection programs.

Historical Background: In March 2002, while conducting inspections in response to Bulletin 2001-01, the Davis-Besse Nuclear Power Station identified three CRDM nozzles with indications of axial cracking, which were through-wall, and resulted in reactor coolant pressure boundary leakage. During the nozzle repair activities, a 7 inch by 4-to-5 inch cavity on the downhill side of nozzle 3, down to the stainless steel cladding was identified. The extent of the damage indicated that it occurred over an extended period and that the licensee's programs to inspect the RPV head and to identify and correct boric acid leakage were ineffective.

One of the NRC follow-up actions to the Davis-Besse event was formation of a Lessons Learned Task Force (LLTF). The LLTF conducted an independent evaluation of the NRC's regulatory processes related to assuring reactor vessel head integrity in order to identify and recommend areas of improvement applicable to the NRC and the industry. A report summarizing their findings and recommendations was published on September 30, 2002. The report contains several consolidated lists of recommendations. The LLTF report was reviewed by a Review Team (RT), consisting of several senior management personnel appointed by the Executive Director for Operations (EDO). The RT issued a report on

November 26, 2002, endorsing all but two of the LLTF recommendations, and placing them into four overarching groups. On January 3, 2003, the EDO issued a memo to the Director, NRR, and the Director, RES, tasking them with developing a plan for accomplishing the recommendations. This action plan addresses the recommendations in the "Assessment of Stress Cracking" grouping of the RT report. The LLTF recommendations are listed in the attached Table 1, and have been identified under the appropriate milestone(s).

Proposed Actions: The staff is interacting with all PWR licensees, the American Society of Mechanical Engineers (ASME), the Electric Power Research Institute (EPRI) Materials Reliability Program (MRP), and other external stakeholders in addressing the issues discussed above. This action plan includes milestones aimed at guiding the NRC and industry to effectively manage RVH degradation and BACC. Throughout the implementation of this action plan, the NRC will establish the necessary communications mechanisms to ensure that the NRC, the industry, and all stakeholders are informed and sharing the same information. This will be accomplished through public meetings, technical working groups, ACRS briefings, and web site postings, as appropriate.

The Part I milestones deal with development of improved inspection requirements for the RPV head and VHP nozzles. Interim inspection guidelines for the RPV upper head have been issued via Order EA-03-009 and associated temporary inspection guidelines (TI-150) have been issued for use by NRC inspectors. These will be updated as needed based on inspection results. The staff will monitor and assess the adequacy of revisions to the ASME Boiler and Pressure Vessel Code regarding RPV head inspection, which will be based on the inspection program developed by the EPRI MRP. If the revised ASME Code requirements are acceptable, based on the staff's technical evaluations, the NRC will initiate action to incorporate them by reference in a revision to 10 CFR 50.55a.

The Part II milestones evaluate whether industry BACC programs are meeting NRC expectations and whether additional inspection guidance should be issued. First, the staff will establish a technical basis for BACC program requirements through ongoing and planned research programs. This will include evaluation of boric acid events in past reports and in responses to Bulletin 2002-01, and studies of rates of reactor pressure boundary materials in boric acid solutions. The staff is also monitoring development of revised ASME Code requirements by the Section XI Task Group on Boric Acid. If the staff determines that additional interim guidelines are needed prior to issuance of the revised Code requirements, they will be issued by an appropriate regulatory tool. When the ASME Code requirements are revised, the NRC will initiate action to endorse them, if acceptable. If the revised ASME code requirements cannot be made acceptable to the NRC, then alternate requirements would have to be developed and implemented by an appropriate regulatory tool. Based on the leaks discovered in lower vessel head penetrations at South Texas Project, the staff issued Bulletin 2003-02 regarding RPV lower head inspections. Associated temporary inspection guidelines (TI-152) were issued for use by NRC inspectors. The staff will complete and evaluate the results of ongoing research on materials degradation, engage external stakeholders and develop a plan to implement a proactive approach to manage degradation of the RCPB.

The Part III milestones address the LLTF findings that the NRC inspection guidelines did not provide effective oversight of licensee RPV head inspection and BACC programs. Revised guidelines for these activities will be developed. Throughout the process of establishing new requirements, existing NRC inspection procedures would be evaluated to verify whether they adequately address the revised requirements, and would be updated as needed.

Originating Documents:

Memorandum from Travers, W.D. to Collins, S. and Thadani, A. C., dated January 3, 2003, "Actions Resulting From The Davis-Besse Lessons Learned Task Force Report Recommendations." (ADAMS Accession No. ML023640431)

Memorandum from Paperiello, C.J. to Travers, W.D., dated November 26, 2002, "Senior Management Review of the Lessons-Learned Report of the Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head." (ADAMS Accession No. ML023260433)

Memorandum from Howell, A.T. to Kane, W.F., dated September 30, 2002, "Degradation of the Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head Lessons-Learned Report." (ADAMS Accession No. ML022740211)

Regulatory Assessment: The current method for managing PWSCC in the VHP nozzles of U.S. PWRs is dependent on the implementation of inspection methods intended to provide early detection of degradation of the reactor coolant pressure boundary. Title 10, Section 50.55a(g)(4) of the *Code of Federal Regulations* requires, in part, that ASME Code Class 1, 2, and 3 components must meet the inservice inspection requirements of Section XI of the ASME Boiler and Pressure Vessel Code throughout the service life of a boiling or pressurized water reactor. Pursuant to Inspection Category B-P of Table IWB-2500-1 to Section XI of the ASME Boiler and Pressure Vessel Code, licensees are required to perform VT-2 visual examinations of their vessel head penetration nozzles and reactor vessel heads once every refueling outage for the system leak tests, and once an inspection interval for the hydrostatic pressure test.

Based on the experience with the VHP nozzle cracking phenomenon, the VT-2 visual examination methods required by the ASME Code for inspections of VHP nozzles do not provide reasonable assurance that leakage from a through-wall flaw in a nozzle will be detected. The VT-2 visual examination methods specified by the ASME Code are not directed at detecting the very small amounts of boric acid deposits, e.g., on the order of a few grams, that have been associated with VHP nozzle leaks in operating plants. In addition, the location of thermal insulating materials and physical obstructions may prevent the VT-2 visual examination methods from identifying minute amounts of boric acid deposits on the outer surface of the vessel head. Specifically, Paragraph IWA-5242 of Section XI of the ASME Boiler and Pressure Vessel Code does not require licensees to remove thermal insulation materials when performing ASME VT-2 visual examinations of reactor vessel heads. Cleanliness of reactor vessel heads during the examinations, which is critical for visual examination methods to be capable of distinguishing between boric acid residues that result from VHP nozzle leaks and those residues that result from leaks in other reactor coolant system components, is not addressed by the ASME Code.

Based on knowledge obtained from evaluation of the Davis-Besse event, and information provided from PWR licensees in response to Bulletins 2001-01, 2002-01, and 2002-02, the NRC issued an Order to all PWR plants establishing enhanced inspection requirements on an interim basis, which will provide adequate assurance of safe plant operation until permanent requirements are established and promulgated.

Current Status: Part I activities included continued monitoring of outage inspection results, follow-up with plants discovering defects, and evaluation of requests for relaxation from First Revised Order EA-03-009.

The staff evaluated the existing SCC models and determined that they are acceptable for use in prioritizing RPV head inspections. The report is publicly available in ADAMS (ML032461221).

The staff collected information on Alloy 600, Alloy 690 and other nickel-based alloy nozzle cracking and issued a summary report for internal use. The report is publicly available in ADAMS (ML040910354).

The staff developed a rule plan to incorporate the inspection requirements for the RPV upper head into 10 CFR 50.55a. This was submitted for Commission approval in July 2004. The Commission decided not to proceed with this rulemaking and directed the staff to continue to work with the industry to incorporate revised inspection requirements into the ASME code (SRM-SECY-04-0115, August 6, 2004). The staff participated in ASME Code Committee development of revised inspection requirements. In June 2005, the ASME Board on Nuclear Codes and Standards approved Code Case –729, which provides additional inspection requirements for RPV upper heads. Therefore, Part I, item 5 is considered complete. Once Code Case –729 is formally published (expected in December 2005), the staff will evaluate endorsing it in a revision to 10 CFR 50.55a.

In Part II activities, the review and evaluation of licensee responses to Bulletin 2002-01 regarding BACC have been completed. A summary of the evaluation was published in RIS 2003-13 (ML032100653). The

evaluation of responses to Bulletin 2002-01, which included audits of BACC programs at five plants, determined that the plants complied with requirements at the programmatic level. In general, the results indicated weaknesses in the licensees' BACC and ASME Section XI programs. The weaknesses identified in the RIS included identifying pressure boundary leakage and potential leakage paths, looking for boric acid crystals, walking down systems when the plant is entering or leaving the hot shutdown mode, and detecting small leaks during normal power operation. Based on this review and the discovery of leakage on vessel bottom penetrations at South Texas Project, Bulletin 2003-02 was issued.

The staff collected information on available worldwide operating experience on boric acid corrosion of pressure boundary materials. The staff also contracted Argonne National Lab to conduct a test program on boric acid corrosion of light-water reactor pressure vessel materials. The results were published in NUREG/CR-6875. This information and the information previously collected on nozzle cracking along with the staff evaluation of the SCC models have been incorporated into NUREG-1823, "U.S. Plant Experience with Alloy 600 Cracking and Boric Acid Corrosion of Light-Water Reactor Pressure Vessel Materials" (ML050690012).

The staff used the information collected on boric acid corrosion and the information previously collected regarding Alloy 600, Alloy 690 and other nickel-based alloy nozzle cracking to develop a course of action and an implementation schedule to address LLTF 3.1.1(1). The staff met with industry representatives on March 24, 2005, to discuss their activities for addressing PWSCC in nickel based alloy butt welds and in other locations in the reactor coolant system. The presentations were high level and lacked the technical details and schedular commitments the staff were expecting. The staff also held a meeting with industry representatives on September 29, 2005, during which representatives of the Materials Reliability Program indicated that their inspection guidelines for this issue would not be available until the end of 2006. Based on the results of these meetings and interactions with NRR senior management, the staff is evaluating Code Case N-722 for incorporation into 10 CFR 50.55a. This code case was approved by the ASME in August 2005. It contains inspection rules for boric acid corrosion and cracking of nickel-based alloy nozzles and addresses the course of actions associated with the closure of LLTF 3.1.1(1). A proposed rule that will add a reference to Code Case N-722 is expected to be published next summer. The final rule is expected to be published in FY07.

In Part III activities, inspection procedure revisions addressing RPV head inspection and boric acid corrosion control programs were issued. Temporary Instruction (TI) 2515/150, issued on October 18, 2002, provides guidance for assessing the licensees' RPV head inspections pursuant to Order EA-03-009. The TI also includes instructions for follow-up on findings of boric acid accumulation. Inspection Procedure (IP) 71111.08, "Inservice Inspection Activities," dated May 14, 2004, provides periodic inspection requirements and guidance for boric acid corrosion control. The Regions provided feedback regarding the implementation of TI 2515/150 and IP 71111.08 since October 2002. In addition, the Inspection Program Branch (IIPB) reviewed inspection results from TI 2515/150 and IP 71111.08. As a result of the licensees' visual and non-visual inspections and NRC direct observations and oversight of licensees' activities, a number of facilities have made repairs to their vessel heads and some have replaced the vessel heads. In some cases, repairs were required; in others the licensee took actions voluntarily. Feedback from each Region and IIPB staff review indicates that the licensees' programs are generally adequate for locating and evaluating and/or correcting boric acid leaks. Although several inspection findings were identified, none were of greater than very low significance. The staff will continue to evaluate the effectiveness of this IP as part of annual ROP self-assessment and make appropriate improvements as needed.

Schedule Changes Since Last Update: None

Contacts:

NRR Lead PM:	Brendan Moroney, DLPM, 415-3974
NRR/DE Lead Contact:	William Bateman, EMCB, 415-2795
NRR/DE Technical Contacts:	William Koo, EMCB, 415-2706
	Edmund Sullivan, EMCB, 415-2796
RES Technical Contact:	William Cullen, DET/MEB, 415-6754
NRR/DIPM Lead Contact:	Stuart Richards, IIPB, 415-1257