May 14, 2002

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

SUBJECT: FINAL SAFETY EVALUATION OF THE “BWRVIP VESSEL AND INTERNALS PROJECT, BWR VESSEL AND INTERNALS PROJECT, TECHNICAL BASIS FOR REVISIONS TO GENERIC LETTER 88-01 INSPECTION SCHEDULES (BWRVIP-75),” EPRI REPORT TR-113932, OCTOBER 1999 (TAC NO. MA5012)

Dear Mr. Terry:

The NRC staff has completed its review of the Electric Power Research Institute (EPRI) proprietary report TR-113932, “BWR Vessel and Internals Project, Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules (BWRVIP-75),” dated October 1999, submitted to the U. S. Nuclear Regulatory Commission (NRC) for staff review by letter dated October 27, 1999. The non-proprietary version of the BWRVIP-75 report was submitted by letter dated February 29, 2000. It was supplemented by letter dated August 28, 2001, in response to the open items in the staff’s initial safety evaluation (SE), dated September 15, 2000.

The BWRVIP-75 report proposes revisions to the extent and frequencies for piping inspection contained in Generic Letter (GL) 88-01. The proposed revisions are based on the consideration of inspection results and service experience gained by the industry since the issuance of GL 88-01, and includes additional knowledge regarding the benefits of improved BWR water chemistry. The BWRVIP-75 report also provides justification for the proposed inspection criteria for Category A through E welds for the respective conditions of normal water chemistry (NWC) and hydrogen water chemistry (HWC).

The NRC staff has reviewed the BWRVIP-75 report, as supplemented, and finds that the revised guidance of the BWRVIP-75 report, with the modifications as described in the enclosed SE, is acceptable for inspection of the subject safety-related Class I piping welds, as described. However, regarding the use of factors of improvement (FOI) to determine the effectiveness of a licensee’s HWC program, the staff disagrees with the BWRVIP on this issue; therefore, at this time, the staff is not approving the use of FOI for BWR austenitic stainless steel piping. This finding is based on information submitted by the above cited letters, and a public meeting held at Argonne National Laboratory (ANL) on October 29 and 30, 2001. The staff has concluded that licensee implementation of the guidelines in the BWRVIP-75 report, as modified, will provide an acceptable level of quality for inspection of the safety-related components addressed. Further, the staff finds that the revised BWRVIP-75 guidance is acceptable for licensee referencing as the technical basis for relief from, or as an alternative to, the ASME Code and 10 CFR 50.55a, in order to use the sample schedules and frequencies specified in the revised BWRVIP-75 report that are less than those required by the ASME Code.

The staff requests that you incorporate the staff's recommendations, as well as your responses to other issues raised in the staff's initial SE, into a revised, final BWRVIP-75 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.

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

Sincerely,

/ra/

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

Enclosure: As stated

cc: BWRVIP Service List

The staff requests that you incorporate the staff's recommendations, as well as your responses to other issues raised in the staff's initial SE, into a revised, final BWRVIP-75 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.

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

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William H. Bateman, Chief
Materials and Chemical Engineering Branch
Division of Engineering
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Enclosure: As stated

cc: BWRVIP Service List

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cc:

George Vanderheyden, Executive Chair
BWRVIP Assessment Committee
Exelon Corp.
200 Exelon Way (KSA 3-N)
Kennett Square, PA 19348

Bill Eaton, Executive Chair,
BWRVIP Inspection Focus Group
Grand Gulf Gen. Mgr., Plant Operations
Entergy Operations, Inc.
PO BOX 756, Waterloo Rd
Port Gibson, MS 39150-0756

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

George T. Jones, Executive Chair
BWRVIP Repair Focus Group
Vice President, Nuclear Engrg. & Support
PP&L, Inc.
M/S GENA61
2 N 9th St
Allentown, PA 18101-1139

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

Richard Ciemiewicz, Technical Vice Chair
BWRVIP Assessment Committee
Exelon Corp.
Peach Bottom Atomic Power Station
M/S SMB3-6
1848 Lay Road
Delta, PA 17314-9032

David Berko
Institute of Nuclear Power Operations
Suite 100
700 Galleria Parkway, SE
Atlanta, GA 30339-5957

Robin Dyle, Technical Chairman
BWRVIP Assessment Committee
Southern Nuclear Operating Co.
40 Inverness Center Parkway
Birmingham, AL 35242

Gary Park, Chairman
BWRVIP Inspection Focus Group
Nuclear Management Co.
3313 DAEC Road
Palo, IA 52324-9646

John Wilson, Technical Chair
BWRVIP Mitigation Committee
AmerGen Energy Co.
Clinton Power Station, M/C T-31C
P.O. Box 678
Clinton, IL 61727

Vaughn Wagoner, Technical Chair
BWRVIP Integration Committee
Carolina Power & Light Company
One Hannover Square 9C1
P.O. Box 1551
Raleigh, NC 27612

Bruce McLeod, Technical Chair
BWRVIP Repair Focus Group
Southern Nuclear Operating Co.
Post Office Box 1295
40 Inverness Center Parkway
Birmingham, AL 35201

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

U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

FINAL SAFETY EVALUATION OF EPRI REPORT TR-113932, OCTOBER 1999

"BWR VESSEL AND INTERNALS PROJECT, TECHNICAL BASIS FOR

REVISIONS TO GENERIC LETTER 88-01 INSPECTION SCHEDULES (BWRVIP-75)"

1.0 INTRODUCTION

1.1 Background

By letter dated October 27, 1999, as supplemented by letters dated February 29, 2000, and August 28, 2001, the BWR Vessel and Internals Project (BWRVIP) submitted the Electric Power Research Institute (EPRI) proprietary report TR-113932, "BWR Vessel and Internals Project, Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules (BWRVIP-75)," for staff review. The February 29, 2000, letter provided a non-proprietary version of the BWRVIP-75 report. The report was supplemented by letter dated August 28, 2001, in response to the open items in the NRC staff's initial safety evaluation (SE) dated September 15, 2000. Representatives of the BWR Owners Group and the BWRVIP made a presentation to the staff during a public meeting on March 16, 1999 (see meeting summary dated April 12, 1999), providing information on their proposed approach to revise the inspection schedule specified in Generic Letter (GL) 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988.

The original BWRVIP-75 report proposed revisions to the extent and frequencies for piping inspection contained in GL 88-01. The proposed revisions were based on the consideration of industry inspection results and service experience gained since the issuance of GL 88-01, and included additional knowledge regarding the benefits of improved BWR water chemistry. The subject report also provided the BWRVIP's justification for the proposed inspection criteria for Category A through E welds for the respective conditions of normal water chemistry (NWC) and hydrogen water chemistry (HWC).

By letter dated September 15, 2000, the staff forwarded its initial SE to the BWRVIP. This initial SE contained nine open items (i.e., Proposed Inspection Frequency and Scope for Category A Welds, Proposed Inspection Frequency for Category B Welds, Proposed Inspection Frequency for Category C Welds, Proposed Inspection Frequency for Category E Welds (weld overlay repair), Inspection of Category E Welds (Stress Improved) with Existing Cracks, Sample Expansion, Reactor Water Coolant Conductivity, Effective HWC and NMCA Programs, and Identification of Safety Significant Locations) which were required to be addressed by a BWR licensee utilizing the BWRVIP-75 report for a plant-specific modification to its GL 88-01 inspection program. The BWRVIP provided a generic response to these open items by letter dated August 28, 2001.

The staff and its contractor, Argonne National Laboratory (ANL), held a public meeting with members of the BWRVIP and EPRI on October 29 and 30, 2001, to discuss the open items in the staff's technical review of several BWRVIP reports (i.e., BWRVIP -59, -62, -63 and -75).

The responses to each open item in the BWRVIP-75 SE were discussed in detail. The staff agreed that all of the BWRVIP responses were acceptable with some minor changes. These modifications are summarized below.

1.2 Purpose

The staff reviewed the BWRVIP-75 report to determine whether the proposed revisions to the piping inspection schedules (extent and frequencies) would provide acceptable levels of quality for inspection and reasonable assurance that the structural integrity of the affected BWR piping will be maintained. 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.

1.3 Organization of the Report

Because the BWRVIP-75 report is proprietary, this SE was written so as not to repeat proprietary information contained in the report. This SE gives a brief summary of the general contents of the BWRVIP-75 report in Section 2, and a description of the GL 88-01 weld categories and staff positions. The staff's evaluation in Section 3 does not discuss in detail the proprietary provisions of the BWRVIP-75 report, nor does it discuss in detail the parts of the BWRVIP-75 report it finds acceptable. The staff's conclusions and open items that the staff requests the BWRVIP to resolve are summarized in Section 4.0. The staff has structured its evaluation according to the organization of the BWRVIP-75 report.

2.0 SUMMARY OF BWRVIP-75 REPORT

The BWRVIP-75 report addressed the following topics in the following order:

- GL 88-01 Summary: provides a summary of GL 88-01, including definitions and inspection requirements for Category A through G weldments; a discussion on the possible use of HWC to inhibit the initiation and growth of IGSCC, which could provide plant-specific credit to alter weld examination frequencies for plants using HWC; and a summary of the staff's position on sample expansion for Categories A through E welds.
- Revised Inspection Criteria: describes the proposed revised inspection criteria and bases, sample expansion criteria, and a modified inspection frequency that provides credit for effective HWC for Category A through E piping welds. For some cases, the BWRVIP-75 report includes a revised sample size smaller than that required by ASME Section XI, for which it acknowledges that licensees will have to submit a plant-specific request for relief from, or alternative to, the Code to use the revised sample sizes specified.
- Risk Consideration: discusses the impact associated with reducing the inspection frequencies of weldments originally under the scope of the GL 88-01 program. The BWRVIP-75 report proposes that the selection of weldments to inspect should be risk-informed and identifies two generic high risk significant locations.

3.0 STAFF EVALUATION

The staff's September 15, 2000, initial SE contained nine open items. The BWRVIP, in its letter of August 28, 2001, addressed these items, which are discussed below.

Open Item 3.1 Proposed Inspection Frequency and Scope for Category A Welds

The Staff's September 15, 2000, Initial SE's Open Item 3.1 Stated:

> In accordance with GL 88-01, IGSCC Category A welds are fabricated with IGSCC resistant materials, and the required inspection frequency is 25 percent of the population every ten years. The BWRVIP-75 report proposes an NWC inspection scope for Category B-J welds that are 10 percent of the population every 10 years, and for Category B-F welds, 25 percent every 10 years. For HWC conditions, the proposed inspection frequency is 10 percent of the population every ten years for all Category A welds.
>
> The staff position is that, to reduce the inspection sample size below 25 percent, the stainless steel piping needs the application of two mitigation measures. The staff considers the resistant material to be one mitigating measure. Welds with an effective second mitigating measure (e.g., heat sink welding (HSW), mechanical stress improvement process (MSIP), induction heating stress improvement (IHSI), and/or HWC), in addition to the use of resistant materials, will have a low likelihood of IGSCC crack initiation and, with such, the proposed inspection frequency and scope are acceptable. Further, the staff has reviewed the information presented on operating experience and agrees that IGSCC is the principal degradation mechanism for this piping. Therefore, mitigating IGSCC crack initiation and growth provides an acceptable basis for the proposed changes. A note, as described below, is recommended to be placed in Table 3-1 pertaining to Category A welds to clarify the need for a second mitigator and sample selection guidelines for the inspection reduction for Category B-J welds:
>
> "Note: Category B-J welds can be inspected with a scope of 10 percent every ten years when a second mitigator is applied. The acceptable second mitigator is heat sink welding (HSW), mechanical stress improvement process (MSIP), induction heating stress improvement (IHSI) and/or hydrogen water chemistry (HWC). A licensee will need to pursue changes from existing10 CFR 50.55a requirements as an alternative for Category B-J and B-F welds pursuant to 10 CFR 50.55a(a)(3). These inspections may be credited toward ASME Section XI requirements; however, inspections of those welds outside the GL 88-01 scope are not affected and are not to be included in any request for relief or alternative based on the BWRVIP-75 report or the associated NRC staff's safety evaluation. During the selection of locations for inspection, consideration should be given regarding locations where IGSCC could be accelerated by crevice corrosion or thermal fatigue. In addition, locations having attributes that would promote IGSCC should have higher priority for inspection. The attributes to be considered are: high carbon or low ferrite content, crevice or stagnant flow conditions, evidence of weld repair, surface cold work, and high fit-up, residual and operating stresses."

The BWRVIP's August 28, 2001, Response to Open Item 3.1 Stated:

The BWRVIP does not agree that it is necessary to apply a second mitigator to warrant a reduced inspection sample size below 25 percent. As documented in BWRVIP-75, the performance of Category A welds indicates a low likelihood of cracking. Furthermore, insights gained from industry studies on risk do support a sample reduction to less than 25%. However, the BWRVIP agrees with the staff position in order to resolve this open item.

The appropriate portions of NRC's note contained in Open Item 3.1 have been incorporated into Notes 1 and 3 of Table 3-1.

Staff's Evaluation of BWRVIP Response to Open Item 3.1:

Based on the discussions held with the BWRVIP during the public meeting on this issue, the staff had the following modifications to Notes 1 and 3 of Table 3-1, which the BWRVIP agreed to incorporate into a revised BWRVIP-75 report. The highlighted words are to be added and the struck-out words are to be deleted:

1. For the examination sample percentages that are less than required by ASME Section XI, a licensee will need to pursue an alternative to 10 CFR 50.55a requirements for Category B-J and B-F welds pursuant to 10 CFR 50.55a(a)(3)(i). These inspections may be credited toward ASME Section XI ultrasonic ~~**inspection**~~ **examination** requirements and the **Code** required surface examinations may be limited to those welds selected. However, if a licensee has an existing NRC approved alternative, a second request for an alternative to 10 CFR 50.55a may not be required **if the scope of the second request is covered by the existing NRC-approved alternative**.

Note 3 is to be split into two parts, with the first two sentences being 3.a, and with "solution annealing" being added. Note 3.a replaces Note 3 in the Table under "B-J." Note 3.b consists of the remaining two sentences in the original Note 3, and is added to the <u>Proposed Inspection Frequency</u> column in the Table.

3.**a.** Category B-J welds can be inspected with a scope of 10 percent every 10 years when a second mitigator is applied. The acceptable second mitigator is heat sink welding (HSW), mechanical stress improvement process (MSIP), induction heating stress improvement (IHSI)**, solution annealing** or hydrogen water chemistry (HWC).

b. During the selection of locations for inspection, consideration should be given regarding locations where IGSCC could be accelerated by crevice corrosion or thermal fatigue. In addition, locations having attributes that would promote IGSCC should have higher priority for inspection. The attributes ~~**to**~~ **that may** be considered **include** ~~**are**~~: high carbon or low ferrite content, crevice or stagnant flow conditions, evidence of weld repair, surface cold work, and high fit-up, residual and operating stresses.

With the above modifications to the BWRVIP-75 report, the staff considers Open Item 3.1 to be adequately resolved.

Open Item 3.2 <u>Proposed Inspection Frequency for Category B Welds</u>

The Staff's September 15, 2000, Initial SE's Open Item 3.2 Stated:

> The present required inspection frequency for Category B welds is 50 percent of the population every ten years. The BWRVIP-75 report proposed new inspection criteria of 25 percent every ten years for NWC and 10 percent every ten years when HWC is implemented.
>
> The staff has a concern regarding the long term effectiveness of the mitigation measure by stress improvement in combination with non-resistant materials. Specifically, as stated in EPRI report TR-112076, "Induction Heating Stress Improvement Effectiveness on Crack Growth in Operating Plants (BWRVIP-61)," January 1999, four of the 21 plants responding to the EPRI survey on IHSI effectiveness " . . . have exhibited 'new reported IGSCC indications' after application of IHSI," affecting 78 welds with either new indications or changes to existing indications after IHSI was applied. This illustrates that " . . . the IHSI treatment effectiveness depends on the applied stress to which the piping component is subjected in service." Therefore, although the laboratory testing and plant performance experience of the stress improved components has been generally favorable, and the BWRVIP-61 report did conclude " . . . that the most likely cause(s) for the post-IHSI IGSCC observed in the four plants . . . is the result of preexisting IGSCC which was undetected following the IHSI treatment," there remain uncertainties in the effect of plant operation transients and potential reconfiguration of the piping system, as well as the potential relaxation of residual stresses, for the long term.
>
> In view of the above, the staff recommends, for plants that used IHSI to mitigate IGSCC, but do not comply fully with the recommendations of the BWRVIP-61 report (i.e., properly applied SI and qualified UT), that the inspection frequency for Category B welds be revised to 25 percent of the population every six years under NWC conditions, or 25 percent every 10 years under HWC conditions. When noble metal chemical addition (NMCA) is implemented with HWC, the inspection frequency may be reduced to a schedule of 10 percent of the population every 10 years. This is based on the consideration that the use of NMCA with HWC will provide greater confidence that the potential for crack initiation will be reduced and the rate of crack growth slowed. Consequently, it will provide added assurance for the structural integrity of piping when exposed to such environment. The conditions for effective HWC and NMCA programs are discussed further in Open Item 3.8, below.
>
> For plants in compliance with the recommendations of the BWRVIP-61 report, the staff approves the new inspection criteria for Category B welds proposed in the BWRVIP-75 report.

The BWRVIP's August 28, 2001, Response to Open Item 3.2 Stated:

> As stated in Section 3.2.2 of BWRVIP-75, there have been 775 examinations of Category B IHSI-treated welds with no occurrences of IGSCC. The performance of Category B welds has been identical to that of Category A. BWRVIP-61 concluded that stress improvement

was fully effective for Category B welds and did not recommend any additional actions. It is important to point out that the occurrence of IGSCC in stress-improved welds has been limited to Category C welds treated with IHSI. The performance of MSIP-treated welds has been exemplary.

Furthermore, it should be noted that HWC (injection of H_2 at sufficient levels to achieve the desired ECP) has been demonstrated to be an effective mitigator of IGSCC. NMCA, through [its] catalyst effect, is simply a means of achieving the desired ECP/water chemistry that ensures the effectiveness of HWC. Therefore, the BWRVIP does not believe that it is appropriate to vary the inspection samples between HWC and NMCA. As such, the BWRVIP does not intend to revise Table 3-1 to specify separate inspection samples for NMCA.

The BWRVIP does not agree with the staff's concern in regard to the "long-term effectiveness" of stress improvement for Category B welds. This was clearly identified in BWRVIP-61. However, we do agree that all examinations should be conducted with qualified procedures and techniques in order to utilize BWRVIP-75. If qualified IGSCC examinations have not been conducted, the inspection frequency for Category B welds will be limited to 25 percent of the population every six years under NWC conditions, or 25 percent every ten years under HWC conditions. If qualified IGSCC examinations have been conducted, the schedule as originally specified in BWRVIP-75 can be used. This is shown in the revised Table 3-1, attached.

Staff's Evaluation of BWRVIP Response to Open Item 3.2:

Based on the discussions held with the BWRVIP during the public meeting on this issue, the staff had the following modifications to Note 4, with the highlighted and struck-out words to be deleted:

4. If qualified IGSCC examinations have not been conducted, the inspection frequency for Category B welds will be ~~**limited to**~~ 25 percent of the population every 6 years under NWC conditions, or 25 percent every 10 years under HWC conditions.

The BWRVIP stated that Note 4 is only applicable to a limited number of plants that had not completed their initial qualified examinations (Performance Demonstration Initiative (PDI) type examination, as defined in the BWRVIP-75 report) when the subject report was written. Further, once all plants have successfully completed their initial qualified examinations, then Note 4 will no longer be applicable. In addition, Note 5 (see Staff's Evaluation of BWRVIP Response to Open Item 3.3) is to be added to Table 3-1 for Category B welds. Considering these modifications, and based on the above discussion and that all licensees will utilize PDI-type examinations for all BWRVIP-75 inspections, the staff agrees with the BWRVIP's position for Open Item 3.2 and considers it to be adequately resolved.

Open Item 3.3 Proposed Inspection Frequency for Category C Welds

The Staff's September 15, 2000, Initial SE's Open Item 3.3 Stated:

> The presently required inspection frequency for Category C welds is 100 percent of the population every ten years. The BWRVIP-75 proposed inspection criteria are 25 percent every ten years under NWC and 10 percent every 10 years when HWC is implemented.
>
> For the same considerations given above in Open Item 3.2, the staff recommends that the inspection frequency for Category C welds treated with the IHSI process be 50 percent every ten years and 25 percent every ten years under NWC and HWC conditions, respectively. When NMCA is implemented in HWC condition, the inspection frequency may be reduced to 10 percent of the population every ten years. The recommended inspection frequency for Category C welds with NWC condition is larger than that of Category B because there is less likelihood that cracks would already have initiated in Category B welds prior to the application of SI treatment.
>
> For plants in compliance with the recommendations of the BWRVIP-61 report, the staff approves the new inspection criteria for Category C welds proposed in the BWRVIP-75 report.

The BWRVIP's August 28, 2001, Response to Open Item 3.3 Stated:

> As discussed in the response to Open Item 3.2, the BWRVIP does not believe that it is appropriate to vary the inspection samples between HWC and NMCA. As such, the BWRVIP does not intend to revise Table 3-1 to specify separate inspection samples for NMCA. The BWRVIP agrees with the staff concern for Category C welds treated with IHSI. Therefore, as stated in Section 3.3.2 and note 5 of Table 3-1, the following is required for implementation of BWRVIP-75:
>
> 1. The Owner must ensure that an effective stress improvement was performed. In this case, use of BWRVIP-61 can be used as a guidance document.
> 2. There must have been either:
>   a) a preservice and inservice examination with a qualified procedure with no cracking identified, or
>   b) at least one examination performed with a qualified procedure after more than two operating cycles and no cracking detected.

Staff's Evaluation of BWRVIP Response to Open Item 3.3:

> Based on the discussions held with the BWRVIP during the public meeting on this issue, the staff had the following modifications to Note 5, which the BWRVIP agreed to incorporate into a revised BWRVIP-75 report. In Note 5, the highlighted words are to be added:
>
> 5. The Owner must ensure that an effective stress improvement was **achieved** ~~**performed**~~. Additionally, there must have been either:

a) a preservice **(post-stress improvement)** and inservice examination with a qualified procedure with no cracking identified, or

b) **for welds that were previously stress-improved but did not receive a preservice examination,** at least one examination performed with a qualified procedure ~~**after more than**~~ **within** two operating cycles **of the licensee's adoption of this guidance** and no cracking detected.

With the above modifications to the BWRVIP-75 report, the staff considers Open Item 3.3 to be adequately resolved.

Open Item 3.4 Proposed Inspection Frequency for Category E Welds (weld overlay repair)

The Staff's September 15, 2000, Initial SE's Open Item 3.4 Stated:

The presently required inspection frequency for Category E welds is 100 percent every two refueling cycles. The BWRVIP-75 proposed inspection criteria are that the subject Category E welds, after receiving one qualified inservice examination within three outages after the initial post-overlay examination (PSI), would have an inspection frequency of 25 percent every ten years under NWC and 10 percent every 10 years when HWC is implemented.

The performance experience and inspection results of the overlay repaired welds have been satisfactory. However, the staff still has concerns regarding the structural integrity of such welds in the long term, since the cracks in the base metal of the piping are not removed. The potential of those cracks propagating into or around the weld overlay still exist as the residual stress distribution becomes more tensile when the flaw depth exceeds half the wall thickness. The staff considers that the BWRVIP-75 report's proposed inspection criteria may not provide the required assurance needed to conclude that the structural integrity of the overlay repaired welds will be maintained in cases where the overlay material is less resistant to IGSCC.

The BWRVIP categorized weld overlay repairs made with material not resistant to IGSCC (e.g., Alloy 182) as Category E. The staff disagrees with this categorization, since both the base material of the piping and the overlay material are not resistant to IGSCC; therefore, there is little likelihood that the cracks could be arrested in the weld overlay. The staff does not agree that inspection relief should be given to such welds and they should be categorized as Category F.

Accordingly, the staff recommends the following inspection schedule: after three successive satisfactory inspections (once every two refueling cycles) where no indication of crack growth or new cracking is found, the Category E welds repaired by weld overlay using resistant materials may be inspected at a frequency of 25 percent of the population every ten years under NWC, and 10 percent every ten years when HWC and/or NMCA is implemented.

The BWRVIP's August 28, 2001, Response to Open Item 3.4 Stated:

> The BWRVIP does not agree with the staff concerning reclassification of weld overlays made with non-resistant material to Category F.
>
> The BWRVIP did not reclassify these welds or any other welds in the development of BWRVIP-75. The weld classifications used were those specified in GL88-01. The purpose of BWRVIP-75 was to provide revised inspection frequencies and sample sizes based on inspection history and performance of welds. Specifically in regard to weld overlays, GL 88-01 makes no distinction in categorization concerning materials used in the application of a weld overlay. Welds that have been repaired using a full structural weld overlay are Category E in accordance with GL 88-01.
>
> The application of a weld overlay provides a realignment of the stresses, i.e., places the inside surface in compression. Thus, a weld overlay does reduce the potential for existing IGSCC to propagate. Also, the change in the stress pattern mitigates new initiation of IGSCC. This is born out by the fact that there have been 1018 examinations performed on 262 overlays with no detectable growth in existing IGSCC susceptible material. Therefore, it is inappropriate of the NRC to now require a more stringent reclassification of these welds than required by GL 88-01.
>
> In the case of overlays made of non-resistant materials, there are 15 years of data that indicates these welds are performing well. No overlay has developed flaws in the effective overlay and none have leaked in service. Thus, the inspection requirements for all weld overlays are the same. However, when the overlay material is not considered resistant, the sample expansion criteria of GL 88-01 are retained. This is the same position stated in Section 3.5.1.1 of BWRVIP-75. The sample expansion criteria of this category of welds and others will be addressed in the response to Open Item 3.6.
>
> We have the following comments regarding the number of inspections needed before BWRVIP-75 can be implemented. As noted in the previous paragraph, the performance of weld overlays in preserving piping integrity is exemplary. Also, the improvements in inspection techniques and procedures provide a high confidence that IGSCC can be more readily detected than when GL88-01 was issued. Accordingly, BWRVIP-75 requires the appropriate number of weld overlay examinations before implementing BWRVIP-75 in lieu of GL88-01. Therefore, based on the number of successful examinations performed to date, and the improvements in inspection techniques, the three successive examinations specified by the staff are not warranted. Therefore, the BWRVIP believes that the inspection frequencies and sample size for weld overlays remain as stated in BWRVIP-75.

Staff's Evaluation of BWRVIP Response to Open Item 3.4:

> The staff originally understood that the BWRVIP-75 report was reclassifying weld overlays based on inspection history. In as the BWRVIP's response to the open item states that this is not the case, the staff requests that the BWRVIP report be modified to include a note that, for licensees which have welds made of non-resistant materials, licensees shall identify these welds in their plant-specific submittal to adopt the BWRVIP-75 guidance for weld examination sample determination and scope expansion criteria. These welds will be reviewed on a case-basis by the staff regarding their specific examination sample

determination and scope expansion criteria. With this modification to the BWRVIP-75 report, the staff considers Open Item 3.4 to be adequately resolved.

Open Item 3.5 Inspection of Category E Welds (Stress Improved) with Existing Cracks

The Staff's September 15, 2000, Initial SE's Open Item 3.5 Stated:

Section 3.5.1.2 of the BWRVIP-75 report provides inspection guidelines for cracked welds that have been mitigated by a stress improvement process. One of the proposed guidelines states that examination of welds with existing cracking prior to stress improvement will be examined at a frequency specified in the flaw evaluation. The staff does not agree with the proposed inspection frequency because proper flaw evaluation cannot be performed without a precise knowledge of residual stress distribution. After four successive inspections of welds that were stress improved that have no indications of crack growth or no new cracking found, the inspection schedule may be upgraded to that of the corresponding Category D welds.

The staff recommends that all welds with active cracks should be inspected every refueling outage since these welds should be categorized as Category F.

The BWRVIP's August 28, 2001, Response to Open Item 3.5 Stated:

While the BWRVIP agrees with the staff that piping with active cracks should be classified as Category F, it is irrelevant for the welds under consideration. As stated in the response to Open Item 3.4, the BWRVIP did not reclassify these welds or any other welds in the development of BWRVIP-75. The weld classifications used were those specified in GL 88-01. As such, stress improved welds containing existing cracks may be classified as Category E according to GL88-01 as long as the conditions stated therein are satisfied. It is this classification of weld that is under consideration in Section 3.5.1.2 of BWRVIP-75.

Based on the SE, the BWRVIP believes the intent of Section 3.5.1.2 was misunderstood. The following is a clarification of Section 3.5.1.2.

1. Existing non-overlayed Category E welds (i.e., welds that are cracked and have been treated with a stress improvement process to mitigate growth) that have received two qualified inservice examinations will be examined at a frequency of 100% every six years.
2. If these welds are effectively treated with HWC the examination requirement can be reduced such that 100% of the population will be examined over a 10-year period.
3. In the future, if a flawed weld is stress-improved and thus classified as Category E, a post stress-improvement preservice examination must be performed. This must be followed by two successive inservice examinations to be performed every second refueling outage (i.e., a repeat inspection after two cycles and another inspection after two more cycles). After these examinations have been completed, and no additional cracking has been detected, the examination can be extended to one examination every six years or once per ten years if effective HWC is maintained.

4. If new cracking or significant crack growth is detected for this classification of welds, the welds may be immediately reclassified as Category F in accordance with GL88-01.

5. As an alternative to Item 4, a weld specific flaw evaluation may be performed to determine the appropriate reinspection frequency. This flaw evaluation may be performed in accordance with GL 88-01 or a combination of ASME Section XI IWB-3600 and BWRVIP-14.

Staff's Evaluation of BWRVIP Response to Open Item 3.5:

Based on the discussions held with the BWRVIP during the public meeting on this issue, the staff agrees with the clarification to Section 3.5.1.2, but requested a modification to the proposed items 4 and 5, which the BWRVIP agreed to incorporate into a revised BWRVIP-75 report. The highlighted words are to be added:

4. If new cracking or significant crack growth is detected for this classification of welds, the welds **shall** be immediately reclassified as Category F in accordance with GL 88-01**, or the alternative flaw evaluation in Item 5 below shall be performed**.

5. As an alternative to Item 4, a weld specific flaw evaluation may be performed to determine the appropriate reinspection frequency. This flaw evaluation may be performed in accordance with GL88-01 or a combination of ASME Section XI IWB-3600 and BWRVIP-14. **This evaluation shall be provided to the staff for approval of the proposed revised reinspection frequency within 120 days of plant restart.**

Open Item 3.6 <u>Sample Expansion</u>

The Staff's September 15, 2000, Initial SE's Open Item 3.6 Stated:

The BWRVIP-75 report proposed a sample expansion criterion for Category A, B and C welds that differ from that in GL 88-01. The first sample expansion after detection of cracking would be the same size and approximately the same distribution as the initial sample. If a flaw is found in the expanded sample, 25 percent of the remaining population would be examined. If additional flaws are detected, all remaining overlay repaired welds will be examined. The size and distribution of the expanded sample may be altered if an approved technical justification can be ascertained.

The staff finds, based on the information provided in the BWRVIP-75 report, that the proposed sample expansion criteria for Category A, B and C is not acceptable and that the sample expansion criteria delineated in GL 88-01 should continue to be used (see "Staff Position on Sample Expansion" in Appendix A).

The sample expansion criteria proposed for Category E welds, which are overlay repaired by IGSCC resistant materials, are less conservative than those for Categories A, B and C. The difference is at the second sample expansion. The staff does not agree with the proposed criterion that sample expansion for Category E welds are not required if the in-service crack extension is limited to a layer of the weld overlay that was not credited in the weld overlay design. The staff considers that inspection samples should be expanded when significant circumferential crack growth (i.e., 25 percent increase of what was previously examined) is detected. The additional weld inspections are needed because conditions for cracking are different from those anticipated. The subject report also proposes that welds with such flaws will be examined two of three successive outages. If no change is noted, the weld can revert to the original examination frequency. The staff considers that going back to its original examination frequency after two inspections is not conservative (it could be 10 percent in ten years), because potential crack growth could exist in the long term.

Therefore, the staff recommends that the sample expansion criteria for Category E welds should follow the same scheme as originally proposed in the BWRVIP-75 report for Category A, B and C welds, and that such welds should follow the inspection schedule of corresponding Category D welds.

The BWRVIP's August 28, 2001, Response to Open Item 3.6 Stated:

The BWRVIP believes that the scope expansion criteria in BWRVIP-75 for Category A, B and C are appropriate. Based on the inspection history of the welds in these categories, the proposed scope expansion criteria would be sufficiently conservative. However, the BWRVIP will agree with the staff position in order to resolve this open item.

The BWRVIP will revise the scope expansion sample size for Category E welds repaired by weld overlay using resistant materials to match that of Category A, B and C. However, the criteria for when scope expansion is required should remain the same as specified in BWRVIP-75. GL 88-01 defines significant crack growth for weld overlays as a) crack extension to a depth greater than 75% of the original wall thickness or b) for cracks that were originally deeper than 75% of the pipe wall, evidence of crack growth into the effective weld overlay. As noted in the response to Open Item 3.4, there have been 1018 examinations performed on 262 overlays with no detectable growth in existing IGSCC susceptible material. Also as noted in Reference 19 of BWRVIP-75, the weld overlay materials have been shown to be highly resistant to IGSCC. Therefore, the BWRVIP believes that the proposed criteria for sample expansion stated in BWRVIP-75 of cracking that extends into the effective weld overlay is appropriate.

For all other Category E welds, the scope expansion criteria and sample size will remain the same as that specified for Category E in GL88-01.

Staff's Evaluation of BWRVIP Response to Open Item 3.6:

Based on the discussions held with the BWRVIP during the public meeting on this issue, the staff requested that the criteria for sample expansion for Category E welds (resistant material) be modified such that, for the first expansion, an equal number to the original inspection population be examined; for the second expansion, fifty percent (50%) of the total population is examined; and, for the third expansion, the full population (100%) is examined. The BWRVIP agreed to incorporate this into a revised BWRVIP-75 report.

With this modification to the BWRVIP-75 report, the staff considers Open Item 3.6 to be adequately resolved.

Open Item 3.7 <u>Reactor Water Coolant Conductivity</u>

The Staff's September 15, 2000, Initial SE's Open Item 3.7 Stated:

> The proposed reduction of inspection frequency is supported in part by the improved quality of reactor water chemistry. Therefore, to ensure maintaining good water chemistry, it is necessary to specify an acceptable average conductivity for reactor water coolant consistent with that currently experienced by the BWR fleet. The improvement in water chemistry in the BWR fleet is shown in Figure 2-2 of the BWR Water Chemistry Guidelines, 1996 Revision (BWRVIP-29). The average reactor water conductivity in the BWR fleet in 1980 was over 0.4 uS/cm and in 1995 it had improved to just slightly above 0.1 uS/cm. The staff recommends that to qualify for the reduced inspection frequency, the average conductivity in reactor water coolant should not exceed the recommendations in the BWRVIP-29 report, or later revisions. The average conductivity can be calculated from the measurements made during the entire inspection interval based on the total operating time at a temperature at or above 200 °F.

The BWRVIP's August 28, 2001, Response to Open Item 3.7 Stated:

> The BWRVIP agrees with the NRC that reactor water coolant conductivity is an important parameter to monitor as part of an effective reactor water chemistry control program. As indicated on page 3-1 of BWRVIP-75 report, the entire industry has implemented the EPRI/BWRVIP guidelines for water chemistry control to reduce IGSCC initiation and growth. BWRVIP-75 will be clarified to state that utilities will continue to follow the guidance in "BWR Water Chemistry Guidelines 2000 Revision (BWRVIP-79)" or later approved versions of the report.
>
> It should be noted that while chemistry is monitored and actions taken when monitored parameters exceed action levels, there is no requirement in the guidelines to calculate an average conductivity. All plants maintain records of their water chemistry monitoring. These records will be made available, when requested, to demonstrate that a plant has operated within the EPRI/BWRVIP conductivity guidelines.
>
> NRC has correctly identified that the BWR fleet has operated at an average conductivity of approximately 0.1 µS/cm which is well below action level 1 of 0.3 µS/cm specified in BWRVIP-79. This performance indicates that implementation of the water chemistry guidelines results in an average conductivity that supports a reduced potential for IGSCC under NWC and effective mitigation of IGSCC under HWC. Further, it is worth noting that the fleet average conductivity is well below the conductivity of 0.3 µS/cm used in Figure 3-1 of BWRVIP-75 to determine factors of improvement. This demonstrates that effective HWC as defined in BWRVIP-75 is conservative.

Staff's Evaluation of BWRVIP Response to Open Item 3.7:

> With the above modifications to the BWRVIP-75 report, the staff considers Open Item 3.7 to be adequately resolved.

Open Item 3.8 <u>Effective HWC and NMCA Programs</u>

The Staff's September 15, 2000, Initial SE's Open Item 3.1 Stated:

(A) The staff recommends that the HWC program be considered effective (i.e., qualifying for the reduced inspection schedule) for the external piping if it meets the following acceptance criteria:

(1) The ECP measurements using reference electrodes should meet -230 mV or less. ECP should be measured by at least two different reference electrodes and use the highest ECP reading to determine the effectiveness of HWC. The in-situ ECP measurements should be performed at each piping system requested for inspection relief. With adequate demonstration, ECP may only be measured at the bounding location for the affected piping systems.

Alternately, since direct continuous ECP measurements may not be feasible at this time, as the currently available reference electrodes may not last a full fuel cycle in the reactor water environment, it may be necessary to perform alternate ECP measurements based on monitoring of secondary parameters. The acceptable secondary parameters are (i) feedwater hydrogen flow rate or concentration, (ii) reactor coolant dissolved oxygen, (iii) reactor coolant dissolved hydrogen, (iv) main steam line radiation level, and/or (v) conductivity. These secondary parameters should be monitored regularly to verify the effectiveness of HWC when direct ECP measurements are not available. These secondary parameters should be calibrated against in-situ ECP measurements for all operating conditions at least once every 10 years at the most conservative location of each plant. An acceptable monitoring frequency is at least once every twelve hours.

(2) HWC should be available at least 80 percent of the time. For example, in an inspection interval of ten years, the HWC availability can be calculated based on the total operating time at a temperature equal to or above 200 °F. If the HWC availability requirement is not met, the inspection frequency should be increased to the NWC frequency.

(3) Conductivity transients (> 0.3 uS/cm), such as those resulting from condenser leakage or resin intrusion, may occur during plant operation. Short transients may not have any significant effect on IGSCC. Therefore, when the duration of the conductivity transients under HWC condition is 24 hours or less, the time associated with the transients need not be subtracted from the acceptable HWC service time.

(4) When the hydrogen injection is interrupted for less than ten hours, the interrupted time need not be excluded from the calculation of the acceptable HWC service time as long as the ECP is still below -230 mV or the secondary parameters meet the acceptance criteria.

Noble metal chemistry addition (NMCA) is a process whereby a solution of noble metal compounds is injected into the reactor water, and then deposit on the reactor internals surface to catalytically reduce the ECP in the presence of hydrogen concentrations. This process has been shown to provide IGSCC protection at relatively low hydrogen concentrations (compared to HWC concentrations) and results in very little increase in plant operating dose rates. Laboratory tests have shown that the materials with such catalytic coatings exhibit very low crack growth rates (CGRs) as its ECP is lowered to below -400 mV with feedwater hydrogen concentration less than 0.2 ppm.

(B) For an effective NMCA program, the following acceptance criteria should be met:

(1) The hydrogen vs. oxygen molar ratio should be measured to determine the effectiveness of the NMCA condition. The acceptable hydrogen vs. oxygen molar ratio is 4 and above. A more detailed discussion of the hydrogen vs. oxygen molar ratio will be provided in the staff's SE for the BWRVIP-62 report.

(2) The acceptable NMCA program should have a monitoring program to determine if the NMCA remains applied and to determine when the process needs to be re-applied.

(3) NMCA is only applicable when HWC is available, and shall be available at greater than 90 percent of the hot operating time. Tests at Duane Arnold have shown that the ECP responds very quickly to hydrogen injection or stoppages with NMCA, and that the "memory" effect associated with conventional HWC (to be discussed in the staff's SE for the BWRVIP-62 report) appears to be absent for NMCA. If the NMCA availability requirement is not met, the inspection frequency should be increased to that of the HWC or NWC condition, as appropriate.

(4) Conductivity transients (> 0.3 uS/cm) may occur during plant operation. Short transients may not have any significant effect on IGSCC. Therefore, when the duration of the conductivity transients under NMCA condition is 24 hours or less, the time associated with the transients need not be subtracted from the acceptable NMCA service time.

The BWRVIP's August 28, 2001, Response to Open Item 3.8 Stated:

The BWRVIP agrees with the NRC that certain water chemistry parameters should be monitored in order to maintain an effective HWC program. As noted in BWRVIP-75, effective HWC does include injection of hydrogen alone or in combination with NMCA. Furthermore, BWRVIP-62 provides extensive guidance that a licensee can use to maintain effective HWC and NMCA programs. Therefore, the BWRVIP is confident that compliance with BWRVIP-62, as described in Section 3.6 of BWRVIP-75, assures adequate protection of the piping and provides a technical basis for revisions to the inspection frequency.

A.1 The BWRVIP agrees with the NRC that monitoring of ECP and secondary parameters are appropriate. This is clearly documented in Table 3-5 of BWRVIP-62. However, the BWRVIP believes that some of the staff's criteria in Open Item 3.8 (A)(1) are overly conservative and inconsistent with the guidance in BWRVIP-62. The details are provided below.

1. While the BWRVIP recognizes that the use of two ECP probes can be advantageous, it can be demonstrated that use of one ECP probe is sufficient.

2. In regard to secondary parameters the BWRVIP has the following comments.

   a. The BWRVIP agrees that secondary parameters can be used to verify the effectiveness of HWC and should be correlated with ECP measurements. However, it is not necessary to measure ECP in multiple locations or at the most conservative location in piping systems to assess the effectiveness of HWC. This is consistent with the guidance in Section 3.3 of BWRVIP-62.

b. The staff identified a list of potential secondary parameters in Open Item 3.8. The BWRVIP agrees with the parameters listed except for conductivity. Conductivity is not a secondary parameter although it is prudent to monitor it. Additionally, main steam line oxygen is another secondary parameter that can be used. By adding this parameter to the staff's list of secondary parameters, it is now consistent with Table 3-5 of BWRVIP-62 for HWC.

c. As noted in Section 3.4 of BWRVIP-62, no single secondary parameter should be considered the sole monitor of HWC performance. BWRVIP-62 provides guidance on use of the parameters contained in Table 3-5.

d. The BWRVIP disagrees with the staff position that monitoring frequency be at least once every 12 hours. The BWRVIP believes that daily monitoring of the secondary parameters is sufficient and this is consistent with standard plant water chemistry monitoring practices.

Therefore, the BWRVIP proposes to incorporate the following changes in BWRVIP-62 regarding an effective HWC program.

1) When measured ECP is used as a primary parameter, the licensees will install at least two reference electrodes. However, reference electrodes can fail in service. Therefore, once a licensee has demonstrated the adequacy of a single reference electrode, that electrode can be used to assess the effectiveness of HWC.

2) If the ECP probes should fail during service then for Category 1 plants (Table 3-5 of BWRVIP-62), the correlated secondary parameter data will be used to assess the effectiveness of HWC as outlined below.

   a. For Category 1 plants, the secondary parameters will be correlated with ECP measurements. Additionally secondary parameter data will be collected, maintained and correlated to supplement ECP probe data. Licensees will monitor a minimum of two secondary parameters preferably feedwater hydrogen injection rate or concentration and main steam line radiation.

   b. If secondary parameters are utilized, they will be validated at least once every ten years. One method to accomplish this validation is to correlate the secondary parameters against the measurements from an in-situ ECP probe. Other methods could be developed such as the use of sister plant data or validated models. This is consistent with BWRVIP-62.

   c. Secondary parameters will be monitored on a daily basis.

A.2 The BWRVIP agrees with the staff position that 80% availability at an ECP of -230 mV guarantees effective HWC. However, we continue to believe that these values do not represent an absolute threshold such that if neither one is achieved, HWC is no longer beneficial. Data presented in Figure 3-1 of BWRVIP-75 show that the reduction in crack growth rate by HWC can be conservatively determined through a combination of ECP and availability. Any lowering of ECP from Normal Water Chemistry values provides some benefit in reducing crack growth rate. Therefore, the BWRVIP believes there is sufficient technical basis to determine the benefit of HWC using the factor of improvement (FOI) approach described in Section 3.6 of BWRVIP-75. Using a FOI of

3 provides sufficient margin to assure a fully effective HWC program and is more conservative than the FOI of 2 discussed in BWRVIP-62.

A.3 Regarding conductivity transients, the BWRVIP accepts the staff position with the following two clarifications:

1. Conductivity transient is defined as an event where the reactor water conductivity exceeds Action Level 1 value of conductivity (0.3 µS/cm) in the BWR Water Chemistry Guidelines-2000 revision (BWRVIP-79) for power operation. The Guidelines define Action Level 1 value as the value of a parameter beyond which data or engineering judgement indicates that long-term system reliability may be threatened, thereby warranting an improvement of operating practices. The Guidelines also state that for plants starting up with NMCA, contributions due to soluble iron may be subtracted from the measured conductivity to evaluate conformance to action levels.

2. For conductivity transients exceeding 24 hours, only the time in excess of 24 hours need be considered when calculating availability.

A.4 The BWRVIP does not believe it is appropriate to exclude the first 10 hours of interrupted hydrogen injection when calculating availability. Additional information is contained in reference 3-3 of BWRVIP-62 which has been reviewed by the NRC.

B.1 As stated in BWRVIP-62, whenever a hydrogen vs. oxygen molar ratio greater than two is achieved with NMCA it has been shown that the ECP is less than -230 mV. NRC and the BWRVIP agree that this assures effective HWC.

Based on ECP data from NMCA plants that became available after BWRVIP-62 was submitted, the BWRVIP now considers that a hydrogen vs. oxygen molar ratio of 2 is acceptable and that a molar ratio of 4 is not essential to ensure protection of plant components. The BWRVIP recognizes that a plant needs to provide a margin in hydrogen injection rate to achieve the molar ratio of 2. However, if the molar ratio is too high it could result in increased main steam line radiation fields because of N-16 carry over. Therefore the molar ratio should be optimized to ensure protection and to minimize N-16 carryover. The following data demonstrates that a molar ratio of 2 will be adequate to ensure protection.

Figure 1 shows the effect of feedwater hydrogen concentration on ECP for several NMCA plants. It shows that an ECP of approximately -400 mV or lower is achieved at a feedwater hydrogen concentration of approximately 0.15 ppm irrespective of the plant type or the monitoring location. This observation is consistent with the molar ratio calculated with the BWRVIA radiolysis ECP model which changes from less than 2 to greater than 2 between 0.1 to 0.15 ppm feedwater hydrogen at locations between the top of downcomer to the bottom of the vessel. For example, the results for FitzPatrick plotted in Figure 2 show how the molar ratio in this region changes with feedwater hydrogen concentration. These results are typical of other BWRs. When the feedwater hydrogen is 0.1 ppm the molar ratios are less than 2 in this region. However, when the feedwater hydrogen concentration is increased to 0.15 ppm the molar ratios are greater than 2 at all locations from the top of the downcomer to the vessel bottom. At higher hydrogen concentrations the molar ratios increase at different rates depending on the locations with the top of downcomer being the most limiting location. The modeling results predict that protection with NMCA should be achieved at feedwater hydrogen concentrations of 0.15 ppm that is consistent with the ECP data of Figure 1. These results show that a calculated molar ratio of 2 at the most limiting location (top of downcomer) will provide protection in NMCA plants. Monitoring of ECP or measured molar ratio in reactor water as indicated in Table 3-5 of BWRVIP-62 will provide further verification of protection.

Therefore, the BWRVIP believes that an appropriate acceptance criterion for effective NMCA is a molar ratio of two. Alternatively, direct measurement of ECP can be used to determine effective mitigation. This will be incorporated into BWRVIP-62.

B.2 The BWRVIP agrees with the staff position that there should be a monitoring program to determine if the NMCA remains applied and to determine when the process needs to be re-applied.

B.3 The BWRVIP agrees that for NMCA to be effective, hydrogen must be injected. For periods of equal availability, the use of hydrogen with NMCA is equivalent to that of hydrogen alone if both achieve an ECP of -230 mV(SHE). Therefore, the acceptable level of availability should not be dependent on the method used to achieve effective HWC. However, we continue to believe that these values do not represent an absolute threshold such that if neither one is achieved, HWC is no longer beneficial. Data presented in Figure 3-1 of BWRVIP-75 show that the reduction in crack growth rate by HWC can be conservatively determined through a combination of ECP and availability. Any lowering of ECP from Normal Water Chemistry values provides some benefit in reducing crack growth rate. Therefore, the BWRVIP believes there is sufficient technical basis to determine the benefit of HWC using the factor of improvement (FOI) approach described in Section 3.6 of BWRVIP-75. Using a FOI of 3 provides sufficient margin to assure a fully effective HWC program and is more conservative than the FOI of 2 discussed in BWRVIP-62.

B.4 Regarding conductivity transients, the BWRVIP accepts the staff position with the following two clarifications:

1. Conductivity transient is defined as an event where the reactor water conductivity exceeds Action Level 1 value of conductivity (0.3 μS/cm) in the BWR Water Chemistry Guidelines-2000 revision (BWRVIP-79) for power operation. The Guidelines define Action Level 1 value as the value of a parameter beyond which data or engineering judgement indicates that long-term system reliability may be threatened, thereby warranting an improvement of operating practices. The Guidelines also state that for plants starting up with NMCA, contributions due to soluble iron may be subtracted from the measured conductivity to evaluate conformance to action levels.

2. For conductivity transients exceeding 24 hours, only the time in excess of 24 hours need be considered when calculating availability.

Staff's Evaluation of BWRVIP Response to Open Item 3.8:

> The staff agrees that it is not necessary to monitor ECP in multiple locations or at the most conservative location; however, it should be clearly stated in the BWRVIP-75 report that licensees which take credit for HWC should verify and validate that an effective HWC program (i.e., available at least 80 percent of the time and an ECP of -230 mV or less), in accordance with the staff-approved BWRVIP-62 guidelines, has been achieved for welds in every piping system for which HWC credit is taken. Based on the discussions held with the BWRVIP during the public meeting on this issue, the BWRVIP agreed to incorporate this into a revised BWRVIP-75 report. Regarding the use of factors of improvement (FOI) to determine the effectiveness of a licensee's HWC program, the staff disagrees with the BWRVIP on this issue; therefore, at this time, the staff is not approving the use of FOI for BWR austenitic stainless steel piping. With this modification to the BWRVIP-75 report, the staff considers Open Item 3.8 to be adequately resolved.

Open Item 3.9 <u>Identification of Safety Significant Locations</u>

The Staff's September 15, 2000, Initial SE's Open Item 3.9 Stated:

> The staff met with senior management representatives of the BWRVIP and the BWR Owner's Group (BWROG) on September 13, 2000, to discuss issues of concern, including the staff's review of the BWRVIP-75 report. During this meeting, the BWRVIP stated that the BWRVIP-75 report is a deterministic evaluation, and the proposed methodology does not rely on risk insights to justify the proposed reduction in inspection scope or frequency. This is not clear from the report, especially Section 4.0, "Risk Consideration." The staff requests that the report be modified to clearly state that the methodology used is deterministically based. The staff concurs with the BWRVIP-75 report that the use of risk insights by licensees will improve the final distribution of weldments to be inspected by systematically incorporating plant-specific characteristics in the selection process.
>
> The safety significance of the locations to be inspected should be determined using a ranking process, similar to that discussed in Section 4 of the BWRVIP-75 report, by a panel knowledgeable of the IGSCC mechanism and its impact on the subject piping systems to identify the locations of greatest safety significance with respect to changes in the IGSCC inspection program. The staff recommends that inspection locations should be distributed among the weldments in each category until the required percentage of locations have been selected, with the highest safety-significant locations being selected first. During the selection of inspection locations, licensees should give additional consideration to those locations having attributes that would promote IGSCC, or where IGSCC could be accelerated by crevice corrosion or thermal fatigue. The attributes to be considered are: high carbon or low ferrite content, crevice or stagnant flow condition, evidence of weld repair, surface cold work, and high fit-up, residual and operating stresses. These locations should have higher inspection priority.

The BWRVIP's August 28, 2001, Response to Open Item 3.9 Stated:

> The BWRVIP has issued a letter to the NRC (BWRVIP letter 2000- 268, dated October 17, 2000) stating that the BWRVIP-75 report is a deterministic evaluation and the proposed

methodology does not rely on risk insights to justify the proposed reduction in inspection and frequency. The BWRVIP will revise the BWRVIP-75 report to clarify this point.

Given that BWRVIP-75 is deterministic and has been accepted by the staff based on that, it is inappropriate to then require the use of risk in selecting the examination population. However, as stated in Section 4.1 of BWRVIP-75, we find that a subset of locations within the piping subject to GL 88-01 would be the more risk significant than other locations. Generally, these locations are found in reactor coolant pressure boundary piping that supports the ECCS function or containment outside the drywell and that are subject to thermal fatigue or crevice corrosion in addition to IGSCC. Therefore we continue to recommend that the focus of the examination population selection be in these areas.

Staff's Evaluation of BWRVIP Response to Open Item 3.9:

Based on the discussions held with the BWRVIP during the public meeting on this issue, the staff requested that wording similar to that in Footnote 3.b be added to Section 4. The BWRVIP agreed to incorporate into a revised BWRVIP-75 report the following highlighted words:

During the selection of locations for inspection, consideration should be given regarding locations where IGSCC could be accelerated by crevice corrosion or thermal fatigue. In addition, locations having attributes that would promote IGSCC should have higher priority for inspection. The attributes that may be considered include: high carbon or low ferrite content, crevice or stagnant flow condition, evidence of weld repair, surface cold work, and high fit-up, residual and operating stresses.

With this modification to the BWRVIP-75 report, the staff considers Open Item 3.9 to be adequately resolved.

4.0 CONCLUSION

The staff has reviewed the BWRVIP-75 report and proposed revisions and finds that the revised guidance of the BWRVIP-75 report for revisions of Generic Letter 88-01 inspection schedules, as described above, is acceptable for inspection of the subject safety-related BWR piping welds. However, regarding the use of factors of improvement (FOI) to determine the effectiveness of a licensee's HWC program, the staff disagrees with the BWRVIP on this issue; therefore, at this time, the staff is not approving the use of FOI for BWR austenitic stainless steel piping. The staff concludes that the licensee's implementation of the guidelines in the BWRVIP-75 report, with modifications to address the staff's conclusions and recommendations above, will provide reasonable assurance for the structural integrity of the affected BWR piping welds as addressed in the BWRVIP-75 report.

The staff has concluded that licensee implementation of the guidelines in the BWRVIP-75 report will provide an acceptable level of quality for examination of the safety-related BWR piping welds addressed in the BWRVIP-75 report. The staff finds that the revised BWRVIP-75 report can be used in lieu of the inspection guidance in GL 88-01 and NUREG-0313, Rev. 2, or as the technical basis for a plant-specific request for a license amendment to change technical specifications requiring GL 88-01 or NUREG-0313, Rev. 2 inspections. Further, the staff finds that the revised BWRVIP-75 guidance is acceptable for licensee referencing as the technical basis for relief from, or as an alternative to, the ASME Code and 10 CFR 50.55a, in order to use the sample schedules and frequencies specified in the revised BWRVIP-75 report that are less than those required by the ASME Code.

5.0 REFERENCES

1. "BWR Vessel and Internals Project, Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules (BWRVIP-75)," EPRI Report TR-113932, October, 1999.
2. Summary of March 16, 1999, Meeting with BWR Owners Group and BWRVIP to Discuss Revisions to NUREG-0313, dated April 12, 1999
3. U.S. Nuclear Regulatory Commission, Generic Letter 88-01, "NRC Position on Intergranular Stress Corrosion Cracking (IGSCC) in BWR Austenitic Stainless Steel Piping," January 25, 1988.
4. W. S. Hazelton and W. H. Koo,"Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," NUREG-0313, Rev. 2, USNRC January 1988.
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