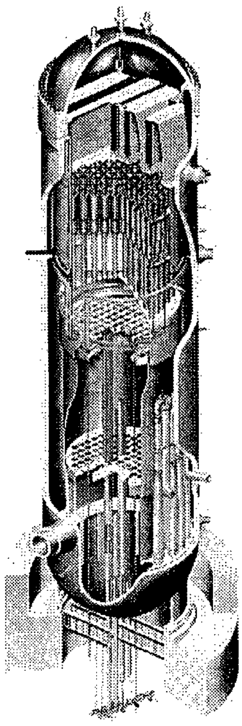
ELECTRIC POWER RESEARCH INSTITUTE

BWRVIP-18NP, Revision 1: BWR Vessel and Internals Project

BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines



NON-PROPRIETARY INFORMATION

NOTICE: This report contains the non-propriety information that is included in the proprietary version of this report. The proprietary version of this report contains proprietary information that is the intellectual property of BWRVIP utility members and EPRI. Accordingly, the proprietary report is available only under license from EPRI and may not be reproduced or disclosed, wholly or in part, by any Licensee to any other person or organization.

BWRVIP-18NP, Revision 1:BWR Vessel and Internals Project

BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines

1016568NP

Final Report, October 2008

EPRI Project Manager
R. Carter

Electric Power Research Institute • 3412 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

ORGANIZATION(S) THAT PREPARED THIS REPORT:

EPRI

NON-PROPRIETARY INFORMATION

NOTICE: This report contains the non-propriety information that is included in the proprietary version of this report. The proprietary version of this report contains proprietary information that is the intellectual property of BWRVIP utility members and EPRI. Accordingly, the proprietary report is available only under license from EPRI and may not be reproduced or disclosed, wholly or in part, by any Licensee to any other person or organization.

THE WORK DESCRIBED IN THIS REPORT WAS PROCURED AND PREPARED ACCORDING TO EPRI'S QUALITY ASSURANCE PROGRAM, WHICH COMPLIES WITH THE REQUIREMENTS OF TITLE 10 OF THE CODE OF FEDERAL REGULATIONS, PART 50, APPENDIX B.

ORDERING INFORMATION

Requests for copies of this report should be directed to EPRI Orders and Conferences, 1355 Willow Way, Suite 278, Concord, CA 94520, (800) 313-3774, press 2 or internally x5379, (925) 609-9169, (925) 609-1310 (fax).

CITATIONS

This report was prepared by

EPRI
3412 Hillview Avenue
Palo Alto, CA 94304

This report describes research sponsored by EPRI.

The report is a corporate document that should be cited in the literature in the following manner:

BWRVIP-18NP, Revision 1: BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines. EPRI. Palo Alto, CA: 2008. 1016568NP.

This report is based on the following previously published report:

BWRVIP-18-A: BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines. EPRI, Palo Alto, CA: 2005. 1011469.

REPORT SUMMARY

The Boiling Water Reactor Vessel and Internals Project (BWRVIP), formed in June 1994, is an association of utilities focused exclusively on boiling water reactor (BWR) vessel and internals issues. This BWRVIP report contains generic guidelines that describe locations on the core spray piping and spargers for which inspection is needed, categories of plants for which inspection needs would differ, extent of inspection and reinspection for each location, and flaw evaluation procedures to determine allowable flaw sizes for each location or type of location. A previous version of this report was published as BWRVIP-18-A (EPRI report 1011469). This report (BWRVIP-18, Rev. 1) incorporates the additional inspection requirements for inaccessible core spray welds originally contained in BWRVIP-168 (*BWRVIP-168: BWR Vessel and Internals Project, Guidelines for Disposition of Inaccessible Core Spray Piping Welds in BWR Internals," EPRI Technical Report 1013390, March 2007*).

Background
Events in 1993 and 1994 confirmed that intergranular stress corrosion cracking (IGSCC) is a significant issue for BWR internals. U.S. BWR executives formed the BWRVIP in June 1994 to address integrity issues arising from service-related degradation of these key components, beginning with core shroud cracking. A subsequent safety assessment (BWRVIP-06) that evaluated the consequences of core spray cracking determined that inspection of the core spray piping and spargers is necessary to assure long-term integrity, and thus the ability to achieve safe shutdown for worst-case scenarios. As a result, the BWRVIP made development of the core spray inspection and evaluation guidelines a high priority.

Objective
To provide generic inspection and flaw evaluation (I&E) guidelines for BWR core spray internals.

Approach
The Assessment Committee of the BWRVIP formed a focus group to develop core spray internals I&E guidelines. The group, comprising utility and industry experts, reviewed available information, including IGSCC experience, to develop generic I&E guidelines. This information was used to identify the core spray internals locations susceptible to IGSCC and to develop approaches for inspection, reinspection, and flaw evaluation.

Results
The I&E guidelines provide information on weld locations in core spray piping, spargers, and brackets; a discussion of susceptibility considerations; a "baseline" approach for the first inspection each plant will do using new BWRVIP requirements for the core spray components; and an approach for subsequent reinspections.

The guidelines also contain a flaw evaluation methodology that provides guidance on performing flaw evaluations and determining loading and stresses. Loading combinations are recommended for plants that do not already have such information. Methodology is provided to use stress information calculated from finite element analyses of the core spray system under these loading combinations, and to perform limit load flaw evaluation at each weld. Example evaluations are provided for piping and sparger locations.

EPRI Perspective

The BWRVIP undertook a large effort to develop a comprehensive set of guides that will provide every member utility with the necessary information to make cost-effective decisions on degradation management for key components in their plant. These Inspection and Evaluation (I&E) Guidelines provides BWR owners with NRC approved tools to answer such questions as: What needs to be inspected, when does it need to be inspected, and what is the technical basis for run-repair decisions when degradation is observed? Utility implementation of these guidelines for safety-critical BWR internals will assure that components have not approached safe limits and thus confirm their serviceability.

Keywords

Inspection
BWR
Vessels
Core Spray Systems
Stress Corrosion Cracking
Intergranular Stress Corrosion Cracking

EXECUTIVE SUMMARY

Core spray cracking was first detected in 1978 and was found to be more widespread in subsequent years. In response, the NRC issued IE Bulletin 80-13, requiring that visual inspections be done of a better quality than those required by the ASME Code. Most plants have been performing inspections to the IE Bulletin 80-13 requirements for many years, and in the process have found and addressed core spray cracking incidents.

A safety assessment performed by the BWRVIP indicated that inspection is an important part of assuring core spray integrity. As a result, the BWRVIP made development of the core spray inspection and evaluation guidelines a high priority. It is the intent that, for BWRVIP members, these guidelines can be followed in the place of prior GE SILs (Services Information Letters) and, when approved by the regulator, in the place of the requirements of IE Bulletin 80-13.

These inspection and evaluation (I&E) guidelines provide information on weld locations in BWR/2, BWR/3-5 and BWR/6 core spray piping, spargers and brackets. Unique aspects of the core spray designs make these logical groupings.

These guidelines contain discussion of susceptibility considerations which concludes that all core spray systems may be subject to cracking. The susceptibility trends may, as further inspection data accumulates, provide a basis to change reinspection frequencies.

The guidelines present a BWRVIP "baseline" approach for the first inspection each plant will do to new BWRVIP requirements for the core spray components. The piping inspection can be visual or ultrasonic. The sparger and bracket inspections are visual. Reinspection scope and frequency are determined, taking into consideration the improved techniques recommended, and considering the susceptibility and function of each welded and bolted core spray location.

The flaw evaluation methodology provides guidance on performing flaw evaluations and determining loading and stresses. Loading combinations are recommended for plants that do not already have such information. Methodology is provided to take stresses from finite element analyses of the core spray system under these loading combinations and to perform limit load flaw evaluation at each weld. Example evaluations are provided for piping and sparger locations.

RECORD OF REVISIONS

Revision Number	Revisions
BWRVIP-18	Original Report (TR-106740)
BWRVIP-18-A	The report as originally published (TR-106740) was revised to incorporate changes proposed by the BWRVIP in responses to NRC Requests for Additional Information, recommendations in the NRC Safety Evaluation (SE), and other necessary revisions identified since the last issuance of the report. All changes, except corrections to typographical errors, are marked with margin bars. In accordance with a NRC request, the SE is included here as an appendix and the report number includes an "A" indicating the version of the report accepted by the NRC staff. A NRC Final Safety Evaluation accepting this report for referencing in license renewal applications is also included in an appendix. Non-essential format changes were made to comply with the current EPRI publication guidelines. Appendix C added: License Renewal Appendix. Appendix D added: NRC Final Safety Evaluation. Appendix E added: NRC Acceptance for Referencing Report for Demonstration of Compliance with License Renewal Rule. Details of the revision can be found in Appendix F.
BWRVIP-18, Revision 1	BWRVIP-18-A was revised to incorporate the inspection recommendations for inaccessible welds as described in BWRVIP-168. All changes, except corrections to typographical errors, are marked with margin bars. Details of the revision can be found in Appendix H. Note: Margin bars marking changes in BWRVIP-18-A have been deleted in the current version of the report (BWRVIP-18, Rev.1)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1
INTRODUCTION

1.1 Background

Core spray cracking was first detected in 1978 during routine in-vessel visual inspections. As the cracking was found to be more widespread in subsequent years, and recognizing the tight nature of stress corrosion cracking, the NRC issued IE Bulletin 80-13, requiring that visual inspections be done of a better quality than those required by ASME Boiler and Pressure Vessel Code Section XI. Most plants have been performing inspections to the IE Bulletin 80-13 requirements for many years, and have continued to find and address core spray cracking.

Recently, the BWRVIP prepared a safety assessment of BWR internals as a follow-on to the activities completed on shroud cracking. In the evaluation of core spray and the consequences of core spray cracking, it was clear that inspection is an important part of assuring core spray integrity, and thus the ability to achieve safe shutdown for worst case scenarios. As a result, the BWRVIP made development of the core spray inspection and evaluation guidelines a high priority for 1996.

1.2 Objectives and Scope

These core spray inspection & evaluation (I&E) guidelines are generic guidelines intended to address the following issues:

- Locations on the core spray piping and spargers for which inspection is needed
- Categories of plants for which inspection needs would differ
- Extent of inspection for each location
- Flaw evaluation procedures to determine allowable flaw sizes for each location or type of location

The I&E guidelines provide design information on the piping and sparger geometries and weld locations for several plant categories. The scope addresses all weld and bolted locations identified from design drawings of the core spray piping, spargers and brackets, as well as known types of existing repairs. Typical core spray piping and sparger configurations are shown schematically in Figures 2-1 through 2-4. These figures show the weld and bolted locations for each configuration, with the identifiers used throughout these guidelines for each location.

There is some discussion of susceptibility considerations which may, as further inspection data accumulates, influence the extent of reinspection needed for various core spray locations.

These guidelines present a BWRVIP "baseline" approach for the first inspection each plant will do using the new BWRVIP requirements for the core spray components. Reinspection approaches are presented which vary depending on the type of plant and the outcome of the previous inspections.

Loading combination recommendations are provided in the event that plant documents do not already specify such combinations. Methodology is provided to take stresses from finite element analyses of the core spray system under these loading combinations and to perform limit load flaw evaluation at each weld. The limit load methodology is demonstrated in an example analysis.

1.3 Implementation Requirements

In accordance with the requirements of Nuclear Energy Institute (NEI) 03-08, Guideline for Management of Material Issues, Sections 3, 4 and 5 of this report are "needed" and the remaining sections are for information only.

Note that, as of the publication date of this report, the revisions designated herein have not been approved by the NRC. The NRC Safety Evaluation included here as Appendix D applies to the original version the report (BWRVIP-18, EPRI Report TR-106740). The NRC Acceptance letter included as Appendix G applies to BWRVIP-18-A (EPRI Report 1011469).

2

CORE SPRAY PIPING DESIGN AND SUSCEPTIBILITY INFORMATION

The core spray piping and sparger assembly provides the flow path for core cooling water from the vessel nozzle, through the shroud to provide a uniform distribution of spray to assure cooling when the core cannot be fully reflooded. In addition, in some newer BWRs, the core spray assembly provides the flow path for injection of boron for the standby liquid control (SLC) system. The assembly consists of the following basic subcomponents:

- Junction or tee box connections route flow from the vessel nozzle or shroud penetration to different piping runs,
- Piping runs consist of welded joints needed to connect the individual piping segments into the overall assembly,
- Spargers with multiple nozzles deliver the core spray water to achieve proper flow distribution over the core, and
- Attachment brackets support the assembly at different locations along the piping and sparger runs.

Figures 2-1 through 2-3 display the overall configuration of the entire core spray piping assembly for each of the main categories of plants: BWR/2, BWR/3-5 and BWR/6. Figure 2-4 displays the general core spray sparger configuration. These figures display the locations of the welds in these assemblies, with weld identifications which are used throughout this report, and which correspond to the weld identifications used in the BWRVIP Safety Assessment Report [1]. While the entire assembly is generally similar, there are several differences in design and fabrication conditions that exist in the different types of BWR, as well as between plants of the same BWR type. Some of these differences potentially affect the susceptibility of locations on the core spray assembly.

Design and fabrication differences include the following:

- Piping material (304 vs. 304L vs. 316L Stainless Steels)
- Material condition (annealed vs. welded vs. cold worked)
- Piping diameter and wall thickness
- Piping type (seamless vs. welded)
- Weld design (creviced vs. non-creviced)
- Type of weld (fillet vs. groove vs. partial penetration)
- Welding process (flux vs. non-flux)

The ways in which some of these characteristics play a role in core spray piping and sparger cracking susceptibility are discussed in Sections 2.1 and 2.2.

Content Deleted -
EPRI Proprietary Information

Figure 2-1
Typical BWR/2 Core Spray Piping Configuration

Content Deleted -
EPRI Proprietary Information

Figure 2-2
Typical BWR/3-5 Core Spray Piping Configuration

Content Deleted -
EPRI Proprietary Information

Figure 2-3
Typical BWR/6 Core Spray Piping Configuration

Content Deleted -
EPRI Proprietary Information

Figure 2-4
Typical Core Spray Sparger

2.1 Susceptibility Factors

The occurrence of IGSCC relies on the combined presence of an aggressive environment, a susceptible material and stress. These specific factors will be discussed for the core spray system in more detail below.

Another important consideration in evaluating IGSCC susceptibility is the cracking history, because of the variability of the phenomenon. A discussion of cracking history is in Section 3 as part of the background discussion on inspection.

2.1.1 Environment

The environment in the core spray region is highly oxidizing in all BWRs, because the most oxidizing reactor water is that exiting the core and occupying the upper vessel regions. Radiolysis model calculations, validated by electrochemical corrosion potential (ECP) measurements at several internal locations, predict that the environment in contact with core spray internals has relatively high levels of peroxide, H_2O_2, which leads to high ECP values. High ECP is considered one of the key factors in promoting IGSCC in austenitic stainless steel components, when present in combination with adverse material microstructures and the imposed residual and fit-up stresses.

Content Deleted -
EPRI Proprietary Information

2.1.2 Materials

The basic core spray piping material is generally either Type 304, 304L or 316L austenitic stainless steel. The design drawings for BWR/6 call for use of Type 316L in the annulus piping, but fabrication practice at the time was such that material records for each plant must be checked to confirm the material used. The piping diameter ranges from "4 to 6" depending on the reactor size and model.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

2.1.3 Stress State

As discussed earlier, all weld locations which were not solution annealed have residual stresses associated with them. In general, the welds in the core spray system are similar enough that the residual stresses would not provide a means to differentiate by location or plant type. However, some useful trends can be established from analyses performed in the past.

Content Deleted -
EPRI Proprietary Information

2.1.4 Hot Operating Time

The final parameter assessed is the hot operating time associated with cracking. The objective is to determine if there is a threshold of operating time before cracking begins, and if that threshold is affected by other factors.

Table 3-1 provides a summary of cracking observed in past inspections.

Content Deleted -
EPRI Proprietary Information

2.1.5 Integrated Susceptibility Assessment

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

2.2 Design of Typical Core Spray Assemblies

The core spray assembly contains welds that can be divided into three categories:creviced locations, non-creviced locations and bracket locations. Many of the welds in the core spray assembly are creviced due to the presence of a fillet weld or a partial penetration weld. The regions with the highest expected crack susceptibility are the creviced locations. Each specific weld region is discussed in this section.

Aside from plant differences in specific weld locations, there is one significant difference in core spray piping geometries from plant to plant. In BWR/3-6 piping, the length of the horizontal run of piping can vary. In some plants, the horizontal pipe runs are of equal length, but for some plants one run is twice the length of the other. The piping length has a significant effect on the magnitude of some of the loads described in Section 4.

2.2.1 Thermal Sleeves

In Figures 2-1 through 2-3, the thermal sleeve welds are not identified. They are located between the nozzle safe end and the connection to the junction box (P1). The original designs of thermal sleeves in the vessel nozzles varied considerably from plant to plant. Many plants have modified their core spray safe ends and thermal sleeves as part of a core spray external piping replacement. There are still numerous designs of thermal sleeves, but they can be grouped into three categories:

1. Welded-in thermal sleeves,
2. Mechanically connected thermal sleeves,
3. Slip-fit thermal sleeves.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 2-5
Welded Thermal Sleeve Examples

Content Deleted -
EPRI Proprietary Information

Figure 2-6
Threaded Thermal Sleeve Example

Content Deleted -
EPRI Proprietary Information

Figure 2-7
Slip-Fit Thermal Sleeve Example

2.2.2 Junction Box, Vessel Nozzle Region: Welds P1, P2, and P3

BWR/2

The junction box in BWR/2s is located outside the shroud, as shown in Figure 2-1. There is no P1 weld, as the thermal sleeve is welded directly to an elbow, with weld P4a. The P2 and P3 welds are full penetration welds of the pipes to the tee outside the shroud.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 2-8
BWR/3-5 Core Spray Piping Junction Box Assembly

Content Deleted -
EPRI Proprietary Information

Figure 2-9
BWR/3-5 Junction Box Cover Plate Weld P2

Content Deleted -
EPRI Proprietary Information

Figure 2-10
BWR/3-5 Junction Box-to-Pipe Weld P3

2.2.3 Piping and Elbow Groove Welds: Welds P4

Content Deleted -
EPRI Proprietary Information

2.2.4 Sleeve Coupling Region: Welds P5, P6, P7

The sleeve coupling design shown in Figure 2-11 is typical for BWR/2-5 plants. This configuration was used to allow field assembly of the upper and lower downcomers.

Content Deleted -
EPRI Proprietary Information

Figure 2-11
BWR/2-5 Sleeve Coupling Assembly

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 2-12
BWR/6 Pipe Coupling Assembly

2.2.5 Shroud Connection Region: Welds P8, P8a, P8b, P9

Content Deleted -
EPRI Proprietary Information

**Content Deleted -
EPRI Proprietary Information**

Figure 2-13
BWR/2-5 Core Spray Piping and Sparger Interface

**Content Deleted -
EPRI Proprietary Information**

Content Deleted -
EPRI Proprietary Information

Figure 2-14
Typical BWR/3-5 Attachment of Core Spray Pipe to Shroud

In at least one plant, there are shroud penetrations that, in addition to having P8a, P8b and P9, have redundant fillet welds connecting the ID and OD of the shroud to the core spray sparger and piping, respectively. For this configuration, the inside of the collar region is a sealed pocket of air if the welds which seal the collar region have not cracked.

BWR/6

The BWR/6 eliminated these welds by using a flange that bolts directly to the top guide portion of the shroud (Figure 2-15), with tack welds to assure bolt position (P8). The sparger tee is attached to the shroud with a mechanical retaining ring called location P9 (Figure 2-16), which is held in place by the piping flange.

Content Deleted -
EPRI Proprietary Information

Figure 2-15
BWR/6 Core Spray Pipe Flange Attachment to Shroud

2.2.6 Core Spray Sparger Tee Box Region: Welds S1, S2

There are several locations that are groove welds in the sparger assembly tee box and piping (Figure 2-17). These include welds S1 in BWR/2-5, S2 and any groove welds that were used to construct the sparger piping lengths.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 2-16
BWR/6 Core Spray Sparger Tee Attachment to Shroud

Content Deleted -
EPRI Proprietary Information

Figure 2-17
Typical BWR/3-5 Core Spray Sparger Tee Box Assembly

The BWR/6 tee is forged, so there is no cover plate or S1 weld.

2.2.7 Core Spray Nozzle Assembly: Welds S3

The next locations along the sparger that have the potential for cracking are the S3a welds attaching the spray nozzles to the sparger.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 2-18
Typical Sparger Nozzle and Drain Configurations (Welds S3)

2.2.8 Sparger Pipe End Cap: Weld S4

Weld S4 is a groove weld that attaches a cap to the end of the sparger pipe (Figure 2-18).

Content Deleted -
EPRI Proprietary Information

2.2.9 Bracket Locations: Welds PB, SB

The bracket locations of interest are the attachment regions needed to carry out the brackets function: maintenance of the position of the piping or spargers. The brackets are welded to either the RPV wall or the shroud wall.

Content Deleted -
EPRI Proprietary Information

2.3 Conclusions

Content Deleted -
EPRI Proprietary Information

Inspection guidelines are presented in Section 3. Those guidelines take into consideration the general conclusions on susceptibility from Section 2.1 and the specific susceptibility characteristics of each location from Section 2.2.

3
INSPECTION STRATEGY

3.1 Background

3.1.1 Core Spray Inspection History

Content Deleted -
EPRI Proprietary Information

Responding to the instances of cracking in core spray spargers, in May 1980 the NRC issued IE Bulletin No. 80-13, "Cracking in Core Spray Spargers". This bulletin required visual inspection of the core spray spargers and associated piping at the next scheduled outage and at each refueling outage until further notice. Because IGSCC is tight, the NRC required the use of improved inspection techniques, and the performance of a video system resolution capability verification. Acceptable resolution is determined by in-situ demonstration using a 0.001" (1 mil) wire. This NRC bulletin established the need for augmented inspection programs which addressed performance of core spray piping and sparger examination at an increased frequency, using improved inspection techniques.

Since the issuance of IE Bulletin No. 80-13, most BWR utilities have been routinely performing visual examination of core spray piping and spargers to augmented inspection programs. Over time, additional cracking has been observed as a result of these routine visual examinations.

In 1989, GE issued SIL No. 289 Revision 1 Supplement 1, dated February 23, 1989 and SIL No. 289 Revision 1 Supplement 1 Revision 1, dated March 15, 1989. These SILs identified two other locations in the core spray system piping as susceptible to cracking. These locations were the piping junction box front cover plate weld (P2), and the weld joint which connects the piping junction box to the core spray thermal sleeve (P1).

However, no cracking has been observed to date in either of these welds, although P1 is not fully accessible for inspection at all plants.

Content Deleted -
EPRI Proprietary Information

Table 3-1
Core Spray Piping and Core Spray Sparger Cracking Experience

Content Deleted -
EPRI Proprietary Information

Table 3-1
Core Spray Piping and Core Spray Sparger Cracking Experience (Continued)

Content Deleted -
EPRI Proprietary Information

RICSIL No. 074 advises that additional core spray piping welds have been identified as being susceptible to cracking. Inspections performed on core spray since the issuance of the RICSIL have identified additional incidences of cracking. GE issued SIL No. 289, Revision 1, Supplement 2 advising that additional core spray piping welds within the vessel have been identified as being susceptible to cracking. The SIL also provided recommendations pertaining to the recent findings.

SIL No. 289, Revision 1, Supplement 2 provided short term inspection recommendations to address detection of cracking in creviced welds. The inspection recommendations included:

1. Continue with the required 80–13 examinations for the core spray piping and spargers. In addition, perform visual examination of creviced weld locations at very close camera–to–subject distances (1 – 3 inches).
2. Clean welds and adjacent surfaces to remove oxide sediments if the sediments mask or hinder detection of indications. Cleaning techniques should not produce a polished surface finish that could cause excessive glare and prevent detecting indications. Cleaning is considered optional, but has resulted in closer correlation between visual and UT results.
3. Perform supplemental UT to confirm significant visual indications, especially at creviced locations to provide an estimate of ID length.

Content Deleted -
EPRI Proprietary Information

SIL 289, Revision 1, Supplement 2 provides general recommendations for the entire core spray piping and sparger system which are especially applicable to the more safety-significant locations. This document provides specific inspection guidelines for all locations of the core spray internals, taking into consideration safety significance and expected susceptibility of each location. As such, it is the intent, for BWRVIP members, that these guidelines supersede the GE SIL and will, upon approval by the regulators, supersede the requirements of IE Bulletin No. 80-13.

3.1.2 Examination Methods

The discussions which follow refer to several inspection methods under the general categories of ultrasonic (UT) and visual (VT). However, any current or future method which interrogates both the inside and outside piping surface could be used in place of UT.

Content Deleted -
EPRI Proprietary Information

3.2 BWRVIP "Baseline" Inspection

The core spray IVVIs which have been performed per IE Bulletin No. 80-13 and SILs for many years have been valuable in providing early detection of cracking. Since the inspection methods are changing to involve different visual techniques and UT, the term "baseline" is used here to denote the first inspection that satisfies these BWRVIP guidelines, even if performed prior to issuance of the guidelines. The guidelines are intended to provide flexible options for inspection while assuring that structural integrity and function of the core spray system are adequately maintained. The guidelines are also generic in nature, based on the overall understanding of the various designs of core spray. There may be plant-specific situations where more rigorous inspections are chosen or where less rigorous inspections are justified.

3.2.1 Plant Categories

Plant categorization has been based on core spray piping and sparger design differences. There are three basic plant categories:

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Tables 3-2 through 3-4 itemize the inspection locations for each of these plant categories. For many locations, the same inspection methods can be used. The tables provide inspection guidelines for each location, either by specifying the method or by referring to a flow chart which outlines the inspection strategy. For each location, the selected inspection method or strategy also has a basis reference, which is a paragraph within this section of the report explaining the reasons for the inspection chosen for that location.

3.2.2 Piping Locations

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Table 3-2
BWR/2 Core Spray Assembly Inspection Locations *

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Table 3-3
BWR/3-5 Core Spray Assembly Inspection Locations *

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Table 3-4
BWR/6 Core Spray Assembly Inspection Locations *

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

3.2.3 Sparger Locations

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

3.2.4 Other Locations

Other locations for which inspection guidelines are provided are the BWR/6 piping flange connection and the sparger tee connection to the shroud (P8 and S1), piping and sparger surfaces away from welds, the piping and sparger brackets, the hidden welds, and any repairs that might be in place. The hidden welds include P4a, P9 and thermal sleeve welds in BWR/2 designs; P1, P9 and thermal sleeve welds in BWR/3-5 designs; and P1a, P1b, and P9 in BWR/6 designs.

Thermal Sleeve Welds

Content Deleted -
EPRI Proprietary Information

P1 Welds

Content Deleted -
EPRI Proprietary Information

P4a Welds

Content Deleted -
EPRI Proprietary Information

P9 Welds

Content Deleted -
EPRI Proprietary Information

BWR/6 Shroud Connections

Content Deleted -
EPRI Proprietary Information

Piping and Sparger Surfaces away from Welds

Content Deleted -
EPRI Proprietary Information

**Content Deleted -
EPRI Proprietary Information**

Piping and Sparger Brackets

**Content Deleted -
EPRI Proprietary Information**

Repairs

**Content Deleted -
EPRI Proprietary Information**

3.3 BWRVIP Reinspection

The reinspection strategy for both piping and sparger locations is presented in Table 3-5.

Content Deleted -
EPRI Proprietary Information

Table 3-5
Piping and Sparger Reinspection Frequencies (Note 7, 9)

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Details of the reinspection strategy for piping, spargers and other locations are described in the following subsections.

3.3.1 Piping Reinspection Approach

The piping reinspection approach is shown in Table 3-5. The reinspection method matches that of the baseline inspection and the scope of reinspection depends upon the findings of the previous inspection (i.e., what, if any, welds were previously cracked).

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

3.3.2 Sparger Reinspection Approach

The sparger reinspection strategy is shown in Table 3-5. Sparger reinspection is assumed to be visual, as was baseline inspection. The welds, which again include previously identified cracked welds, are reinspected with the same method used for their baseline inspections.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

3.3.3 Reinspection of Other Locations

Locations discussed in Section 3.2.4 must, for the most part, be reinspected periodically.

Content Deleted -
EPRI Proprietary Information

3.4 Inspection Program for Inaccessible Welds

Several principles are used to define an inspection strategy for inaccessible welds in BWR internal core spray piping. These principles are: (1) any cracking that is detected must be evaluated to determine if acceptable, deterministic margins will be maintained through the desired operating period, and (2) if necessary, cracked welds will be repaired to maintain acceptable deterministic margins throughout the desired operating interval.

Content Deleted -
EPRI Proprietary Information

3.4.1 Inspection Strategy for Inaccessible Thermal Sleeve Welds and P1, P4a, and P9

A strategy for maintaining the integrity of the internal core spray piping is defined in this section. This strategy identifies conditions under which either inspection, replacement or repair might be required for inaccessible welds based on the inspection results from similar plant specific accessible welds. Inspection of an inaccessible weld is not required where there is redundant load carrying capability for the inaccessible weld.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

3.4.2 Basis for the Allowable Inspection Interval for Inaccessible Welds

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Table 3-6
Program for Inspecting Inaccessible Welds

Content Deleted -
EPRI Proprietary Information

3.4.3 Guidelines for Determining the Inspection Interval for Inaccessible Welds

The following procedure can be used to determine the plant-specific inspection interval for inaccessible welds.

Content Deleted -
EPRI Proprietary Information

3.4.4 Example Inspection Interval Determination for Inaccessible Welds

Content Deleted -
EPRI Proprietary Information

4 LOADING

This section describes the details of the various loadings and the load combinations that need to be considered to determine the primary and secondary stress levels appropriate for various operating conditions. The flaw evaluation methodology is described in Section 5.0. An example application of the evaluation methodology is provided in Appendix A.

In the event that the loads and load combinations in this section differ from those in the plant FSAR, the loads and combinations in the FSAR should be used.

4.1 Significant Loads – Core Spray Piping

The applied loads on the core spray piping consist of the following: deadweight, seismic inertia, seismic anchor displacements, fluid drag, loads due to flow initiation, and anchor displacements. Each of these loads are briefly discussed next.

4.1.1 Deadweight (DW)

Content Deleted -
EPRI Proprietary Information

4.1.2 Seismic Inertia

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

4.1.3 Seismic Anchor Displacements

Content Deleted -
EPRI Proprietary Information

4.1.4 Fluid Drag

Content Deleted -
EPRI Proprietary Information

4.1.5 Core Spray Injection Loading (CSIN)

Content Deleted -
EPRI Proprietary Information

4.1.6 Pressure/Temperature Anchor Displacements

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

4.2 Significant Loads – Sparger

Content Deleted -
EPRI Proprietary Information

4.3 Load Combinations

4.3.1 Core Spray Piping

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

4.3.2 Core Spray Spargers

The following is a suggested list of load combinations that may be used in the evaluation of normal/upset condition if not specified in plant FSAR/UFSAR:

Content Deleted -
EPRI Proprietary Information

4.4 Consideration of Shroud Repair

Content Deleted -
EPRI Proprietary Information

4.5 Stress Analysis Methodology

For any particular load source such as the seismic inertia, the load magnitudes at various locations in the core spray piping and spargers are typically determined through finite element analysis in which the piping and the components are modeled as beam elements.

Content Deleted -
EPRI Proprietary Information

5
EVALUATION METHODOLOGIES

Note to revision 1: In revising this section, some paragraphs from the previous version were re-ordered in order to improve readability. These changes, as well as any resultant changes in section numbering, are not identified with revision bars.

Structural and leak rate evaluations must be performed to ensure that adequate structural and leakage margins are maintained for cracked core spray internal components during operation. This section describes the structural and leak rate evaluation methodologies and computational procedures needed to evaluate cracks in both accessible and inaccessible welds. The evaluation approaches for the piping are different than the attachments such as the support brackets, which are treated separately. Crack growth considerations also are provided.

5.1 Piping and Sparger Locations

This section provides methods for evaluating the acceptability of flaws in core spray piping and spargers. Based on observed flaw lengths and assumed crack growth rates, a point in time can be calculated at which the flaws will have grown to such a size that core spray function may be impaired. Reinspection of the flaws must be scheduled prior to the time at which the flaws have grown to unacceptable sizes. However, in no cases can the results of a flaw evaluation be used to extend the reinspection interval beyond that described in Section 3.

5.1.1 Flaw Characterization

NDE Uncertainty

In performing some flaw evaluations, the measured length and depth of observed flaws may need to be adjusted to account for NDE uncertainty. These adjustments shall be made in accordance with current BWRVIP recommendations.

Consideration of Welds with Partial Inspection Access

The access for inspection may be limited at some of the circumferential welds in the core spray system. For example, welds along the horizontal length of the line running close to the RPV wall may have limited accessibility on the back side. If cracking is detected on the accessible side of such a weld, the issue that needs to be addressed is what must be assumed in terms of cracked length on the inaccessible side.

Content Deleted -
EPRI Proprietary Information

Crack Growth

Content Deleted -
EPRI Proprietary Information

5.1.2 Structural Evaluation

Limit Load Evaluation Methodology

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 5-1
Stress Distribution in a Cracked Pipe at Limit Load

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Z Factor

To account for the reduced toughness of the flux welds (as compared to non-flux welds) the Section XI procedures prescribe a penalty factor, called a 'Z' factor. The examples of flux welds are submerged arc welds (SAW) and shielded metal arc welds (SMAW). Gas metal-arc welds (GMAW) and gas tungsten-arc welds (GTAW) are examples of non-flux welds.

Content Deleted -
EPRI Proprietary Information

Flaw Proximity Considerations

If multiple indications are detected during the inspection at a location, then the interactions, if any, between these indications must be accounted for in the structural margin evaluation.

Content Deleted -
EPRI Proprietary Information

Limit Load Methodology for Multiple Circumferential Indications

Content Deleted -
EPRI Proprietary Information

Allowable Flaw Size Determination

Content Deleted -
EPRI Proprietary Information

Time to Reach the Minimum Acceptable Structural Margin

Content Deleted -
EPRI Proprietary Information

5.1.3 Leakage Considerations

Core Spray Piping

Leakage from known flaws as well as from assumed cracks in partially accessible and inaccessible welds must be evaluated as described in Section 5.1.4 to ensure that the leakage is bounded by plant specific core spray margins. Any fluid that leaks from the core spray piping into the RPV annulus is potentially unavailable for core cooling during the event when core spray operation is postulated. A reduction in the core spray flow (whether as a result of leakage through cracks or for any other reason) may result in an increase in the Peak Cladding Temperature (PCT). Thus, the tolerable leakage is a function of acceptable increase in the calculated value of PCT, which is a part of the plant-unique LOCA analysis.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Spargers

The allowable deviation of core spray distribution due to cracking in the core spray sparger must be determined on a plant-specific basis.

Content Deleted -
EPRI Proprietary Information

5.1.4 Leak Rate Calculation Methods

Leak Rate from Cracks Detected in Accessible and Partially Accessible Welds

Leakage from the core spray piping into the RPV annulus could come from a number of sources such as through the vent hole in the T-box or thermal sleeve, through the gap between the sleeve and the nozzle ID where the sleeve is of slip-fit design, or through the presence of any through-wall cracks in the piping. The leakage rate through the vent, or a crack, can be estimated assuming incompressible Bernoulli flow through the hole:

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Leak Rate from Cracks in Inaccessible Welds

The leakage discussed in Section 5.1.3 includes leakage from cracks in accessible and inaccessible welds. The previous paragraph provides a methodology for determining the leakage from through-wall cracks in core spray piping where the flaw size is known from the inspection results, as defined in Section 5.1.1. This section presents an approach to compute the leak rate from inaccessible welds where the flaw size is unknown. In this approach, the plant specific leak rate distribution determined from Equation 5-8 for the accessible welds is used to estimate the leak rate for the inaccessible welds.

The following steps are used to predict the leak rate from inaccessible welds.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Table 5-1
Program for Predicting Leak Rates from Inaccessible Welds

Content Deleted -
EPRI Proprietary Information

Example Applications

Content Deleted -
EPRI Proprietary Information

Table 5-2
Calculated Leak Rate Distribution for Eight Similar Accessible Welds with Through-Wall Flaws

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 5-2
Plot of the Leak Rate Distribution for Similar Accessible Welds and the Estimated Leak Rates for Inaccessible Welds

**Content Deleted -
EPRI Proprietary Information**

**Table 5-3
Calculated Leak Rate Distribution for Three Similar Accessible Welds with Through-Wall Flaws**

**Content Deleted -
EPRI Proprietary Information**

5.2 Bracket Locations

In the horizontal curved section, the core spray piping is supported by brackets that are welded to the RPV wall or shroud (BWR/2). The brackets provide support in the radial and/or vertical directions. The forces at these locations for various load combinations are expected to be available from the analysis of the finite element model. Figure 5-3 shows the geometry of a typical support bracket.

**Content Deleted -
EPRI Proprietary Information**

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure 5-3
Geometry of a Core Spray Line Bracket

6 REFERENCES

1. *BWRVIP-06-A: BWR Vessel and Internals Project, Safety Assessment of BWR Reactor Internals*. March 2002. EPRI Technical Report 1006598.
2. H. H. Klepfer, et al., "Investigation of Cause of Cracking in Austenitic Stainless Steel Piping," GE Report NEDO-21000, July 1975.
3. A. J. Giannuzzi, et al., *Studies on AISI Type 304 Stainless Steel Piping Weldments for Use in BWR Applications*. December 1978. EPRI NP-944.
4. *BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*. October 1995. EPRI Report TR-105696.
5. NUREG-0484, "Methodology for Combining Dynamic Responses," Revision 1.
6. American Society of Mechanical Engineers Boiler & Pressure Vessel Code, Section XI, 1989 Edition (Paragraph IWB-3640 and Appendix C).
7. Ranganath, S. and Mehta, H.S., "Engineering Methods for the Assessment of Ductile Fracture Margin in Nuclear Power Plant Piping," Elastic-Plastic Fracture Second Symposium, Vol. II-Fracture Resistance Curves and Engineering Applications, ASTM STP 803, ASTM, pp. II-309 to II-330.
8. *BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines (BWRVIP-76)*. November 1999. EPRI Report TR-114232.
9. *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals (BWRVIP-14)*. March 1996. EPRI Report TR-105873.
10. *Guidelines for Reinspection of BWR Core Shrouds (BWRVIP-07)*. February 1996. EPRI Report TR-105747.
11. *PICEP: Pipe Crack Evaluation Program*. August 1984. EPRI Report No. NP-3596-SR.
12. "Analytical Model for Loss-of-Coolant Analysis in Accordance with 10CFR50 Appendix K," GE Report NEDE-20566-A, September 1986.
13. Shiralkar, B.S., et. al., "SAFER/GESTR Application Methodology," GE Report NEDE-23785-1-A, February 1985.
14. *BWRVIP-48-A: BWR Vessel and Internals Project, Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines*. November 2004. EPRI Report 1009948.
15. *BWRVIP-168: BWR Vessel and Internals Project, Guidelines for Disposition of Inaccessible Core Spray Piping Welds in BWR Internals.* March 2007. EPRI Technical Report 1013390.

A

EXAMPLE CORE SPRAY PIPING AND SPARGER FLAW EVALUATION

A.1 Example Core Spray Piping Flaw Evaluation

The internal core spray piping system for a BWR-4 which has an unrepaired shroud with limited cracking, was selected for this example evaluation. The piping material is Type 304 stainless steel. The piping is 6 inch, schedule 40. Figure A-1 shows the finite element model of the system. The piping and the components are represented by beam-type elements. The loadings were determined as discussed in the next section.

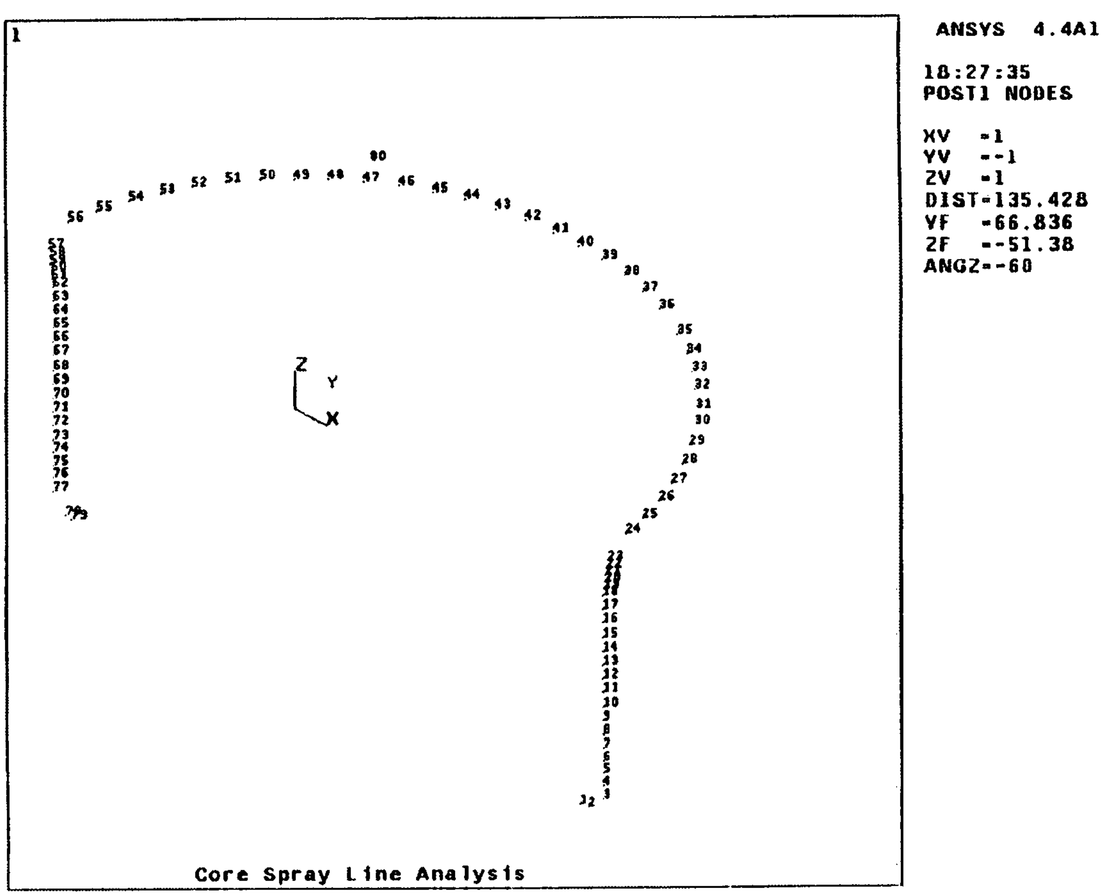


Figure A-1
Finite Element Model of Example Core Spray System

A.1.1 Loadings

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

A.1.2 Calculated Stresses at a Location

The forces and moments at various nodes in the model for all of the load sources were calculated using the ANSYS finite element code. These forces and moments were then combined to obtain total forces and moments for a given load combination. Thus, for each load combination and each node, a set of forces and moments were obtained. Furthermore, within each set, the moments from the displacement-controlled loadings were tabulated separately for the calculation of P_e stress.

As an example, the calculated values of P_m, P_b and P_e stress levels at a node representing the weld near the coupling in the vertical section are summarized below for the governing condition load combination:

Content Deleted -
EPRI Proprietary Information

A.1.3 Allowable Flaw Calculation

The results of the flaw evaluation at the same element/node are included in the table below. For the flux weld case, the Z factor based on equation (5-7) was calculated two ways: one using the NPS of 6 inches (Z=1.18) and the other using a NPS of 24 inches (Z=1.45).

Content Deleted -
EPRI Proprietary Information

A.1.4 Leak Rate Calculation and Assessment

Content Deleted -
EPRI Proprietary Information

A.2 Example Sparger Evaluation

Structurally, the core spray sparger is essentially a curved pipe supported at several locations along its length. Figure A-2 shows the finite element model of a sparger. The nominal diameter of the sparger pipe is 3.5 inches and the thickness is 0.226 inch corresponding to schedule 40S. The pipe material is Type 304 stainless steel.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure A-2
Finite Element Model of Example Sparger

Content Deleted -
EPRI Proprietary Information

B

SEISMIC INERTIA ANALYSIS CONSIDERATION

B.1 General

For this example, the core spray piping was supported at the reactor nozzle, RPV wall and the shroud. Therefore, the seismic excitation imparted to the core spray piping was a function of the responses of the RPV and the shroud. Typically a plant seismic model and the associated seismic analysis results are either described in the UFSAR or available in separate reports. The objective of this appendix is to describe some of the methods in which such information can be used to calculate seismic inertia loading on the core spray piping and spargers.

The available seismic analysis information varies considerably from plant to plant. In some cases, the seismic response spectrum information may be available at the desired RPV and shroud elevations. In other cases, only the zero period acceleration (ZPA) at these locations may be available. The example considered is from a BWR/4 plant. Although the modal analysis method was used to calculate the seismic inertia stresses in this example case, the equivalent static coefficient approach is also described for completeness.

B.2 Seismic Model and Analysis Information

Figure B-1 shows the lumped-mass horizontal model of the RPV and its internals for the example system. Node 83 on the RPV corresponds approximately to the core spray nozzle elevation. Similarly, node 67 on the shroud corresponds approximately to the location where the core spray system penetrates the shroud. The OBE response spectrum information in this case was available only at node 83 and is shown in Figure B-2.

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

Figure B-1
Horizontal Model of RPV and its Internals

Content Deleted -
EPRI Proprietary Information

Figure B-2
Horizontal Acceleration Spectrum at Node 83

Content Deleted -
EPRI Proprietary Information

Figure B-3
Vertical Model of RPV and its Internals

Content Deleted -
EPRI Proprietary Information

Figure B-4
Vertical Acceleration Spectrum at Node 53 of Figure B-3

B.3 Static Coefficient Method for Inertia Loading

B.3.1 Horizontal Equivalent Acceleration

Content Deleted -
EPRI Proprietary Information

Content Deleted -
EPRI Proprietary Information

B.3.2 Vertical Equivalent Acceleration

Content Deleted -
EPRI Proprietary Information

B.4 Modal Superposition Analysis

The modal superposition analysis involves determining the modal frequencies as a first step followed by the summation of the modal responses to obtain the total response and the loads. The loads calculated using this approach were found to be smaller than those calculated using the equivalent static coefficient method. Therefore, only the stresses based on the modal superposition approach were used in the load combinations.

Content Deleted -
EPRI Proprietary Information

C
LICENSE RENEWAL

Appendix C

BWR Core Spray Internals
Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10 CFR 54.21)

EPRI PROPRIETARY

Appendix C
BWR Core Spray Internals
Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10 CFR 54.21)

The purpose of Appendix C is to demonstrate that this report provides the necessary information to comply with the technical information requirements pursuant to paragraphs 54.21(a) and (c), and 54.22, and the NRC's finding under 54.29(a) of the license renewal rule (Reference C.[1]). It is intended that the NRC's review and approval of Appendix C will allow utilities the option to incorporate the report and Appendix by reference in a plant-specific integrated plant assessment (IPA) and time-limited aging analysis (TLAA) evaluation. If a license renewal applicant confirms that this report applies to their plant's current licensing basis (CLB) and that the results of the Appendix C IPA and TLAA evaluation are in effect at their plant, then no further review by the NRC of the matters described herein is needed.

C.1. Description of the BWR Core Spray Internals and Intended Functions

The BWR core spray internals consists of the core spray piping and the sparger assembly inside the reactor vessel. The core spray piping from the reactor vessel nozzle to and including the sparger assembly are within the scope of the license renewal rule. The components and subcomponents for this assembly are described in Section 2.0. The design, materials, operations and environmental conditions, and other technical information are also provided in Section 2.0.

The core spray internals are required to ensure the capability to shut down the reactor and maintain it in a safe-shut down condition (54.4(a)(1)(ii)) under accident conditions, prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to 10 CFR 100 guidelines (54.4(a)(1)(iii)), and for some BWRs, they are relied on in the safety analyses or plant evaluations to perform a function that demonstrates compliance with the Commission's regulations for anticipated transients without scram (54.4(a)(3)). Therefore, the intended functions for the core spray internals are to:

(1) Provide a flow path for core cooling water from the vessel nozzle, through the shroud to the sparger;

(2) Provide a uniform distribution of spray to assure core cooling when the core cannot be fully reflooded; and

(3) In some newer BWRs, provide the flow path for the injection of boron for the standby liquid control (SLC) system.

Content Deleted -
EPRI Proprietary Information

EPRI PROPRIETARY

Content Deleted -
EPRI Proprietary Information

C.2. Core Spray Internals Components Subject to Aging Management Review (54.21(a)(1))

Paragraph 54.21(a)(1) of the rule provides the requirements for identifying the core spray internals components that are subject to aging management review. To satisfy the requirements of 54.21(a)(1), the guidance provided in the NEI industry guideline (Reference C.[2]) was used to identify the passive components and then to identify those that are long-lived. For the core spray internals, a screening methodology was not needed to make these determinations. All of the components are passive and long-lived. Therefore, the core spray internals components (see Figures 2-1 through 2-3) subject to aging management review are the:

Content Deleted -
EPRI Proprietary Information

C.3. Management of Aging Effects (54.21(a)(3))

(a) Description of Aging Effects

For the purpose of this Appendix, the BWR Reactor Pressure Vessel Internals License Renewal Industry Report (Reference C.[3]) is used to identify the aging mechanisms for the core spray internals. Aging mechanisms are the causes of the aging effects. NUREG 1557 (Reference C.[4]) is used to establish the correlation between the aging effects and their associated aging mechanisms. If the industry report concludes that the aging mechanism is significant, then the associated aging effect is included in this aging management review.

Content Deleted -
EPRI Proprietary Information

EPRI PROPRIETARY

**Content Deleted -
EPRI Proprietary Information**

(b) Assessment of Aging Effects and Programs

The core spray internals inspection history is described in Section 3.3.1. The regulatory and vendor generic communications that apply to the core spray internals and address the crack initiation and growth aging affect are also identified. The cracking history is summarized in Table 3-1.

The examination methods under the categories of ultrasonic (UT) and visual (VT) are briefly discussed in Section 3.1.2. A reference to the implementation methods and definitions for the these methods is also provided.

The inspection strategy for the core spray internals involves a baseline inspection followed by focused reinspections of the core spray piping and sparger. The existence of flaws are detected by the examinations methods. The flaw evaluation and leak rate calculation methodologies described in Section 5.0 are used to verify that the intended functions can be maintained or to establish the need for alternative action. An interim qualitative assessment is used for the thermal sleeve hidden weld (P1). The development of an inspection technique for this thermal sleeve location is being addressed by the BWRVIP Inspection Committee.

The elements of the baseline inspection approach are shown in Figures 3-1 and 3-2 for the piping and sparger, respectively. Section 3.2 describes the baseline approach and implementation guidance. Additional inspection guidelines are provided in Section 3.2.4 for the hidden welds (thermal sleeve welds in BWR/2-6, P1 and P9 in BWR/2-5), the BWR/6 piping flange connection and the sparger tee connection to the shroud(P8 and S1), piping and sparger surfaces away from welds, the piping and sparger brackets, and any repairs that might be in place.

The elements of the reinspection approach for the piping and sparger are shown in Figures 3-3 and 3-4, respectively. The reinspection approach and implementation guidance is described in Section 3.3.

**Content Deleted -
EPRI Proprietary Information**

EPRI PROPRIETARY

Content Deleted -
EPRI Proprietary Information

(c) Demonstration that the Effects of Aging are Adequately Managed

Content Deleted -
EPRI Proprietary Information

C.4. Time Limited Aging Analyses (54.21(c)(1))

The six criteria contained in the NEI industry guideline (Reference C.[3]) were applied to identify the time limited aging analysis (TLAA) issues. That is, those calculations and analyses that:

1. Involve core spray internals components
2. Consider the effects of aging
3. Involve time-limited assumptions defined by the current operating term
4. Were determined to be relevant in making a safety determination
5. Involved conclusions or provide the basis for conclusions related to the capability of the core spray internals to perform their intended functions, and
6. Are incorporated or contained by reference in the CLB.

No generic TLAA's applicable to the core spray internals, as defined by the six criteria above, were found. If a plant-specific analysis identified by an applicant meets all six criteria above, then this analysis will be considered a TLAA for license renewal and evaluated by the applicant.

EPRI PROPRIETARY

C.5. Exemptions (54.21(c)(2))

Exemptions associated with the core spray internals that contain TLAA analysis issues will be identified and evaluated for license renewal by individual applicants.

C.6. Technical Specification Changes or Additions (54.22)

There are no changes or additions to technical specifications associated with core spray internals as a result of this aging management review to ensure that the effects of aging are adequately managed.

C.7. Demonstration that Activities will Continue to be Conducted in Accordance with the CLB (54.29(a))

Sections C.1, C.2, and C.3 address the requirements 54.21(a) of the rule. The components of the core spray internals that are subject to aging management review are identified and it is demonstrated that the effects of aging are adequately managed.

Sections C. 4 and C.5 address the requirements of 54.21(c) of the rule. The time limited aging analyses (TLAAs) and exemptions that require evaluation will be evaluated by the applicant.

Section C.6 addresses the requirements of 54.22 of the rule. There are no technical specification changes or additions necessary to manage the effects of aging for the core spray internals during the period of extended operation.

Therefore, actions have been identified and have been or will be taken by utilities with BWR plants, such that there is reasonable assurance that the activities authorized by license renewal for the core spray internals will continue to be conducted in accordance with the CLB.

C.8. References

(1) Title 10 of the Code of Federal Regulations, Part 54, "Requirements for License Renewal of Operating Licenses for Nuclear Power Plants,"(60 Federal Register 22461), May 8, 1995.

(2) Nuclear Energy Institute Report NEI 95-10(Rev. 0), Industry Guideline for Implementing the Requirements of 10 CFR Part 54 the License Renewal Rule.

(3) NUMARC 90-03, BWR Reactor Pressure Vessel Internals License Renewal Industry Report, Revision 1, June,1992

(4) NUREG 1557, Summary of Technical Information and Agreements from Nuclear Management and Resources Council Industry Reports Addressing License Renewal, October, 1996

D

NRC FINAL SAFETY EVALUATION FOR BWRVIP-18

Note: This Safety Evaluation applies to a previous version of this report (BWRVIP-18, EPRI report TR-106740). As of the date of publication of this report (BWRVIP-18, Rev. 1), the revisions contained herein have not been approved by the NRC.

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

99-495

December 2, 1999

Carl Terry, BWRVIP Chairman
Niagara Mohawk Power Company
Post Office Box 63
Lycoming, NY 13093

SUBJECT: FINAL SAFETY EVALUATION OF BWR CORE SPRAY INTERNALS INSPECTION AND FLAW EVALUATION GUIDELINES (BWRVIP-18) (TAC NO. M96219)

Dear Mr. Terry:

The NRC staff has completed its review of the proposed revisions to the Electric Power Research Institute (EPRI) proprietary report TR-106740, "BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," dated July 1996. This report was submitted by letter dated July 28, 1996, as supplemented by letter dated October 8, 1997, for NRC staff review and approval.

On June 8, 1998, the NRC staff issued its initial safety evaluation (SE) of the BWRVIP-18 report, which found the BWRVIP-18 report to be acceptable for inspection and assessment of the subject safety-related core spray internal components, except where the NRC staff's conclusions differed from the BWRVIP's, as discussed in the SE. The BWRVIP was requested to resolve the open issues raised in the staff's initial SE. By letter dated January 11, 1999, you provided a response which proposed guidance to resolve the issues identified in the NRC staff's initial SE.

The NRC staff has reviewed your proposed revisions to the BWRVIP-18 report and finds, in the enclosed final safety evaluation, that your response to the open issues is acceptable, with one exception, based on information submitted by the above cited letters. The exception is the guidance to the issue pertaining to the consideration of inspection uncertainties in flaw evaluations. The NRC staff has determined that the inspection uncertainties associated with flaw evaluations are not small and could have significant impact on flaw evaluation results. This is discussed in greater detail in the attached SE, and was discussed with members of the BWRVIP during a public meeting on July 21, 1999. As per this discussion, the NRC staff understands that the BWRVIP agrees to incorporate this item into a revised BWRVIP-18 report. Therefore, the staff has concluded that licensee implementation of the guidelines in the BWRVIP-18 report, subject to incorporation of inspection uncertainties as stated in the attached SE, will provide an acceptable level of quality for examination of the safety-related components addressed in the BWRVIP-18 report.

The staff requests that the BWRVIP incorporate the staff's recommendations regarding the issue of inspection uncertainties, as well as your response to other issues raised in the staff's initial SE, into a revised, final BWRVIP-18 report. Please inform the staff within 90 days of the date of this letter as to your proposed actions and schedule for such a revision.

Carl Terry - 2 -

Please contact C. E. (Gene) Carpenter, Jr., of my staff at (301) 415-2169 if you have any further questions regarding this subject.

Sincerely,

Jack Strosnider

Jack R. Strosnider, Director
Division of Engineering
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: See next page

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION FINAL SAFETY EVALUATION OF
BWR VESSEL AND INTERNALS PROJECT, BWR CORE SPRAY INTERNALS
INSPECTION AND FLAW EVALUATION GUIDELINES (BWRVIP-18)
EPRI REPORT TR-106740, JULY 1996

1.0 INTRODUCTION

1.1 Background

By letter dated July 28, 1996, as supplemented by letter dated October 8, 1997, the BWR Vessel and Internals Project (BWRVIP) submitted the Electric Power Research Institute (EPRI) proprietary report TR-106740, "BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," dated July 1996, for NRC staff review and approval.

The BWRVIP-18 report, as supplemented, contains generic guidelines for the inspection and reinspection of the core spray piping and spargers. It describes piping and sparger locations, categories of plants for which inspection needs would differ, and flaw evaluation procedures to determine allowable flaw sizes. The intent of the subject document was, when approved by the NRC, to replace the inspection guidance contained in the NRC's Bulletin 80-13, "Cracking in Core Spray Spargers," dated May 12, 1980, which requested licensees to inspect their core spray spargers and the segment of piping between the inlet nozzle and the vessel shroud during each refueling outage in order to provide adequate assurance of core spray integrity. To date, these inspections have been successful in identifying cracking and flaws in the core spray piping and spargers.

On June 8, 1998, the NRC staff issued its initial safety evaluation (SE) of the BWRVIP-18 report, which found the BWRVIP-18 report to be acceptable for inspection and assessment of the subject safety-related core spray internal components, except where the staff's conclusions differed from the BWRVIP's, as discussed in the SE. The BWRVIP was requested to resolve the open issues raised in the staff's initial SE. By letter dated January 11, 1999, the BWRVIP provided a response which proposed guidance to resolve the issues identified in the staff's initial SE.

1.2 Purpose

The staff reviewed the BWRVIP-18 report, as supplemented, to determine whether its revised guidance addressed the open items in the staff's initial SE, and if it would provide acceptable levels of quality for inspection and flaw evaluation (I&E) of the subject safety-related reactor pressure vessel (RPV) internal components. The review considered the consequences of component failures, potential degradation mechanisms and past service experience, and the ability of the proposed inspections to detect degradation in a timely manner.

ENCLOSURE

1.3 Organization of the Report

Because the BWRVIP-18 report, as supplemented and revised, is proprietary, this SE was written so as not to repeat proprietary information contained in the report or its revision. The staff does not discuss in any detail the provisions of the guidelines nor the parts of the guidelines it finds acceptable. This SE gives a brief summary of the general contents of the report in Section 2.0 and a detailed evaluation in Section 3.0, below, of the new material provided by the BWRVIP to determine if the items documented in the staff's initial SE have been satisfactorily addressed. The staff's conclusions are summarized in Section 4.0.

2.0 SUMMARY OF BWRVIP-18 REPORT

The BWRVIP-18 report addresses the following topics in the following order:

- Core Spray Piping Design and Susceptibility Information
  - Susceptibility Factors
  - Design of Typical Core Spray Assemblies
- Inspection Strategy
  - Examination Methods
  - BWRVIP "Baseline" Inspection and Reinspection
  - Plant Categories
  - Piping Locations
  - Sparger Locations
  - Geometry-Critical Plants
  - Geometry-Tolerant Plants
  - Other Locations
  - Reporting of Inspection Results
- Loading
  - Significant Loads for Core Spray Line and Sparger Piping
  - Load Combinations
  - Consideration of Shroud Repair
  - Stress Analysis Methodology
- Evaluation Methodologies
  - Piping and Sparger Locations
  - Bracket Locations

The BWRVIP-18 report also contains appendices on (A) Core Spray Piping and Sparger Flaw Evaluation Example, (B) Seismic Inertia Analysis Considerations, and an appendix (C) to demonstrate this report's compliance with the technical information requirements of the license renewal rule, 10 CFR Part 54. Appendix C is not evaluated in this SER, but will be evaluated under a separate review.

3.0 STAFF EVALUATION

The staff's June 8, 1998, initial SE provided six open items. The BWRVIP, in its letter of January 11, 1999, addressed these items, which are discussed below.

Issue 3.1 Surface Cleaning and Implementation Requirements for Visual Examination

The staff's June 8, 1998, initial SE stated:

> The BWRVIP-03 guidelines pertaining to the surface cleaning prior to visual examination need to apply to all methods of visual examinations and the subject guidelines need to be restated in full in the BWRVIP-18 report to ensure that a meaningful visual inspection will be performed.
>
> All the implementation requirements, including the equipment, procedure and personnel qualifications established for the enhanced VT-1 method in the BWRVIP-03 report, need to also apply to the CS VT-1, VT-1 and VT-3 visual examination methods with the exception of the required optical resolution capability, which is different for the various visual examination methods.

The BWRVIP January 11, 1999, response stated, in part:

> In response to the NRC's comment on the number of visual methods, the BWRVIP will delete the CS VT-1 examination technique from BWRVIP-18 and the MVT-1 technique from the other I&E guidelines. The EVT-1 method will be specified as the primary technique to be used when fine, tight IGSCC is a primary concern. In other locations, VT-1 or VT-3 will be used as appropriate. Additional locations are discussed later as part of the sparger reinspection issue.
>
> It is the intent of the BWRVIP to make this same revision to all other I&E guidelines and thus have consistent criteria used throughout the BWRVIP inspection program. The I&E guidelines will specify the examination to be performed (EVT-1, VT-1, etc.) and the definition and other inspection technique issues will be described in BWRVIP-03.

Staff's Evaluation

> The staff has reviewed and approved the BWRVIP's response to this issue, as previously stated in the staff's Final Safety Evaluation of the "BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03) Revision 1" dated July 15, 1999. The staff finds that the BWRVIP's response adequately addressed this item.

Issue 3.2 Reinspection of Core Spray Piping Welds

The staff's June 8, 1998, initial SE stated:

> The non-creviced 304/316 welds need to be inspected to the same extent and frequency as the creviced welds.

The BWRVIP January 11, 1999, response stated:

The cracking history depicted in Table 3-1 of BWRVIP-18 indicates a significant propensity for cracking of creviced welds verses non-creviced welds. The few non-creviced welds reported in Table 3-1 are believed to have cracked at a time, relatively early in plant operating history, when water chemistry was not well controlled. All plants now have significantly improved water chemistry through implementation of the EPRI Water Chemistry Guidelines. Therefore, as evidenced by the reported history, cracking in non-creviced welds is expected to be less likely today than for creviced welds. However, because of the role that heavy grinding has in increasing the likelihood of crack initiation, non-creviced welds that are detected during scheduled inspections or by incidental observations (such as through positioning of UT devices or visual inspection of adjacent areas), to have heavy grinding will be added to the target set of welds for reinspection. Thus the target set will include creviced welds, t-box welds, heavily ground welds and unrepaired welds with existing flaws.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

Issue 3.3 Inspection of Core Spray Spargers

The staff's June 8, 1998, initial SE stated:

a. When performing inspection of core spray spargers, all BWR plants need to be treated as geometry-critical plants.

The BWRVIP January 11, 1999, response stated, in part:

a. The BWRVIP believes there is a sufficient basis to treat geometry-tolerant plants differently than geometry-critical plants. However, for simplicity and uniformity, the BWRVIP will revise the BWRVIP-18 guidelines to treat all plants the same when inspecting core spray spargers

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

The staff's June 8, 1998, initial SE stated:

b. All nozzle welds (S3) need to be inspected during each scheduled inspection.

The BWRVIP January 11, 1999, response stated, in part:

b. The core spray nozzle welds (S3) have also been inspected as part of the sparger inspections in accordance with IEB 80-13 and some facilities have also inspected the nozzles to the guidance of BWRVIP-18. The inspection data available to the BWRVIP indicates that two plants have reported cracking where the nozzle connects to the sparger. The location of the cracking is in the heat affected zone of the sparger pipe at the S3 weld location. For both these plants the cracking does not appear to have grown based on reinspections or tests. The nozzle configurations utilize socket type connections that depend on fillet welds for their integrity, and threaded connections that depend on tack welds to prevent nozzle rotation. For the fillet welded socket connections, only about one-third of the weld length is required to maintain the nozzle intact during a core spray injection. For the threaded connection, the tack welds are not subjected to any loads and only serve as a locking mechanism. Even if the tack welds were to completely crack, it is very unlikely that the roughness of the mating fracture surfaces would allow the connection to rotate.

Consequently, the BWRVIP believes that the above inspection scheme is adequate to manage potential cracking in spargers.

Staff's Evaluation:

The staff finds that, based on the information provided, the BWRVIP's proposed inspection scheme for nozzle welds adequately addressed this item.

Issue 3.4 Leakage Considerations

The staff's June 8, 1998, initial SE stated:

All leakage needs to be considered in the LOCA analysis and evaluated for plant-specific acceptability.

The BWRVIP January 11, 1999, response stated:

As noted in the response to Issue 3.3 above, the distinction between geometry-critical and geometry-tolerant plants will be deleted from BWRVIP-18. Therefore, leakage must be considered from all flaws assumed in flaw evaluations. This includes flaws in core spray piping and spargers.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

Issue 3.5 Flaw Evaluation

The staff's June 8, 1998, initial SE stated:

a. The uninspectable areas need to be conservatively assumed to be completely cracked for the purpose of flaw evaluation.

The BWRVIP January 11, 1999, Response stated:

a. Section 5.1.4 of BWRVIP-18 states that as an alternative to "2x," a statistical approach similar to that in BWRVIP-07 can be used to determine the amount of cracking in uninspected areas. The "2x" approach is more conservative than the BWRVIP-07 statistical approach (which has a 95% confidence) as demonstrated by the following example.

For example, assume that 50% of a weld is inspected. If the cracking on the accessible side is 50% of the amount inspected, then assumption of "2x" percent cracked in the uninspected portion of the weld would result in 100% of the remaining weld length being assumed cracked. If the statistical approach in BWRVIP-07 were used, this would result in 65% of the uninspected weld length being assumed cracked. Thus the "2x" term bounds the statistical approach in BWRVIP-07. BWRVIP proposes to only use the "2x" term for determining the amount of cracking in inaccessible areas.

The 2x criteria is to be applied to both the spargers and the piping, however, it should also be noted that the inspection coverage for the majority of core spray piping welds is in excess of 80%. Therefore, typically there is a very small area that will be uninspected.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

The staff's June 8, 1998, initial SE stated:

b. Supplemental UT needs to be performed to determine the limiting flaw length at both creviced and non-creviced locations.

The BWRVIP January 11, 1999, response stated:

b. The BWRVIP agrees that supplemental UT should be performed to determine flaw lengths in creviced welds in core spray piping, unless plant-specific conditions provide a justification for evaluating the OD cracking without a supplemental UT. For non-creviced welds in core spray piping, supplemental UT need only be performed when VT results indicate that cracking is >10% of the inspected weld length. The BWRVIP will continue to perform supplemental UT for creviced locations as described above. For non-creviced locations, the following criteria is proposed:

   1. If the cracking is ≤ 10% of the inspected weld length, no supplemental UT inspection is required. If OD cracking is detected, the flaw will be assumed to be a through-wall flaw for its entire length. The flaw length will be defined as the visually observed length on the OD plus four times the wall thickness.
   2. If the cracking is > 10% of the inspected weld length, supplemental UT will be required to the extent practical based on weld geometry and accessibility.

   Supplemental UT is not required for core spray sparger welds.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

The staff's June 8, 1998, initial SE stated:

c. The inspection uncertainties in measuring the flaw length by UT or VT need to be included when performing the flaw evaluation.

The BWRVIP January 11, 1999, response stated:

c. The BWRVIP has and is continuing to demonstrate and document the measurement uncertainties associated with each of the BWRVIP recommended inspection techniques. It is not the intent of the BWRVIP that this information be used as additional dimensions to be added to the observed flaw sizes when performing flaw evaluations. The purpose of the BWRVIP activity is to ensure that the uncertainties are relatively small and are appropriately accounted for in the margins that exist in the flaw evaluation procedures (code margins, crack growth rates, etc.,). This is consistent with ASME Section XI and other industry codes that provide for evaluation of flaws detected and measured with NDE techniques. Through procedure guidelines and procedure qualification, it is not expected that the uncertainties that may exist in actual plant application would be any different than those observed during the technique qualifications. The BWRVIP and the EPRI NDE Center have worked together to develop the qualification process and have confirmed that the uncertainties are small and do not warrant any unique recognition in the analytical evaluation process.

Staff's Evaluation:

The NRC staff disagrees with the BWRVIP's conclusion. The NRC has required that inspection uncertainties be considered in flaw evaluations in all cases to ensure that the structural integrity of the evaluated components is not compromised. The NRC staff believes that it is not conservative to neglect inspection uncertainties, since the impact on the structural integrity depends on the relative magnitudes of the critical flaw size and the final flaw size, which are unique in each flaw evaluation. The staff's determination is based on a review of the relevant ultrasonic testing (UT) demonstration data provided in the BWRVIP-03 report, "Reactor Pressure Vessel and Internals Examination Guidelines," Revision 1. The staff finds that, in the UT demonstrations performed on the core spray internal piping, the reported length errors are quite significant. Judging from the results of the referenced UT demonstration, it is evident that the inspection uncertainties in measuring the flaw length are not small and, therefore, it should be considered when performing the flaw evaluation as recommended in the staff's SE.

The staff reiterates that the inspection uncertainties in measuring the flaw length by UT or VT needs to be considered when performing the flaw evaluation, and the value of the uncertainties used in the flaw evaluation needs to be demonstrated on a mock up. This requirement needs to be stated in the BWRVIP-18 report when discussing flaw evaluation.

Issue 3.6 Other Items

The staff's June 8, 1998, initial SE stated:

a. To clarify the baseline inspection requirements, a summary statement of the proposed inspection requirements pertaining to inspecting all accessible piping, sparger or attachment welds using various inspection methods needs to be added.

The BWRVIP January 11, 1999, response stated:

a. The "Baseline" inspection described in BWRVIP-18 is the first inspection that satisfies the guidelines in BWRVIP-18. In most cases this "Baseline" includes all accessible piping, sparger and attachment welds. Inspections conducted after this initial "Baseline" inspection are referred to as "reinspections." See Section 3.2 of BWRVIP-18 for clarification of baseline inspections.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

The staff's June 8, 1998, initial SE stated:

b. The inspection of weld P9 needs to be required when cracking of collar welds is found.

The BWRVIP January 11, 1999, response stated:

b. Weld P9 is not universally inspectable with current technology. A method has been demonstrated for one configuration only at this time and work is underway to develop mock-ups for other configurations. Until such time that inspection of P9 is practical and demonstrated for all plant configurations, other technically founded approaches are needed. Weld P9 is redundant to the P8a and P8b welds in BWR/3-5 plants. Therefore, consideration of the integrity of P9 only needs to be considered if the integrity of the P8a and P8b welds is insufficient. In the interim, if the integrity of P8a and P8b is diminished, the condition of P9 would be considered in the overall integrity evaluation of the connection. The evaluation would consider the low likelihood of cracking to an extent that would jeopardize structural integrity considering susceptibility, operational loads, flaw tolerance, etc. Additional evaluations may demonstrate low likelihood of inadequate core spray flow assuming complete severance of P8a, P8b and P9, e.g., displacement would not be sufficient to significantly reduce core spray flow to the fuel. Also, repair or replacement of P8a or P8b is an alternative. Inspection of P9 will be considered as technology is developed and demonstrated for each of the configurations defined by the BWRVIP Inspection Committee. Until then, the evaluation method described above may be used.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

The staff's June 8, 1998, initial SE stated:

c. For plants with a 12-month fuel cycle, if the stated inspection frequency is once every two cycles, such plants can be reinspected once every three cycles instead of 2 cycles.

The BWRVIP January 11, 1999, response stated:

c. Most BWRs are either on 24-month cycles or are planning to implement 24-month cycles. Reinspection every 2 cycles for a plant with a 24-month cycle results in reinspection every 4 years. For a plant with a 12-month cycle, the equivalent 4-year reinspection interval would be 4 cycles. Thus the "***" note that plants with 12-month cycles can double the number of cycles shown is appropriate.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item.

The staff's June 8, 1998, initial SE stated:

d. The reporting of inspection results, flaw evaluation and repair designs needs to be submitted within 60 days after plant startup.

The BWRVIP January 11, 1999, response stated:

d. In an effort to standardize and simplify the reporting of results, the BWRVIP members will implement the following plan. This will ensure the NRC receives internals inspection data in a timely manner and in a consistent format. This plan does not alter or supersede any Code required reporting. The reporting of Code inspections will continue to be performed in accordance with the members ISI program. This plan is for BWR internal component inspections that are part of the BWRVIP program only.

1. BWRVIP members will provide the results of internal inspections performed in accordance with the BWRVIP program to EPRI at the completion of each outage. EPRI will compile these results and forward them to NRC on a semi-annual basis following each outage season.
2. In the event that flaws are detected that require analytical evaluation for acceptance, BWRVIP members agree to notify NRC during the outage this occurs.
3. If a member intends to perform a repair or replacement of a component covered by the BWRVIP program, the NRC will be notified in accordance with the applicable BWRVIP document, or at or before the beginning of the outage in which the repair occurs. This will allow NRC to plan for witnessing the repair if they so desire.

Staff's Evaluation:

The staff finds that the BWRVIP's response adequately addressed this item. For repairs or replacements performed during the same outage where defects are found, the staff requests that the licensee inform the staff of their planned repair or replacement prior to implementation.

4.0 CONCLUSIONS

The staff has completed its review of the BWRVIP-18 report, as revised, and finds that the licensee's implementation of the revised guidelines, with the staff's final comments addressed above, will provide an acceptable level of quality for examination of the safety-related components addressed in the BWRVIP-18 document.

E

NRC ACCEPTANCE FOR REFERENCING REPORT FOR DEMONSTRATION OF COMPLIANCE WITH LICENSE RENEWAL RULE

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

December 7, 2000

Mr. Carl Terry, BWRVIP Chairman
Niagara Mohawk Power Company
Post Office Box 63
Lycoming, NY 13093

SUBJECT: ACCEPTANCE FOR REFERENCING OF BWR VESSEL AND INTERNALS PROJECT, BWR CORE SPRAY INTERNALS INSPECTION AND FLAW EVALUATION GUIDELINES (BWRVIP-18) REPORT FOR COMPLIANCE WITH THE LICENSE RENEWAL RULE (10 CFR PART 54)

Dear Mr. Terry:

By letter dated July 26, 1996, as supplemented by letters dated October 8, 1997, and January 11, 1999, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted the Electric Power Research Institute (EPRI) proprietary report TR-106740, "BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," dated July 1996, for U.S. Nuclear Regulatory Commission (NRC) staff review. By letter dated December 20, 1996, the BWRVIP submitted "Appendix C, BWR Core Spray Internals Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10 CFR 54.21)." The BWRVIP submitted an initial non-proprietary version of this document, TR-107286NP, on August 12, 1996, and an expanded non-proprietary version by letter dated April 8, 1999. On June 8, 1998, the NRC staff issued its initial safety evaluation (SE) of the BWRVIP-18 report, which found the BWRVIP-18 report to be acceptable for inspection and assessment of the subject safety-related core spray internal components, except where the staff's conclusions differed from the BWRVIP's, as discussed in the SE. The BWRVIP was requested to resolve the open issues raised in the staff's initial SE. By letter dated January 11, 1999, the BWRVIP provided a response which proposed guidance to resolve the issues identified in the staff's initial SE. By letter dated December 2, 1999, the NRC staff issued a final safety evaluation report (FSER), in which the staff found the revised BWRVIP-18 report acceptable for the current operating period of BWRs.

As documented in the attached license renewal (LR) SE, the NRC staff has completed its review of the proprietary version of the BWRVIP-18 report. As indicated in the LR SE, the staff found the BWRVIP-18 report acceptable for licensees participating in the BWRVIP to reference in a license renewal application to the extent specified and under the limitations delineated in the LR SE. In order for licensees participating in the BWRVIP to rely on the report, they must commit to the accepted aging management programs (AMPs) defined therein, and complete the action items described in the LR SE. By referencing the BWRVIP-18 report and the AMPs in it, and completing the action items, an applicant can provide sufficient information for the staff to make a finding that there is reasonable assurance that the applicant will adequately manage the effects of aging so that the intended functions of the reactor vessel within the scope of the report will be maintained consistent with the current licensing basis during the period of extended operation.

The staff does not intend to repeat its review of the matters described in the report and found acceptable in the LR SE when the report is incorporated by reference in a LR application, except to ensure that the report's conclusions apply to the specified plant.

In accordance with the procedures established in NUREG-0390, "Topical Report Review Status," the staff requests that the BWRVIP publish the accepted version of BWRVIP-18 within 90 days after receiving this letter. In addition, the published version will incorporate this letter and the enclosed LR SE between the title page and the abstract.

To identify the version of the report that was accepted by the staff, the BWRVIP requests that "A" follow the topical report number (e.g., BWRVIP-18-A).

Sincerely,

Christopher I. Grimes, Branch Chief
License Renewal and Standardization Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Project No. 704

Enclosure: Final Safety Evaluation Report

cc w/encl: See next page

FINAL LICENSE RENEWAL SAFETY EVALUATION REPORT
BY THE OFFICE OF NUCLEAR REACTOR REGULATION
FOR
"BWR VESSEL AND INTERNALS PROJECT, BWR CORE SPRAY
INTERNALS INSPECTION AND FLAW EVALUATION GUIDELINES (BWRVIP-18)"
FOR COMPLIANCE WITH THE LICENSE RENEWAL RULE (10 CFR PART 54)

1.0 INTRODUCTION

1.1 Background

By letter dated July 26, 1996, as supplemented by letters dated October 8, 1997, and January 11, 1999, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted the Electric Power Research Institute (EPRI) proprietary report TR-106740, "BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," dated July 1996, for U.S. Nuclear Regulatory Commission (NRC) staff review. The BWRVIP submitted an initial non-proprietary version of this document, TR-107286NP, on August 12, 1996, and an expanded non-proprietary version by letter dated April 8, 1999.

The BWRVIP-18 report, as supplemented, contains generic guidelines for the inspection and reinspection of the core spray piping and spargers. It describes piping and sparger locations, categories of plants for which inspection needs would differ, and flaw evaluation procedures to determine allowable flaw sizes. The intent of the subject document was, when approved by the NRC, to replace the inspection guidance contained in the NRC's Bulletin 80-13, "Cracking in Core Spray Spargers," dated May 12, 1980, which requested licensees to inspect their core spray spargers and the segment of piping between the inlet nozzle and the vessel shroud during each refueling outage in order to provide adequate assurance of core spray integrity. To date, these inspections have been successful in identifying cracking and flaws in the core spray piping and spargers.

On June 8, 1998, the NRC staff issued its initial safety evaluation (SE) of the BWRVIP-18 report, which found the BWRVIP-18 report to be acceptable for inspection and assessment of the subject safety-related core spray internal components, except where the staff's conclusions differed from the BWRVIP's, as discussed in the SE. The BWRVIP was requested to resolve the open issues raised in the staff's initial SE. By letter dated January 11, 1999, the BWRVIP provided a response which proposed guidance to resolve the issues identified in the staff's initial SE. By letter dated December 2, 1999, the NRC staff issued a final safety evaluation report (FSER), in which the staff found the revised BWRVIP-18 report acceptable for the current operating period of BWRs.

By letter dated December 20, 1996, the BWRVIP submitted a separate document, "Appendix C, BWR Core Spray Internals Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10 CFR 54.21)," for NRC staff review in accordance with the License Renewal Rule (10 CFR Part 54).

ATTACHMENT

Section 54.21 of the LR Rule requires, in part, that each application for license renewal contain an integrated plant assessment (IPA) and an evaluation of time-limited aging analyses (TLAA). The IPA must identify and list those structures and components subject to an aging management review and demonstrate that the effects of aging will be adequately managed so that their intended functions will be maintained consistent with the current licensing basis (CLB) for the period of extended operation. In addition, 10 CFR 54.22 requires that each application include any technical specification changes or additions necessary to manage the effects of aging during the period of extended operation as part of the renewal application.

If an LR applicant participating in the BWRVIP confirms that the BWRVIP-18 report applies to its facility and that the results of the Appendix C IPA and TLAA evaluation are in effect at its plant, then no further review by the NRC staff of the issues described in the documents is necessary, except as specifically identified by the staff below. With this exception, such an applicant may rely on the BWRVIP-18 report for the demonstration required by 10 CFR 54.21(a)(3) with respect to the components and structures within the scope of the report. Under such circumstances, the NRC staff intends to rely on the evaluation in this LR SE to make the findings required by 10 CFR 54.29 with respect to a particular application.

1.2 Purpose

The staff reviewed the BWRVIP-18 report and its Appendix C to determine whether its guidance will provide acceptable levels of quality for inspection and flaw evaluation of the subject safety-related RPV internal components within the scope of the report during the period of extended operation. The staff also considered compliance with the LR Rule in order to allow applicants for renewal the option of incorporating the BWRVIP-18 guidelines by reference in a plant-specific IPA and associated TLAA.

1.3 Organization of this Report

Because the BWRVIP-18 report, as supplemented and modified, is proprietary, this SE was written so as not to repeat information contained in the proprietary portions of the report. The staff does not discuss in any detail the proprietary provisions of the guidelines nor the parts of those guidelines it finds acceptable. A brief summary of the contents of the BWRVIP-18 report is given in Section 2.0 of this SE, with the NRC staff's evaluation presented in Section 3.0. The conclusions are summarized in Section 4.0. The presentation of the evaluation is structured according to the organization of the BWRVIP-18 report.

2.0 SUMMARY OF BWRVIP-18 REPORT

The BWRVIP-18 report and its Appendix C contain a generic evaluation of the management of the effects of aging on the subject RPV internal components so that their intended functions will be maintained consistent with the CLB for the period of extended operation. This evaluation applies to BWR applicants who have committed to implementing the BWRVIP-18 report and want to incorporate the report and Appendix C by reference into a plant-specific IPA and associated TLAAs.

2.1 BWRVIP-18 Topics

The BWRVIP-18 report addresses the following topics:

- Core Spray Piping Design and Susceptibility Information - The various susceptibility factors and the design of typical core spray assemblies are discussed in detail.
- Inspection Strategy - The examination methods are described. The BWRVIP's "baseline" inspection and reinspection strategies are discussed, including the various plant categories, the piping locations and sparger locations of concern, a discussion of other locations of concern, and the reporting of inspection results.
- Loading - Describes the significant loads for core spray line and sparger piping, the load combinations, considerations for loading resulting from core shroud tie rod repairs, and the stress analysis methodology.
- Evaluation Methodologies - Discusses the methodologies used for the various piping, sparger and bracket locations.

The BWRVIP-18 report also contains appendices on (A) Core Spray Piping and Sparger Flaw Evaluation Example and (B) Seismic Inertia Analysis Considerations.

Appendix C discusses the following topics:

2.2 Identification of Structures and Components Subject to an Aging Management Review

10 CFR 54.21(a)(1) requires that an IPA identify and list those structures and components within the scope of license renewal that are subject to an aging management review. Structures and components subject to an aging management review are those structures and components that (1) perform an intended function, as described in 10 CFR 54.4, without moving parts or without a change in configuration or properties and (2) are not subject to replacement based on a qualified life or specified time period. These structures and components are also referred to as "passive" and "long-lived" structures and components.

Section 2.0 of the BWRVIP-18 report describes the intended function of the core spray internals. Their function is to (1) provide a flow path for core cooling water from the vessel nozzle, through the shroud to the sparger, (2) provide a uniform distribution of spray to assure core cooling when the core cannot be fully reflooded, and (3) in some newer BWRs, provide the flow path for the injection of boron from the standby liquid control (SLC) system.

The BWRVIP-18 report's Appendix C identifies the passive and long-lived components as required by 10 CFR 54.21(a)(1). The BWRVIP-18 report states that the core spray internal components subject to aging management review are the:

- Junction or tee box connections at the vessel nozzle or shroud penetration;
- Piping and fittings between the vessel nozzle and sparger;
- Spargers and nozzles; and
- Attachment bracket supports.

2.3 Effects of Aging

The BWRVIP identified the aging mechanisms and aging effects for the core spray internals using the guidance from NUMARC 90-02, "BWR Reactor Pressure Vessel License Renewal Industry Report," Revision 1, dated August 1992. The BWRVIP also used NUREG-1557, "Summary of Technical Information and Agreements from Nuclear Management and Resources Council Industry Reports Addressing License Renewal," dated October 1996, to correlate the aging effects and their associated aging mechanisms. Using these reports, the BWRVIP determined that crack initiation and growth is the only aging effect that requires aging management review for the core spray internals.

In Section 2.0 of the BWRVIP-18 report, the BWRVIP discussed the causes of crack initiation and growth and provided a susceptibility assessment, and also discussed the susceptibility factors of environment, materials, and stress state. The BWRVIP's review of the contributing factors has determined that (1) grinding or mechanical straining and/or (2) the presence of a crevice aggravates crack initiation at weld locations, all of which have residual stresses and an aggressive environment. It also appears that sensitization is an important factor. Cracking has occurred predominantly in Type 304 materials to date.

2.3 Aging Management Programs

10 CFR 54.21(a)(3) requires that the applicant demonstrate, for each component identified, that the effects of aging will be adequately managed so that the intended function will be maintained consistent with the CLB for the period of extended operation.

In Section 3.0 of the BWRVIP-18 report, the BWRVIP discussed the inspection strategy to be used for ensuring that cracks that might occur in the core spray internals are detected in a timely manner. The program specifies implementation of a baseline inspection followed by focused reinspections of the core spray piping and sparger consisting of ultrasonic (UT) and visual (VT) examination methods. The BWRVIP concluded that both its inspection program and plant-specific considerations will result in verification of the structural integrity, consistent with the CLB, for the subject RPV internal components.

2.4 Time-Limited Aging Analyses

10 CFR 54.21(1)(c) requires that each application for license renewal contain an evaluation of TLAA as defined in 10 CFR 54.3. TLAAs considered in the BWRVIP-18 report are those licensee calculations and analyses that:

(1) involve the core spray internal components within the scope of license renewal;

(2) consider the effects of aging;

(3) involve time-limited assumptions defined by the current operating term;

(4) were determined to be relevant by the licensee in making a safety determination;

(5) involve conclusions or provide the basis for conclusions related to the capability of the core spray internals to perform their intended function; and

(6) are contained or incorporated by reference in the CLB.

With respect to the BWRVIP-18 report, if a plant-specific analysis, as identified by an applicant, meets all six of the above criteria, the analysis will be considered a TLAA for license renewal and evaluated by the applicant.

High cycle fatigue from flow induced vibrations, which potentially could be subject to TLAA, has been found to not be a concern through pre-operational testing. Additionally, low cycle fatigue from thermal cycling has been found to be insignificant.

The BWRVIP did not find any generic TLAAs applicable to the core spray internals, as defined by the six criteria above. However, if a plant-specific analysis identified by an applicant satisfies all six criteria above, then this analysis will be considered a TLAA issue for license renewal and evaluated by the applicant.

3.0 STAFF EVALUATION

The staff's FSER of the BWRVIP-18 report for the current operating term was transmitted by letter dated December 2, 1999, to Carl Terry, BWRVIP Chairman. The NRC staff determined that the contents and recommendations in the BWRVIP-18 report, when coupled with the BWRVIP's responses to the specific information requests in the staff's January 22, 1997, RAI, provides a sufficient and acceptable basis for performing examinations and evaluating postulated flaw indications for the core spray internals. The NRC staff concluded that licensee implementation of the guidelines in the BWRVIP-18 report will provide an acceptable level of quality for inspection and flaw evaluation of the components addressed for the current operating term.

The staff has further reviewed the BWRVIP-18 report and its Appendix C to determine if it demonstrates that the effects of aging on the reactor vessel components within the scope of the report will be adequately managed so that the components' intended functions will be maintained consistent with the CLB for the period of extended operation, in accordance with 10 CFR 54.21(a)(3). This is the last step in the IPA described in 10 CFR 54.21(a).

Besides the IPA, 10 CFR Part 54 requires an evaluation of TLAAs in accordance with 10 CFR 54.21(c). The staff reviewed the BWRVIP-18 report to determine if the TLAAs covered by the report were evaluated for license renewal in accordance with 10 CFR 54.21(c)(1).

3.1 Structures and Components Subject to Aging Management Review (AMR)

The staff agrees that the core spray internals are subject to an AMR because they perform intended functions without moving parts or without a change in configuration or properties, and are not subject to replacement based on a qualified life or specified time period. The staff concludes that BWR applicants for license renewal must identify the appropriate subject RPV internal components as subject to aging management to meet the applicable requirements of 10 CFR 54.21(a)(1).

3.2 Intended Functions

The staff agrees that the intended functions of the core spray internals are as stated. Their function is to (1) provide a flow path for core cooling water from the vessel nozzle, through the shroud to the sparger, (2) provide a uniform distribution of spray to assure core cooling when the core cannot be fully reflooded, and (3) in some newer BWRs, provide the flow path for the injection of boron from the standby liquid control (SLC) system.

3.3 Effects of Aging

The information necessary to demonstrate compliance with the requirements of the license renewal rule, 10 CFR 54.21, is provided in Appendix C of the BWRVIP-18 report. The BWR Reactor Pressure Vessel Industry Report NUMARC 90-02, Revision 1, August 1992, and the resolution to the NRC's questions on that industry report were used to identify the aging mechanisms for the core spray internals. If the industry report concluded that the aging mechanism is significant then the aging mechanism was included in the aging management review. Using this methodology, it was determined that crack initiation and growth are the only aging effects that required aging management review.

Accordingly, NUREG-1557 states that crack initiation and growth are the aging effects that need to be considered. For the reasons stated in NUREG-1557, the staff agrees that this mechanism is the only one applicable to the internal components.

3.4 Aging Management Programs (AMP)

The staff evaluated the BWRVIP's AMP to determine if it contains the following 10 elements constituting an adequate AMP for license renewal. Each of the ten elements is listed below followed by a brief discussion as to how the AMP addresses the element.

(1) Scope of Program: The program is focused on managing the effects of crack initiation and growth due to stress corrosion cracking (SCC). The program contains preventative measures to mitigate SCC, inservice inspection (ISI) to monitor the effects of SCC on the intended function of the components, and repair and/or replacement as needed to maintain the ability to perform the intended function

(2) Preventative Actions: Coolant water chemistry is monitored and maintained in accordance with EPRI guidelines. Maintaining high water purity reduces susceptibility to SCC. For those plants using hydrogen water chemistry (HWC) or noble metal chemical addition (NMCA), hydrogen additions are effective in reducing electrochemical (corrosion) potentials in the recirculation piping system, but are less effective in the core region. Noble metal additions, through a catalytic action, appear to increase the effectiveness of hydrogen additions in the core region.

(3) Parameters Monitored or Inspected: The AMP monitors the effects of SCC on the intended function by detection and sizing of cracks by inservice inspection. Inspection and flaw evaluation are performed in accordance with BWRVIP guidelines, as approved by the NRC.

(4) Detection of Aging Effects: Inspection in accordance with BWRVIP guidelines assures that degradation due to SCC is detected before any loss of the intended function of the core plate components.

(5) Monitoring and Trending: The inspection schedule is in accordance with applicable approved BWRVIP guidelines and is adequate for timely detection of cracks. Scope of examination expansion and re-inspection beyond the baseline inspection are required if flaws are detected.

(6) Acceptance Criteria: Any degradation is evaluated in accordance with the applicable approved BWRVIP guidelines.

(7) Corrective Actions: The corrective actions proposed by the BWRVIP have been reviewed and approved in the staff's SE for the BWRVIP-16 and -19 reports, dated August 10, 2000.

(8) & (9) Confirmation Process and Administrative Controls: Site QA procedures, review and approval processes and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR 50 and will continue to be adequate for the license renewal period.

(10) Operating Experience: NRC Inspection & Examination (IE) Bulletin 80-13, "Cracking in Core Spray Spargers," required visual inspections. BWR utilities have been routinely performing examinations and, over time, additional cracking has been observed. General Electric (GE) has issued Rapid Information Communication Services Information Letters (RICSILs) which recommended specific inspection guidelines based on instances of cracking found in operating plants. IE Bulletin 80-13 reviews instances of cracking in core spray spargers. Further cracking history is given in Table 3-1 of the BWRVIP-18 report.

The staff's FSER of the BWRVIP-18 report for the current operating term was transmitted by letter dated December 2, 1999, to Carl Terry, BWRVIP Chairman. For the reasons set forth in the FSER, the staff concluded that the inspection strategy and evaluation methodologies discussed in the BWRVIP-18 report are acceptable. Implementation of the above inspection program provides reasonable assurance that crack initiation and growth will be adequately managed such that the intended functions of the subject safety-related RPV internal components will be maintained consistent with the CLB in the period of extended operation.

3.5 Time Limited Aging Analyses (TLAA)

The BWRVIP did not find any of the six TLAA criteria listed in Section 2.4 applicable for license renewal for the core spray piping system. Therefore, the staff concludes that the BWRVIP-18 document does not contain any generic TLAA issues pertinent for the core spray internals. However, if a plant-specific analysis performed by an applicant satisfies each of the TLAA criteria, then the plant specific analysis will be considered a TLAA for license renewal and be evaluated by the applicant.

4.0 CONCLUSIONS

The staff has reviewed the subject BWRVIP-18 report submitted by the BWRVIP. On the basis of its review, as set forth above, the staff concludes that the BWRVIP-18 report provides an acceptable demonstration that the BWRVIP member utilities referencing this topical report will adequately manage the aging effects of reactor vessel components within the scope of the report, with the exception of the noted renewal applicant action items set forth in Section 4.1

below, so that there is reasonable assurance that the core spray internals will perform their intended functions in accordance with the CLB during the period of extended operation. The BWRVIP-18 report does not contain any generic TLAA issues pertinent for the core spray internals. See Applicant Action Item 4.1(4), below.

Any BWR utility may reference this report in a license renewal application to satisfy the requirements of 10 CFR 54.21(a)(3) for demonstrating that the effects of aging on the reactor vessel components within the scope of this report will be adequately managed. The staff concludes that, upon completion of the renewal applicant action items set forth in Section 4.1 below, referencing the BWRVIP-18 report and its Appendix C in a license renewal application and summarizing in an FSAR supplement the aging management programs and the TLAA evaluations contained in this report will provide the staff with sufficient information to make the findings required by Sections 54.29(a)(1) and (a)(2) for components within the scope of this report.

4.1 Renewal Applicant Action Items

The following are license renewal applicant action items to be addressed in the plant-specific license renewal application when incorporating the BWRVIP-18 report in a renewal application:

(1) The license renewal applicant is to verify that its plant is bounded by the report. Further, the renewal applicant is to commit to programs described as necessary in the BWRVIP-18 report to manage the effects of aging on the functionality of the core spray internals during the period of extended operation. Applicants for license renewal will be responsible for describing any such commitments and identifying how such commitments will be controlled. Any deviations from the aging management programs within the BWRVIP-18 report described as necessary to manage the effects of aging during the period of extended operation and to maintain the functionality of the reactor vessel components or other information presented in the report, such as materials of construction, will have to be identified by the renewal applicant and evaluated on a plant-specific basis in accordance with 10 CFR 54.21(a)(3) and (c)(1).

(2) 10 CFR 54.21(d) requires that an FSAR supplement for the facility contain a summary description of the programs and activities for managing the effects of aging and the evaluation of TLAAs for the period of extended operation. Those applicants for license renewal referencing the BWRVIP-18 report for the core spray internals shall ensure that the programs and activities specified as necessary in the BWRVIP-18 report are summarily described in the FSAR supplement.

(3) 10 CFR 54.22 requires that each application for license renewal include any technical specification changes (and the justification for the changes) or additions necessary to manage the effects of aging during the period of extended operation as part of the renewal application. In its Appendix C to the BWRVIP-18 report, the BWRVIP stated that there are no generic changes or additions to technical specifications associated with the core spray internals as a result of its aging management review and that the applicant will provide the justification for plant-specific changes or additions. Those applicants for license renewal referencing the BWRVIP-18 report for the core spray internals shall ensure that the inspection strategy described in the BWRVIP-18 report does not conflict

with or result in any changes to their technical specifications. If technical specification changes do result, then the applicant must ensure that those changes are included in its application for license renewal.

(4) Applicants referencing the BWRVIP-18 report for license renewal should identify and evaluate any potential TLAA issues which may impact the structural integrity of the subject RPV internal components. This is discussed in more detail in Section 2.4 of this SE.

5.0 REFERENCES

1. NUREG-1557, Summary of Technical Information and Agreements from Nuclear Management and Resources Council Industry Reports Addressing License Renewal, October 1996.

2. Carl Terry, BWRVIP, to USNRC, "BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," EPRI Report TR-106740, dated July 1996.

3. C. E. Carpenter, USNRC, to Carl Terry, BWRVIP, "Propriety Request for Additional Information - Review of BWR Vessel and Internals Project Report, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," dated January 22, 1997.

4. Carl Terry, BWRVIP, to USNRC, "BWRVIP Response to NRC Request for Additional Information on BWRVIP-18," dated October 8, 1997.

5. J. R. Strosnider, USNRC, to Carl Terry, BWRVIP, "Safety Evaluation of BWR Vessel and Internals Project Report, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," dated December 2, 1999.

F

RECORD OF REVISIONS (BWRVIP-18-A)

Entire Appendix Deleted -
EPRI Proprietary Information

G
NRC APPROVAL OF BWRVIP-18-A

ELECTRIC POWER RESEARCH INSTITUTE

2005-386 BWR Vessel & Internals Project (BWRVIP)

(via e-mail)

September 19, 2005

TO: All BWRVIP Committee Members

FROM: Robin Dyle/Tom Mulford *Tom J. Mulford*

SUBJECT: NRC Approval of BWRVIP-18-A (Core Spray I&E Guidelines)

Enclosed for your information is a NRC letter approving the report "BWRVIP-18-A: BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines."

If you have any questions on this subject, please contact Tom Mulford at EPRI by telephone at 650.855.2766 or by e-mail at tmulford@epri.com.

Together . . . Shaping the Future of Electricity

PALO ALTO OFFICE
3420 Hillview Avenue, Palo Alto, CA 94304-1395 USA • 650.855.2000 • Customer Service 800.313.3774 • www.epri.com

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

September 6, 2005

Bill Eaton, BWRVIP Chairman
Entergy Operations, Inc.
Echelon One
1340 Echelon Parkway
Jackson, MS 39213-8202

SUBJECT: NRC APPROVAL LETTER OF BWRVIP-18-A, "BWR VESSEL AND INTERNALS PROJECT BOILING WATER REACTOR CORE SPRAY INTERNALS INSPECTION AND FLAW EVALUATION GUIDELINES"

Dear Mr. Eaton:

By letter dated March 30, 2005, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted Proprietary Report BWRVIP-18-A, "BWR Vessel and Internals Project Boiling Water Reactor Core Spray Internals Inspection and Flaw Evaluation Guidelines," for Nuclear Regulatory Commission (NRC) staff review.

The BWRVIP-18-A report provides generic guidelines for the inspection and reinspection of the core spray piping and spargers. The report describes piping and sparger locations, categories of plants for which inspection needs would differ, and flaw evaluation procedures to determine allowable flaw sizes. The intent of the subject document is, when approved by the staff, to replace the inspection guidance contained in the NRC's Bulletin 80-13, "Cracking in Core Spray Spargers," dated May 13, 1980, which requested that licensees inspect their core spray spargers and the segment of piping between the inlet nozzle and the vessel shroud during each refueling outage in order to provide adequate assurance of core spray system integrity. To date, these inspections have been successful in identifying cracking and flaws in the core spray piping and spargers.

The BWRVIP-18-A report presents a compilation of information from several sources: the subject proprietary report, BWRVIP responses to NRC staff requests for additional information (RAIs) regarding the subject report, and the NRC staff's final safety evaluation (SE) dated December 2, 1999. It should be noted that the BWRVIP also made modifications to the subject report based on the recommendations that the staff provided in its initial SE of the BWRVIP-18 report dated June 8, 1998.

The NRC staff has reviewed the information in the BWRVIP-18-A report and has found that the report accurately incorporates all of the relevant information in the documents noted above to support NRC staff approval of the report. The staff found that a few technical changes were made in the production of the BWRVIP-18-A report. The first revision was that the BWRVIP added text to Sections 2.1.2 and 2.3 of the BWRVIP-18-A report to clarify that no inspection is required of any solution annealed, non-creviced core spray piping welds. The staff determined that the BWRVIP's position is acceptable because solution annealed, non-creviced core spray piping welds are not expected to experience cracking significant enough to require inspection.

B. Eaton -2-

With respect to Open Item 3.3-4 of the staff's SE on the BWRVIP-03 report, "Reactor Pressure Vessel and Internals Examination Guidelines," the staff required that "all BWRVIP inspection and evaluation guidelines be revised to replace Core Spray VT-1 (CSVT-1) and modified visual testing (MVT-1) by enhanced visual testing (EVT-1), VT-1, or VT-3. In addition, EVT-1 is to be specified as the primary technique when fine, tight IGSCC is a primary concern. In all other locations, VT-1 or VT-3 will be used as appropriate." Therefore, in response to this open item, the BWRVIP revised the wording in several places throughout the BWRVIP-18-A report, to replace "CSVT-1" with "EVT-1." The staff found that the BWRVIP adequately revised the applicable sections of the BWRVIP-18-A report to address Open Item 3.3.4 of the BWRVIP-03 report.

The BWRVIP, in response to Item 3.1 of the staff's initial SE on the BWRVIP-18 report dated June 8, 1998, eliminated the discussion of cleaning with regard to the generic visual inspection procedure. The staff determined that this was acceptable because cleaning is addressed in the BWRVIP-03 report, "Reactor Pressure Vessel and Internals Examination Guidelines."

The BWRVIP, in response to Item 3.2 of the staff's initial SE on the BWRVIP-18 report dated June 8, 1998, revised the text in Section 3.3 and Table 3-5, to revise the list of welds to include heavily-ground welds. The staff found this acceptable because the BWRVIP adequately addressed its issue of including heavily-ground welds within the scope of the welds that are to be inspected.

The BWRVIP, in response to Item 3.4 of the staff's initial SE on the BWRVIP-18 report dated June 8, 1998, revised the text in Section 5.1.8 and A.2 of the BWRVIP-18-A report to indicate that leakage is to be evaluated from all flaws. The staff determined that the BWRVIP adequately revised the appropriate sections in the BWRVIP-18-A report to address that leakage is to be evaluated from all flaws.

The BWRVIP, in response to Item 3.5(b) of the staff's initial SE on the BWRVIP-18 report dated June 8, 1998, revised the criteria in Section 3.2.4 of the BWRVIP-18-A report regarding supplemental ultrasonic testing of non-creviced welds. The staff determined that the BWRVIP adequately revised Section 3.2.4 of the BWRVIP-18-A report to include comprehensive inspection criteria with respect to supplemental ultrasonic testing of non-creviced welds.

The BWRVIP, in response to Item 3.6(b) of the staff's initial SE on the BWRVIP-18 report dated June 8, 1998, revised Section 3.2.4 of the BWRVIP-18-A report to address the staff's recommendation that inspections of the P9 weld (identified on page 3-7 of the BWRVIP-18-A report) shall be required when cracking of either of the collar welds (P8a or P8b) is found. The BWRVIP revised Section 3.2.4 to provide requirements for evaluations that are to be performed on the P9 weld and guidelines for other options, i.e., repair or replacement of the collar welds, if the integrity of the collar welds was determined to have diminished. The staff determined that the BWRVIP adequately revised Section 3.2.4 to address the staff's open item regarding collar welds with diminished integrity.

B. Eaton -3-

The last revision was with respect to the deletion of Section 3.4, "Reporting of Inspection Results," of the BWRVIP-18-A report. The BWRVIP determined that all reporting requirements would be removed from the BWRVIP-18-A report since they are already contained in the BWRVIP-94 report, "Program Implementation Guide." The staff found this acceptable because all reporting requirements for inspection and evaluation guidelines are adequately included in the BWRVIP-94 report.

Also, the staff noted that several minor clarifications and editorial revisions were made in the report. The staff confirmed that the clarifications and editorial revisions did not impact the technical aspects of the report.

Based on the discussion above, the staff has determined that the BWRVIP-18-A report is acceptable. Please contact Meena Khanna of my staff at (301) 415-2150 if you have any further questions regarding this subject.

Sincerely,

Mathew A. Mitchell for

William H. Bateman, Chief
Materials and Chemical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

Attachment: As stated

cc: See next page

cc:
Tom Mulford, EPRI BWRVIP
Integration Manager
Raj Pathania, EPRI BWRVIP
Mitigation Manager
Ken Wolfe, EPRI BWRVIP
Repair Manager
Larry Steinert, EPRI BWRVIP
Electric Power Research Institute
P.O. Box 10412
3412 Hillview Ave.
Palo Alto, CA 94303

Robert Carter, EPRI BWRVIP
Assessment Manager
Greg Selby, EPRI BWRVIP
Inspection Manager
EPRI NDE Center
P.O. Box 217097
1300 W. T. Harris Blvd.
Charlotte, NC 28221

George Inch, Technical Chairman
BWRVIP Assessment Committee
Constellation Nuclear
Nine Mile Point Nuclear Station (M/S ESB-1)
348 Lake Road
Lycoming, NY 13093

Denver Atwood, Chairman
BWRVIP Repair Focus Group
Southern Nuclear Operating Co.
Post Office Box 1295
40 Inverness Center Parkway (M/S B031)
Birmingham, AL 35242-4809

Jeff Goldstein, Technical Chairman
BWRVIP Mitigation Committee
Entergy Nuclear NE
440 Hamilton Ave. (M/S K-WPO-11c)
White Plains, NY 10601

Charles J. Wirtz, Chairman
BWRVIP Inspection Focus Group
FirstEnergy Corp.
Perry Nuclear Power Plant (M/S A250)
10 Center Road
Perry, OH 44081

Amir Shahkarami
BWRVIP Executive Oversight Committee Member
Exelon Corporation
4300 Winfield Road
Warrenville, IL 60555-4012

Robin Dyle, Technical Chairman
BWRVIP Integration Committee
Southern Nuclear Operating Co.
42 Inverness Center Parkway (M/S B234)
Birmingham, AL 35242-4809

Al Wrape, Executive Chairman
BWRVIP Assessment Committee
PPL Susquehanna, LLC
2 N. 9th St.
Allentown, PA 18101-1139

H. Lewis Sumner, Executive Chairman
BWRVIP Mitigation Committee
Vice President, Hatch Project
Southern Nuclear Operating Co.
M/S BIN B051, P.O. BOX 1295
40 Inverness Center Parkway
Birmingham, AL 35242-4809

Rick Libra
BWRVIP Executive Oversight Committee Member
DTE Energy
6400 N Dixie Hwy (M/S 280 OBA)
Newport, MI 48166-9726

Greg Selby, EPRI BWRVIP
Inspection Manager
EPRI NDE Center
PO Box 217097/1300 W. T. Harris Blvd.
Charlotte, NC

H
RECORD OF REVISIONS (BWRVIP-18, REV. 1)

Entire Appendix Deleted -
EPRI Proprietary Information

The Electric Power Research Institute (EPRI), with major locations in Palo Alto, California; Charlotte, North Carolina; and Knoxville, Tennessee, was established in 1973 as an independent, nonprofit center for public interest energy and environmental research. EPRI brings together members, participants, the Institute's scientists and engineers, and other leading experts to work collaboratively on solutions to the challenges of electric power. These solutions span nearly every area of electricity generation, delivery, and use, including health, safety, and environment. EPRI's members represent over 90% of the electricity generated in the United States. International participation represents nearly 15% of EPRI's total research, development, and demonstration program.

Together...Shaping the Future of Electricity

Program:

Nuclear Power
BWR Materials Management

Printed on recycled paper in the United States of America

1016568NP

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com