

SUPPLEMENTAL SAFETY EVALUATION

OFFICE OF NUCLEAR REACTOR REGULATION

BOILING WATER REACTOR (BWR) VESSEL AND INTERNALS PROJECT (BWRVIP)

TOPICAL REPORT (TR) "BWR VESSEL AND INTERNALS PROJECT, GUIDELINES FOR
SELECTION AND USE OF MATERIALS FOR REPAIRS TO BWR INTERNALS (BWRVIP-84)"

PROJECT NO. 704

1.0 INTRODUCTION

1.1 History

By letter dated November 1, 2000 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML003768819), as supplemented by letters dated March 26, 2002 (ADAMS Accession No. ML020880255), March 24, 2004 (ADAMS Accession No. ML040860433), and July 30, 2004 (ADAMS Accession No. ML042160157), the BWRVIP submitted to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval the Electric Power Research Institute (EPRI) proprietary report 1000248, "BWR Vessel and Internals Project, Guidelines for Selection and Use of Materials for Repairs to BWR Internals (BWRVIP-84)." The BWRVIP-84 TR provides guidance on the selection and use of materials for the repair and/or replacement of reactor vessel internal (RVI) components. The BWRVIP-84 TR is applicable to General Electric (GE) reactors BWR/2-6 that are implementing RVI component repairs and/or replacements consistent with the BWRVIP repair design criteria (RDC).

The NRC staff reviewed the BWRVIP-84 TR and by letter dated September 6, 2005 (ADAMS Accession No. ML052500529), issued its safety evaluation (SE) with open items (OIs). By letter dated December 5, 2006 (ADAMS Accession No. ML063410283), the BWRVIP addressed the OIs, which are discussed in Section 2.0 of this SE.

1.2 Purpose and Applicability

The BWRVIP-84 TR provides guidance on the selection and use of materials for the repair and/or replacement of RVI components. The BWRVIP-84 TR is applicable to GE reactors BWR/2-6 that are implementing RVI component repairs and/or replacements consistent with the BWRVIP RDC.

2.0 STAFF EVALUATION

Open Item 3.1(a) Exceptions to RDC

In OI 3.1(a) of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the

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BWRVIP revise the first bullet in Section 1.4 of the TR as follows:

Exceptions to this document are considered exceptions to the RDC, with each exception to be specifically identified and justified, approved by the plant owner, and submitted for NRC review and approval in the submittal covering the repair/replacement.

The BWRVIP's December 5, 2006, response to OI 3.1(a) stated:

The BWRVIP notes that requirements for handling exceptions to RDC are listed in the TR BWRVIP-95-A, "BWR Vessel and Internals Project, Guide for Format and Content of BWRVIP Repair Design Submittals," recently approved by the NRC staff. Exceptions to BWRVIP-84 are considered exceptions to the RDCs and must, therefore, be handled in accordance with BWRVIP-95-A. Rather than have requirements for dealing with exceptions defined in two separate reports, the BWRVIP proposes that requirements be contained only in BWRVIP-95-A. It is further proposed that the subject paragraph from BWRVIP-84 be limited to a reminder to the utility that deviations from BWRVIP-84 are, indeed, considered exceptions to the RDCs. The following words are suggested to replace the first bullet in Section 1.4:

Exceptions to this document are considered exceptions to the RDC.

The NRC staff's evaluation of the BWRVIP response to OI 3.1(a):

The NRC staff accepts the BWRVIP response because the BWRVIP-95-A TR addresses the approval requirements when exceptions are taken to the requirements specified in the BWRVIP-84 TR and in the relevant RDC. Therefore, the NRC staff concludes it is not necessary to address the approval process in the BWRVIP-84 TR when a licensee takes any exceptions to the requirements specified in the BWRVIP-84 TR and in the relevant RDC. The NRC staff considers OI 3.1(a) to be adequately resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

Open Item 3.1(b) Exceptions to RDC

In OI 3.1(b) of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP revise the second bullet in Section 1.4 of the TR as follows:

Material utilized for temporary repair/replacements may deviate from these guidelines as long as a technical justification for the deviation is pre-approved by the NRC staff. The technical justification shall demonstrate that the material complies with the design criteria and that it has adequate corrosion resistance in a BWR environment. In addition, the technical justification shall provide adequate assurance that the material used in RVI components shall maintain its integrity under service conditions and that the intended function of the RVI component shall be maintained during plant operation. Prior approval by the NRC staff is required when a material that does not comply with the BWRVIP-84 guidelines is used for temporary repair/replacement of RVI components.

The BWRVIP's December 5, 2006, response to OI 3.1(b) stated:

The BWRVIP agrees with the NRC staff suggestion and will incorporate the change. It is

proposed, however, that the second sentence be modified to read, "The technical justification shall demonstrate that the material is suitable for the intended application and that it has adequate corrosion resistance in a BWR environment."

Note also that materials not meeting BWRVIP-84 requirements, whether used in temporary or permanent repairs, would have to be submitted to the NRC staff for review and approval per BWRVIP-95.

The NRC staff's evaluation of the BWRVIP response to OI 3.1(b):

The NRC staff accepts the BWRVIP's proposed revision because the BWRVIP has agreed to include NRC staff's statements in its SE for the BWRVIP-84 TR with minor editorial revision. The NRC staff's review of this proposed editorial revision indicates that this revision does not affect the intent of the temporary repair criteria. Since all deviations to the BWRVIP-84 guidelines will be reviewed by the NRC staff, the NRC staff considers OI 3.1(b) to be adequately resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

Open Item 3.1-Exceptions to RDC

In OI 3.1(c) of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP revise the third bullet in Section 1.4 of the TR as follows:

Establishment of more stringent (conservative) requirements by the plant owner is not considered an exception. If a licensee chooses to implement a "more stringent" requirement, the licensee should, however, document its basis for determining that the alternate requirement is "more stringent," in particular, with respect to not increasing susceptibility to inservice degradation and not decreasing structural margins.

The BWRVIP's December 5, 2006, response to OI 3.1(c) stated:

The BWRVIP agrees with the change and will revise the report as suggested.

The NRC staff's evaluation of the BWRVIP response to OI 3.1(c):

Since the BWRVIP agreed to revise the third bullet in Section 1.4 of the TR to reflect the NRC staff's position, the NRC staff considers OI 3.1(c) to be adequately resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

Open Item 3.1-Exceptions to RDC

In OI 3.1(d) of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP revise the first bullet in Section 1.5 of the TR as follows:

No modification of existing repair/replacement hardware is required by this document unless there is an OI related to the materials requirements in the NRC staff SE of a specific RDC.

The BWRVIP's December 5, 2006, response to OI 3.1(d) stated:

Since there are no longer any open items related to the individual RDC, and since all

material requirements have been moved from the RDCs to BWRVIP-84, the BWRVIP proposes to retain the original wording of the paragraph.

The NRC staff's evaluation of the BWRVIP response to OI 3.1(d):

Since there are no OIs related to a specific RDC of any previous repair or any OIs related to RVI material requirements of any previous repair, the NRC staff accepts the BWRVIP's response and concludes that it is not necessary to revise the first bullet in Section 1.5 of the TR. Therefore, the NRC staff considers OI 3.1(d) to be adequately resolved.

Open Item 3.3-General Material Guidelines

In OI 3.3 of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP add the following to Section 4.0 of the TR:

If the material to be utilized is not resistant (i.e., non-L grade type 304/316 material) to intergranular stress corrosion cracking (IGSCC) or irradiation-assisted stress corrosion cracking (IASCC), or is not suitable for BWR reactor environmental conditions, the licensee will evaluate and justify the usage of the material on a case-by-case basis and will submit the proposal for NRC staff approval prior to initiation of the repair/replacement.

By letter dated December 5, 2006, the BWRVIP response to OI 3.3 stated:

The BWRVIP agrees with the intent of the comment. Section 4.1 of the guideline states that designs shall utilize materials that are "demonstrated to be highly resistant to IGSCC and IASCC, and be suitable for BWR reactor environmental conditions." Materials included in the NRC staff's proposed paragraph would not be in compliance with the requirement of Section 4.1. Consequently, in accordance with Section 1.4 of BWRVIP-84, as well as BWRVIP-95-A, these materials would have to be submitted to the NRC staff for review and approval prior to use. Since the requirement for NRC staff review and approval are adequately covered elsewhere in the guideline, the BWRVIP proposes that the suggested addition not be made.

The NRC staff's evaluation of the BWRVIP response to OI 3.3:

The NRC staff accepts the BWRVIP's response because Section 1.4 of the BWRVIP-84 TR requires the NRC staff's prior approval when any exceptions to RVI material requirements, e.g., usage of materials that are not resistant to IGSCC or IASCC, are to be taken by the licensees. Consequently, no editorial change is required to Section 4.0 of the BWRVIP-84 TR. Therefore, the NRC staff considers OI 3.3 to be adequately resolved.

Open Item 3.4-General Welding and Fabrication Guidelines

In OI 3.4 of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP add the following to paragraph 5.5 of the BWRVIP-84 TR:

The NRC staff further requires that the BWRVIP revise this section of the BWRVIP-84 report to include a reference to the BWRVIP-44 report, "BWR Vessel and Internals

Project, Underwater Weld Repair of Nickel Alloy Reactor Vessel Internals,” and the ASME Section XI Code Case N-516-2 which was approved by the NRC staff in Regulatory Guide 1.147, “Inservice Inspection Code Case Acceptability, Division 1,” Revision 13, with a limitation requiring the NRC staff’s prior approval of its use for underwater weld repairs/replacements of irradiated materials.

The BWRVIP’s December 5, 2006, response to OI 3.4 stated:

Paragraph 5.4 of the guideline currently states (in part) that “Underwater groove and fillet welding shall be in accordance with Code Case N-516-1.” To address the second part of the NRC staff comment, the BWRVIP proposes to change the wording to state that “Underwater groove and fillet welding shall be in accordance with Code Case N-516-2 as approved by the NRC staff in Regulatory Guide (RG) 1.147, Revision 13, or in accordance with future revisions of the Code Case as approved by the NRC staff. Additionally, should this Code Case be adopted into Section XI, the provisions may still be used once NRC staff has endorsed an Edition or Addenda of the Code containing those rules. (Note that the NRC staff approval of the Code Case contained in Revision 13 of Regulatory Guide 1.147 includes a limitation requiring the NRC staff’s prior approval of its use for underwater weld repairs/replacements of irradiated materials.)

With regard to inclusion of the BWRVIP-44 report, the BWRVIP does not believe this reference is warranted. BWRVIP-44 merely documented that certain types of underwater welding meet the requirements of Code Case N-516 (as well as other requirements). Since the BWRVIP-84 guideline (as revised) will require compliance with Code Case N-516-2, reference to BWRVIP-44 would not add additional requirements.

The NRC staff’s evaluation of the BWRVIP response to OI 3.4:

Consistent with the NRC staff’s recommendation, the BWRVIP agreed to reference ASME Code Case N-516-2 or its later editions with any conditions specified by the NRC staff in RG 1.147. Therefore, the NRC staff accepts the BWRVIP response. The BWRVIP-44 TR, which complies with ASME Code Case N-512, was developed for underwater welding of stainless steel materials using a flux-cored welding process. The NRC staff believes that referencing the BWRVIP-44 TR does not add or affect the requirements that are already specified in the BWRVIP-84 TR. Hence, the NRC staff concludes that it is not necessary to reference the BWRVIP-44 TR in the BWRVIP-84 TR. Therefore, the NRC staff considers OI 3.4 to be resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

Open Item 3.5-Design, Procurement, Fabrication, and Installation of 300 Series or Cast Equivalent Austenitic Stainless Steel for Use in BWR Internals

In OI 3.5.1 of the NRC staff’s SE dated September 6, 2005, the NRC staff requested that the BWRVIP add the following to Appendix A of the BWRVIP-84 TR:

The BWRVIP-84 report does not discuss, in detail, inspections of cast austenitic stainless steel (CASS) components. The NRC staff requires that the BWRVIP modify the BWRVIP-84 report to reference the BWRVIP-41 report, “BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines,” which discusses the susceptibility of CASS

components to IGSCC and neutron and/or thermal embrittlement effects and provides specific inspection and evaluation guidelines.

The BWRVIP's December 5, 2006, response to OI 3.5.1 stated:

The scope of BWRVIP-84 does not include the definition of inspection requirements for repaired components. Its scope is limited to specifying material and fabrication requirements. Inspection requirements are specified in two places: inspections for original components are found in the BWRVIP Inspection and Evaluation Guidelines (e.g., BWRVIP-41 for jet pumps); inspections for repaired components are to be specified by the repair designer as required by each of the RDC.

The NRC staff's evaluation of the BWRVIP response to OI 3.5.1:

The NRC staff reviewed the BWRVIP response and concludes that it is not necessary to address the inspection requirements in the BWRVIP-84 TR because the detailed inspection requirements of the CASS components are specified in the BWRVIP-41 TR and in the appropriate RDC. Therefore, the NRC staff considers OI 3.5.1 to be adequately resolved.

In OI 3.5.2(a) of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP add the following to the end of the proposed revision of Section A.9.2 of the BWRVIP-84 TR that:

The additional requirements that are stipulated in Section A.9.7 of the BWRVIP-84 report shall apply for the subsequent surface preparation of the cold worked stainless steel materials.

The BWRVIP's December 5, 2006, response to OI 3.5.2(a) stated:

The BWRVIP agreed to add the following sentence to the end of the revised Section A.9.2: "When these alternative techniques are utilized, the provisions of Section A.9.7 shall also apply."

The NRC staff's evaluation of the BWRVIP response to OI 3.5.2(a):

Section A.9.7 of the BWRVIP-84 TR requires additional surface preparation of the cold-worked stainless steel materials which mitigates initiation of IGSCC . Therefore, the NRC staff accepts the BWRVIP's response to OI 3.5.2(a) and considers OI 3.5.2(a) to be adequately resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

In OI 3.5.2(b) of the NRC staff's SE dated September 6, 2005, the NRC staff requested that the BWRVIP include additional requirements that are stipulated in Section A.9.7 in the proposed revision to Section A.3.3 of the BWRVIP-84 TR. The NRC staff also recommended that the BWRVIP include the following in the proposed revision to Section A.3.3 of the BWRVIP-84 TR:

Surface preparation techniques on the cold worked stainless steel materials will remove the cold worked surface condition which in turn reduces the susceptibility to stress corrosion cracking and fatigue cracking.

The BWRVIP's December 5, 2006, response to OI 3.5.2(b) stated:

In response to a prior request for additional information from the NRC staff, the BWRVIP agreed to revise section A.3.3 ("Surface Roughness") to read as follows:

The effect of surface roughness on fatigue and stress corrosion cracking shall be evaluated and appropriate surface finishes shall be specified. The surface finishing techniques described in Section A.9.2 may be considered for these applications. When surface finishing is performed per the guidance of Section A.9.2, the additional requirements of Section A.9.7 shall also be applied.

The NRC staff's evaluation of the BWRVIP response to OI 3.5.2(b):

Section A.9.2. addresses surface preparation techniques that are to be implemented on the cold worked stainless steel materials. The NRC staff believes that the surface finishing techniques that are stipulated in Section A.9.2 is essential in achieving quality surface finish which is essential in reducing cracking susceptibility due to IGSCC or fatigue. Therefore, the NRC staff requests that the BWRVIP revise the aforementioned BWRVIP proposal (second sentence) dated March 24, 2004, to read as follows:

"The surface finishing techniques described in Section A.9.2 shall be implemented, as necessary, to minimize material susceptibility to IGSCC and fatigue cracking."

The NRC staff finds this response, with the above modifications (including NRC staff's recommendation), acceptable because it provides guidance for maintaining a good surface finish which is essential in minimizing the potential for cracking due to IGSCC and fatigue. The NRC staff requests that the BWRVIP include its response dated March 24, 2004, with the NRC staff's proposed modifications in Section A of the BWRVIP-84-A TR.

Open Item 3.6.2 -Design, Procurement, Fabrication, and Installation of Alloy X-750 for Use in BWR Internals

In OI 3.6.2 of the NRC staff's SE dated September 6, 2005, the NRC staff recommended that the second sentence of Section B.3.3 be revised as follows.

The surface finishing techniques described in Section B.8.9 shall be implemented, as necessary, to minimize material susceptibility to IGSCC and fatigue cracking.

The BWRVIP's December 5, 2006, response to OI 3.6.2 stated:

After further consideration, the BWRVIP does not believe the response made to the NRC RAI was entirely appropriate. X-750 is not typically employed in a cold worked condition in BWR application. Following any cold working, the component is subjected to a precipitation hardening heat treatment of at least 1300F, to produce the appropriate IGSCC resistant structure and the required strength. The corrosion resistance of Alloy X-750 is dependent on the final precipitation hardening. Any significant cold work following the precipitation hardening heat treatment can deteriorate this condition. For this reason, Section B.8.9 specifies strict requirements for any final surface finishing

applied after hardening. In light of these considerations, the BWRVIP proposes to revise Section 3.3 (Surface Roughness) as follows.

B.3.3 Surface Roughness: The effect of surface roughness on fatigue and stress corrosion cracking shall be evaluated. Final surface finishes shall be specified only if necessary and shall be applied in accordance with the requirements of B.8.9.

The NRC staff's evaluation of the BWRVIP response to OI 3.6.2:

The NRC staff reviewed the response and concludes that the BWRVIP response is acceptable because: (1) Alloy X-750 will not be used in cold worked condition, hence, further surface preparation of this material is not required and, (2) the BWRVIP proposed to include surface finishing of Alloy X-750 only if necessary to minimize cracking due to fatigue or SCC. Therefore, the NRC staff considers OI 3.6.2 to be adequately resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

Open Item 3.7.1 -Design, Procurement, Fabrication, and Installation of Type XM-19 Austenitic Stainless Steel for Use in BWR Internals

In OI 3.7.1 of the NRC staff's SE dated September 6, 2005, the NRC staff recommended that the second sentence of the revised Section C.3.3 be revised as follows:

Surface finishing techniques involving the use of flappers, controlled machining in accordance with demonstrated procedure, mechanical polishing or electro-polishing, among others shall be implemented, as necessary, to minimize material susceptibility to IGSCC and fatigue cracking.

The BWRVIP's December 5, 2006, response to OI 3.7.1 stated:

The BWRVIP concurs and will revise the report as suggested.

The NRC staff's evaluation of the BWRVIP response to OI 3.7.1:

Consistent with the NRC staff's request, the BWRVIP agreed to revise Section C.3.3 to indicate surface finishing techniques that will be used on any cold worked XM-19 material. Therefore, the NRC staff considers OI 3.7.1 to be adequately resolved when the BWRVIP includes its response to this item in the BWRVIP-84-A TR.

Open Item 3.9—Non-Destructive Examination:

In OI 3.9 of the NRC staff's SE dated September 6, 2005, the NRC staff stated:

The BWRVIP-84 report does not discuss in detail NDE requirements for the various materials to be used in repair/replacements. The NRC staff requests that the report be modified to more fully address generic inspection guidance and methodology that should be utilized in the repair/replacements. This can be accomplished by reference to an appropriate revision of the "BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)." The recommendations specified

in either the appropriate revision of the BWRVIP-03 or BWRVIP-84 reports should be implemented and cited, wherever appropriate, to ensure consistency with prior NRC-approved inspection guidelines pertaining to BWR internal components.

The BWRVIP's December 5, 2006, response to OI 3.9 stated:

Sections A.9.4, B.8.6 and C.9.3 specify requirements for NDE of Series 300, X-750 and XM-19 materials respectively. Neither BWRVIP-84 nor the individual RDC include specific recommendations for inspecting repaired components. However, each of the individual RDC contains a requirement that the repair designer specify appropriate inspections for repairs consistent with the intent of the applicable Inspection and Flaw Evaluation Guideline. As previously agreed with the NRC staff, since the details of future designs cannot be anticipated at this time, it is inappropriate for the RDCs (or the Material Guideline) to specify detailed component inspections. The BWRVIP proposes that no change to the BWRVIP-84 guideline be made. (See also the BWRVIP response to Item 3.5.1).

The NRC staff's evaluation of the BWRVIP response to OI 3.9:

The NRC staff reviewed the response and concludes that the BWRVIP response is acceptable because the inspection requirements for a repair of any given RVI component will be addressed in the relevant RDC of the repair. Hence, the BWRVIP-84 TR is not designed to address the inspection requirements for the repairs of the RVI components. Therefore, the NRC staff considers OI 3.9 to be adequately resolved.

3.0 CONCLUSION

The NRC staff has reviewed the responses provided by the BWRVIP in its letter dated December 5, 2006, and find that the BWRVIP has adequately addressed the OIs described in the NRC staff SE dated September 6, 2005. The NRC staff requests that the BWRVIP incorporate the responses listed in its letter dated December 5, 2006, into the "-A" version of the BWRVIP-84 TR. The NRC staff also requests that the BWRVIP submit to the NRC the "-A" version of the BWRVIP-84 TR within 180 days of receipt of this letter.

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