Westinghouse Electric Corporation

Energy Systems

Nuclear Technology Division

Box 355
Pittsburgh Pennsylvania 15230-0355

November 20, 1995
CAW-95-906

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. William Russell

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "RV Closure Head Penetration Tube ID Weld Overlay Repair," WCAP-13998, Rev. 1 (Proprietary)

Dear Mr. Russell:

The proprietary information for which withholding is being requested is further identified in Affidavit CAW-95-906 signed by the owner of the proprietary information, Westinghouse Electric Corporation. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Virginia Power Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-95-906, and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety Regulatory & Licensing Activities

RSL/bbp

Enclosures

cc: Kevin Bohrer/NRC (12H5)

CAW906/NSRLA554L

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared James M. Brennan, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

James M. Brennan

James M. Brennan, Manager
Operating Plant Licensing

Sworn to and subscribed
before me this 20th day
of November, 1995

Lorraine M. Piplica

Notary Public

Notarial Seal
Lorraine M. Piplica, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Dec. 14, 1995
Member, Pennsylvania Association of Notaries

(1) I am Manager, Operating Plant Licensing, in the Nuclear Technology Division, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(g) It is not the property of Westinghouse, but must be treated as proprietary by Westinghouse according to agreements with the owner.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "RV Closure Head Penetration Tube ID Weld Overlay Repair", WCAP-13998 Rev. 1 (Proprietary), November, 1995 for North Anna Power Station Units 1 and 2, being transmitted by the Virginia Power Company letter and Application for Withholding Proprietary Information from Public Disclosure, to the

Document Control Desk, Attention Mr. William T. Russell. The proprietary information as submitted for use by Virginia Power Company for North Anna Power Station Units 1 and 2 is expected to be applicable in other licensee submittals in response to certain NRC requirements for potential reactor vessel head penetration repairs.

This information is part of that which will enable Westinghouse to:

(a) Provide data supporting the acceptability of repairing reactor vessel head penetrations utilizing the "embedded flaw" technique.

(b) Define the concept and benefits of the reactor vessel head penetration "embedded flaw" weld repair approach.

(c) Assist the customer to obtain NRC approval.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar methodologies and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing tests.

Further the deponent sayeth not.

Copyright Notice

Proprietary Information Notice

Transmitted herewith is a proprietary document furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

VRA-95-121

Westinghouse Electric Corporation

Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

November 20, 1995

Mr. R. W. Calder
Supervisor - Materials Engineering
Virginia Power
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060

Ref: RM07-1599
Ref: RM06-1602
Ref: RM30571
Ref: BKI514411
Ref: VRA-95-122

VIRGINIA POWER
NORTH ANNA POWER STATION UNITS 1 AND 2
ANNOTATED LETTER ON REACTOR VESSEL HEAD PENETRATION EMBEDDED FLAW REPAIR

Dear Mr. Calder:

See the eight (8) page attachment which provides a discussion, summary and conclusions for the reactor vessel head penetration embedded flaw repair.

If you have any questions or require anything further, please call me at (412) 374-3370.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

C. D. Webb for,

D. R. Beynon, Jr., Project Manager
Chesapeake/Pittsburgh Area
Operating Plant Programs

Attachment

A. Background

Inspections have shown the presence of cracking in reactor vessel head penetration tubes in a number of pressurized water reactors. The cause of this cracking has been attributed to primary water stress corrosion cracking (PWSCC). Several methods are available for performing repairs to the penetration tubes should cracking be significant enough to warrant repairs. These methods include excavation of the penetration tube to remove shallow flaws and, for deeper flaws, excavation and weld repair. With respect to excavation and weld repair, two methods are available. These methods would be to 1) completely remove the crack by excavation followed by a full or partial weld buildup, and 2) partial removal of the flaw by excavation followed by a weld overlay ("embedded flaw" repair).

B. Introduction

1. Weld Build-up Repair Technique

Several issues are associated with the case of complete removal of the flaw followed by a weld buildup that have an undesirable affect on site schedule, personnel exposure, and component adequacy for continued operation. These are discussed in the following paragraphs.

a. Thermal Sleeve Removal

Due to the spacial constraints associated with the design of the vessel penetration and thermal sleeve, thermal sleeve removal is necessary to completely remove a flaw that is deeper than 0.25 inches for those penetrations which contain thermal sleeves. Removal of the thermal sleeve can be achieved by two methods.

The first method removes a portion of the thermal sleeve through the bottom of the penetration. To accomplish this, first the thermal sleeve is cut at an elevation above the crack in the penetration. However, the distortion and ovality of the penetration produced by the original attachment weld may not permit removal of the thermal sleeve. The thermal sleeve contains an alignment collar that has a small clearance to the penetration ID and may not pass through the bottom end without cutting the thermal sleeve into segments. Following this cutting and removal, the repair is made to the penetration and the thermal sleeve subsequently reinstalled. This reinstallation requires remote welding of the thermal sleeve followed by inspection to verify an acceptable weld as well as correct alignment.

Although the technique for cutting and rewelding of the thermal sleeves has been developed in Europe, additional development and qualification of this process by Westinghouse would be required prior to its use at North Anna.

For those penetrations with ovality and distortion that will not permit thermal sleeve removal through the bottom end, the second method is to remove the thermal sleeve through the top of the penetration. This method requires removal of the CRDM rod travel housing by cutting the canopy seal weld and threading the rod travel housing out of the CRDM latch housing, cutting the thermal sleeve above the thermal sleeve guide, and removal of the remaining thermal sleeve out of the top of the penetration. Following the repair, it is necessary to reinstall the thermal sleeve through the top of the penetration, threading the guide to the bottom of the thermal sleeve and welding it to the thermal sleeve, reinstalling the rod travel housing and reweld the canopy seal weld.

Both of these methods involve a significant amount of remote machining/welding and radiation exposure associated with the removal and installation of the thermal sleeve.

b. Penetration Residual Stress/Inspection Following Repair

One method for application of the weld buildup is to completely fill the excavation and restore the ID of the penetration. While this method provides a surface that can be readily inspected following repair, it will require the application of a significant amount of weld material which results in a significant increase in penetration residual stress which could adversely affect the susceptibility of the penetration to PWSCC. An alternate method for repair is to apply a smaller amount of weld material and thereby minimize the amount of additional penetration residual stress and deformation. However, this method has the drawback of not restoring the penetration ID and would result in a much more difficult surface for post repair inspection by UT (manual method only currently developed) and Eddy Current (development of method is required).

While both of these repair techniques are in accordance with the ASME Code, the embedded flaw repair technique avoids the above mentioned drawbacks.

2. Embedded Flaw Repair

The embedded flaw repair technique involves an excavation at the inside surface of the penetration. This excavation would be sufficient to remove the portion of the crack which is exposed to the reactor coolant at the inside surface of the penetration. The depth of the excavation, 0.125 inch or smaller, would be set such that following application of a weld overlay, the remaining portion of the flaw will qualify as a subsurface flaw according to the rules of ASME Section XI paragraph IWA 3310 (b). The depth of the excavation is controlled by utilizing "hard stops" which are incorporated into the tooling to limit travel of the EDM electrode. Following excavation and prior to welding, a dye penetrant test will be performed to verify that the excavation has covered the full length of the flaw. The weld is applied and examined with dye penetrant, eddy current and ultrasonics to verify an acceptable weld. This approach eliminates exposure of the flaw to the reactor coolant environment, which stops further flaw growth due to PWSCC. See the attached figure entitled "Head Penetration Embedded Flaw Repair" for a schematic of the proposed repair configuration.

3. North Anna Proposed Embedded Flaw Repair

The North Anna 1 and 2 reactor vessel head penetrations are typical of those in Westinghouse designed plants. These penetrations are nominally 4.0 inch OD with a 2.75 inch ID. Installed into the majority of the North Anna Unit 1 head penetrations are thermal sleeves. While these thermal sleeves are generally similar to the standard Westinghouse design, they have a continuous collar located approximately at the elevation of the high side of the penetration attachment weld (see attached figure entitled "Standard Thermal Sleeve Guides"). This collar is machined such that there is a very small clearance between the collar and the head penetration inside diameter to align the thermal sleeve to the penetrations. This close clearance makes removal of the thermal sleeve through the bottom of the penetration uncertain. The potential for interference between the collar and the lower portion of the penetration due to the ovalization of the penetration resulting from the original welding of the penetration into the head is the concern. To eliminate the necessity for thermal sleeve removal, an excavation and weld overlay repair of the penetration is performed through a "window" which will be cut into the thermal sleeve. A local weld overlay (as opposed to 360° coverage) over the cracked area will be used to minimize penetration deformation and residual stresses. This repair process will be equally useful for unsleeved penetrations, but it has particular advantages for

sleeved geometries. Although this repair technique is considered to be practical for axial flaws with a depth up to through wall, it is currently being considered only for flaws which have a depth of up to 75% of the wall thickness. If application of this technique is considered for axial flaws greater than 75% wall thickness or for circumferential flaws, a separate submittal to the NRC will be required. The flaw extent will determine the extent of the repair, and the flaw depth will determine the thickness of the repair weld. The penetration tube is sufficiently stiff, and constrained by the vessel head, so the integrity of the tube will be maintained by the weld overlay regardless of the extent of the flaw. When the repair process is complete the ID surface of the penetration has been restored and is readily re-inspected.

The "embedded flaw" repair methodology has been developed using technology which has been demonstrated in WCAP 13998 (attached), entitled "RV Closure Head Penetration Tube ID Weld Overlay Repair". Although this report contains a number of approaches to penetration tube repair, only some of these are used in the embedded flaw repair technique. Section C, below, will highlight the key portions of the report that are used as the technical basis for the proposed repair.

C. Summary of key relevant topics of WCAP 13998

The technical basis for the embedded flaw repair methodology is developed as shown in report WCAP 13998. The following paragraphs provide a summary of the key relevant topics of the report.

The report contains all the elements of a repair design package, and an outline of the package is contained in Chapter 2. The potential repairs were performed on a full scale mockup of a head penetration along with several mock penetration tubes. The preparation of these mockups is described in Chapter 4.

The welding process uses Alloy 52 filler metal, to maximize the corrosion resistance of the weld. The development of the welding process and its qualification are shown in Chapter 5, which also contains pictorial examples of overlay welds performed over flaws machined into the penetration using electrical discharge machining (EDM). Test results showed no cracks in the weld or cracking of the surrounding area. The welding specification is contained in Appendix A.

A range of weld overlay thicknesses were investigated. It was found that the thickest overlays produced measurable deformation of the tubes, as shown in Chapter 6. Smaller deformations occur with a smaller amount of weld metal thickness. One of the

benefits of the embedded flaw overlay is that with a smaller amount of weld deposit the deformation is minimized.

To verify the adequacy of the weld repair process, a series of residual stress measurements were also performed on excavated and repaired tubes, and these results are discussed in Chapter 7. As expected, the residual stresses are increased as more weld metal is deposited. The residual stresses produced by local weld overlays were comparable to the unrepaired configuration for excavation and weld deposit up to 0.25 inches in depth. The measured residual stresses also compare favorably to those of a three-dimensional finite element analysis for residual stress. These comparisons are shown in Chapter 7, Figures 7.4-1 through 7.4-4.

To complete the weld repair design package, a generic safety evaluation according to 10CFR50.59 was performed, and was provided as a separate document from the WCAP.

D. Comparison of the embedded flaw approach and WCAP 13988

To produce an embedded flaw configuration, a weld overlay thickness of 0.090 to 0.125 inch is needed. The embedded flaw repair will apply the weld in an axial direction. The welding process which was utilized in the WCAP applied the weld in a circumferential direction relative to the longitudinal axis of the penetration.

It is judged that welding axially in this range of thicknesses will maintain the penetration ID surface residual stresses comparable to the unrepaired tube. This judgement is based on the results listed in the WCAP that showed this comparable condition for weld thickness up to 0.25 inch.

Further, the residual stress measurement results and their favorable comparison to previous analyses (refer to Chapter 7 Figures 7.4-1 through 7.4-4 of WCAP 13998) is sufficient to provide confidence that the penetration stresses after weld repair have been fully described such that additional testing for corrosion behavior is not necessary.

In the early days of the Westinghouse program to evaluate small amounts zinc additives to the RCS coolant, measurements were taken of the electrode potentials of the various primary side materials. No difference was found between them, including 600 and 690 materials. This is in agreement with the investigations by others in the high temperature electrochemistry area. At high temperatures the potentials of all of these alloys tend towards the potential of the hydrogen electrode; i.e., there are no differences to promote any galvanic coupling effects.

In addition, Westinghouse has many years experience in laboratory tests and field exposures with alloys 600 and 690 intimately connected either mechanically or by welding in steam generator applications. Exposures of approximately 15 years on hybrid expansion joints have not produced any evidence of galvanic coupling. Sleeving and plugging exposures have not revealed any evidence of galvanic interaction over years (5 at least) of operation.

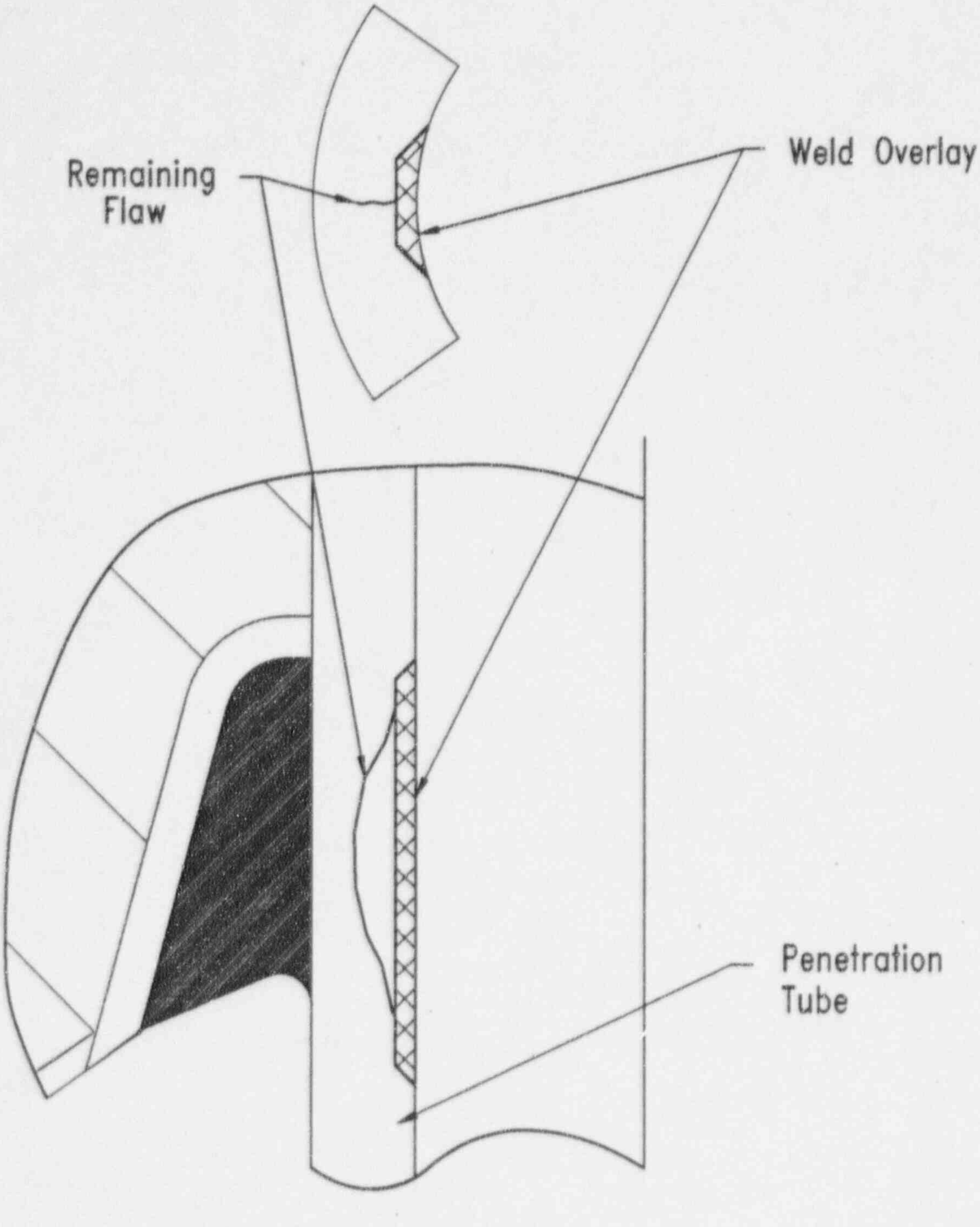
E. Flaw Acceptability

Although the flaw characterization rules of Section XI paragraph IWA 1300 are being used to establish sufficient weld overlay thickness to classify the repaired flaw configuration as subsurface, determinations about flaw acceptability will be based on the NEI/NUMARC guidelines. These guidelines were accepted in a Safety Evaluation Report issued to Wisconsin Electric Power Co. on March 9, 1994 (Docket No. 50-226), and in a previous Safety Evaluation Report issued November 19, 1993 to W. Raison of NEI/NUMARC.

F. Summary and Conclusions

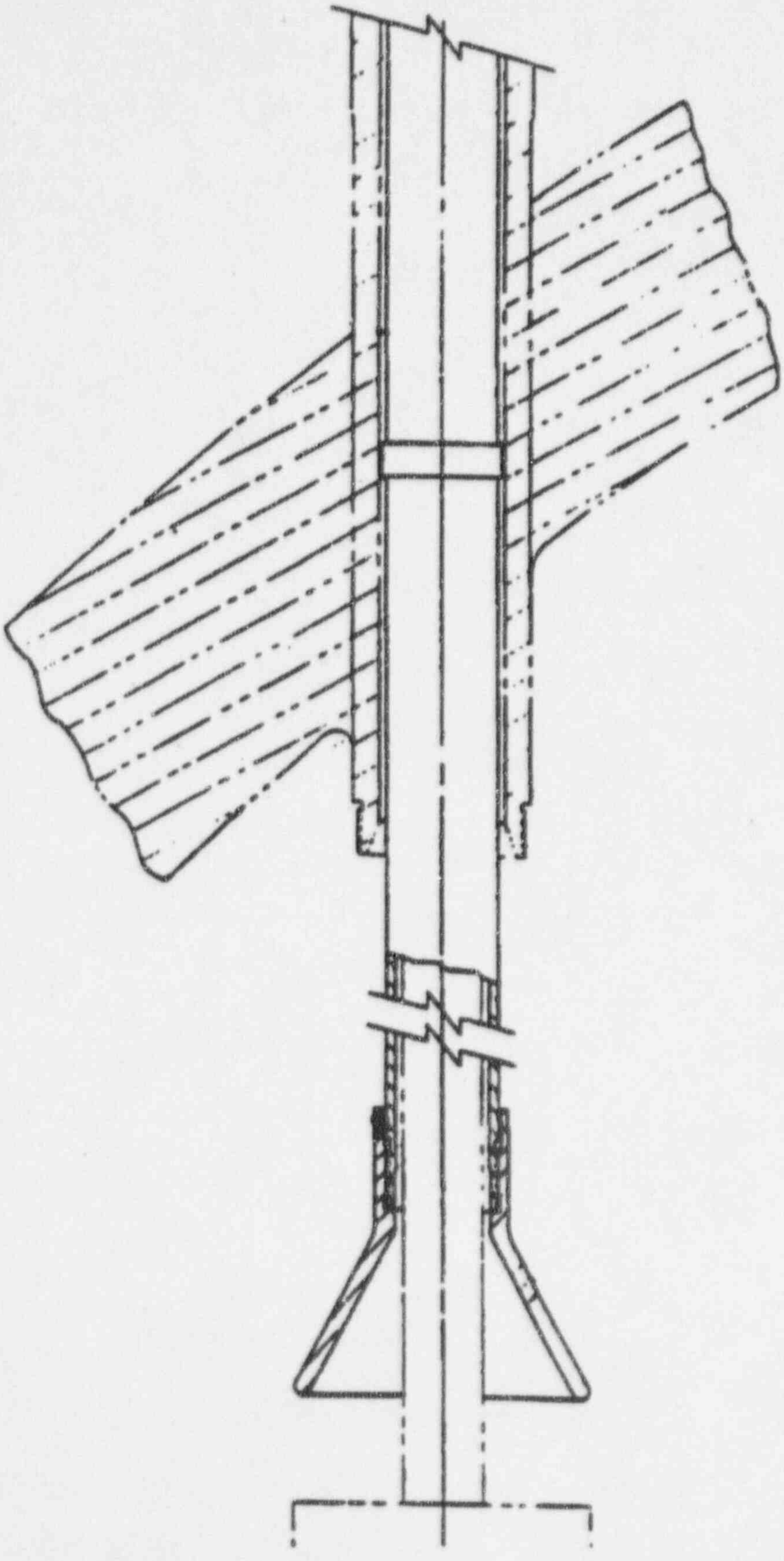
The embedded flaw approach has been developed as a variation on the repair techniques documented in WCAP 13998. The technique is versatile, in that it can be applied to the penetration tubes with or without thermal sleeves, and does not require the removal of the thermal sleeve.

There are a number of advantages to the technique. It results in a permanent repair that seals the flaw from the water environment, and thus stops PWSCC. There is no other mechanism of growth for cracks in these tubes because fatigue fluctuations are very small. The small thickness of the weld minimizes deformation of the tube, as well as residual stresses in the surrounding region.



Head Penetration Embedded Flaw Repair

Standard Thermal Sleeve Guides



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

March 9, 1994

Docket No. 50-266

Mr. Robert E. Link, Vice President
Nuclear Power Department
Wisconsin Electric Power Company
231 West Michigan Street, Room P379
Milwaukee, Wisconsin 53201

Dear Mr. Link:

SUBJECT: ACCEPTANCE CRITERIA FOR CONTROL ROD DRIVE MECHANISM PENETRATION INSPECTIONS AT POINT BEACH NUCLEAR PLANT, UNIT 1

On July 30, 1993, the Nuclear Management and Resources Council (NUMARC) submitted proposed acceptance criteria for flaws detected during control rod drive mechanism (CRDM) penetration inspections to the NRC staff for review and concurrence. These proposed acceptance criteria were based on extensive safety assessments conducted by the Babcock & Wilcox Owners Group (B&WOG), the Combustion Engineering Owners Group (CEOG), and the Westinghouse Owners Group (WOG). The proposed acceptance criteria were separated into criteria for axial flaws and for circumferential flaws by location (above or below the J-Groove weld on the CRDM penetration). The proposal for axial flaws was to allow through-wall axial flaws of any length below the J-Groove weld and axial flaws 75 percent through-wall of any length at or above the J-Groove weld. These criteria conform to the American Society of Mechanical Engineers (ASME) Section XI criteria for flaws in piping. Therefore, the staff has found them acceptable.

The NUMARC proposal for circumferential flaws was through-wall and 75 percent around the circumference below the J-Groove weld, and 75 percent through-wall and 50 percent around the circumference at or above the J-Groove weld. Based on the information submitted by the owners groups that circumferential flaws should not initiate and grow, and the more serious consequences of circumferential flaws, the staff has not accepted the proposed criteria for circumferential flaws. The staff has further stated that acceptance criteria for circumferential flaws would not be pre-approved and that any circumferential flaws would be reviewed on a case-by-case basis.

On January 31, 1994, NUMARC submitted supplemental safety assessments developed by the owners groups. These supplemental assessments provided a more detailed evaluation of the stress states in the nozzles and discussed the circumferential flaws observed at Ringhals and Bugey 3. The Ringhals circumferential flaws were attributed to fabrication flaws and were not related to primary water stress corrosion cracking (PWSCC). The Bugey 3 circumferential flaw initiated at the external surface of the CRDM penetration above the J-Groove weld, and propagated at an angle 30° from horizontal. All three owners groups submitted assessments that included finite element

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analyses that indicated that short, circumferential cracks are possible, although these flaws would not be expected to propagate through-wall due to compressive stresses below the flaws.

Based on its review of the owners groups supplemental evaluations, the staff has concluded that short, partial through-wall circumferential flaws are possible in the CRDM penetrations. Based on the stress analyses presented in the owners groups reports and the length of time that the Point Beach plant has been in operation, a shallow circumferential flaw 10 percent of the circumference of the penetration could exist. Therefore, the staff has concluded that circumferential flaws whose length, including postulated crack growth during the next operating cycle, does not exceed 10 percent of the circumference, are less than 75 percent through-wall, and are in a location consistent with the finite element analysis (outside diameter flaws), are acceptable. These flaws would have to be reinspected in subsequent examinations consistent with the reinspection approach of IWB-2420 of ASME Section XI.

You will not be required to obtain NRC approval to continue operation if short circumferential flaws are identified. However, you will be required to report to the NRC the location, length, and depth of these flaws and any other flaws identified during the inspection. If the depths of the flaws are not determined, you may assume that the depth is one half of the length of the flaw.

Any flaws found during the inspections that are not resulting from PWSCC should be evaluated in a manner consistent with the approach for flaw evaluation in ASME Section XI using the assumptions in the proposed acceptance criteria submitted by NUMARC to NRC on July 30, 1993. Examples of these flaws would be short, shallow fabrication defects or manufacturing defects in locations not predicted by the finite element stress analyses. Should you choose to disposition any flaws (which exceed ASME Section XI criteria) by analysis, the staff will require that your evaluations be reviewed and approved prior to unit startup.

If you have any questions regarding this issue, please contact me at (301) 504-1390.

Sincerely,

Allen G. Hansen

Allen G. Hansen, Project Manager
Project Directorate III-3
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

cc:
See next page