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SUBJECT: Forwards util response to NUREG-0619, "BWR Feedwater Nozzle & Control Rod Drive Return Line Nozzle Cracking." Response should close out open item in facility draft SER.

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January 13, 1982
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Docket No. 50-397

Mr. A. Schwencer, Director
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Schwencer:

Subject: NUCLEAR PROJECT NO. 2
WNP-2 RESPONSE TO NUREG-0619

Enclosed are sixty (60) copies of the WNP-2 response to NUREG-0619, "BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking". The submittal of this response should close out this open item in the WNP-2 draft SER.

Very truly yours,

G. D. Bouchey
Deputy Director, Safety and Security

CDT/jca
Enclosures

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WNP-2 RESPONSE TO NUREG 0619

"BWR FEEDWATER NOZZLE AND CONTROL ROD DRIVE RETURN LINE NOZZLE CRACKING"

M. P. Reis

January 8, 1982

FEEDWATER NOZZLE

The Washington Public Power Supply System Nuclear Project No. 2 (WNP-2) is a General Electric BWR/5. WNP-2 has six feedwater nozzles with forged tee spargers welded to the nozzle thermal sleeves. WNP-2 sparger has radiused flow holes.(1) The operating feedwater temperature is approximately 420°F at 100% rated thermal power.

In Safety Evaluation for the General Electric Topical Report "BWR Feedwater Nozzle/Sparger Final Report, Supplement 2" (NEDE 21821-02) the NRC staff concurs with GE's conclusion that "a particular solution must be devised for each BWR. . ." and stated that "plant specific review will be necessary in order to determine what combination of modifications is acceptable and necessary." WNP-2's solution to the feedwater nozzle cracking problem is described below in its responses to specific NRC technical and administrative positions as set forth in NUREG-0619.

(1) The top mounted elbow option was evaluated for WNP-2. However, it was concluded that the radiused flow holes (rather than square-edged holes) would adequately resolve the flow hole cracking problem (Reference: WPPSS Position Page #3, Reactor Vessel Feedwater Sparger Design, February 24, 1978.

TECHNICAL POSITIONS

Position 4.1(2)[2] 4.2	Interference-fit spargers are not acceptable because their efficacy is expected to decline with time as the interference is lost through wear and plastic deformation.
Response:	WNP-2 features the welded sparger design. This design is specifically stated as acceptable in NUREG-0619, Section 4.1, item (3). The welded sparger/thermal sleeve in conjunction with the forged tee design joint also eliminates cracking at the junction of the sparger arms and thermal sleeve. The cracks were attributed to vibrations caused by water flowing through the gap between the thermal sleeve and the nozzle safe end. The welded joint provides a positive seal against any such leakage.
Position 4.1(4) 4.4.2	Clad nozzles are not acceptable because they are more prone to cracking and more difficult to inspect.
Response:	The WNP-2 feedwater nozzles are not, and never have been, clad.
Position 4.2	The NRC staff believes that licensees and certain applicants must have, at a minimum, a low-flow controller having the characteristics described in Section 3.4.4.3 of NEDE-21821-A[3].
Response:	WNP-2 design currently features a low flow feedwater controller (RFW-FCV-10) also called the "startup valve". This valve may be used to control feedwater flow in the 0-20% power range. Startup valve position is determined by reactor vessel water level. While this low flow controller does not meet all the requirements specified by GE, the Supply System believes it is adequate for its intended purpose. Appendix I evaluates the WNP-2 design with respect to NEDE-21821-A crack propagation assumptions and conclusions.

(2) NUREG 0619 section (and item)
(3) NEDE-21821-A, BWR Feedwater Nozzle/Sparger Final Report, February 1980

Position 4.2 — The staff believes that licensees and certain applicants must reroute the Reactor Water Cleanup System to all feedwater nozzles.

Response: The Reactor Water Cleanup System at WNP-2 has been rerouted such that it discharges into all six feedwater nozzles. This modification was shown in Topical Report NEDE-21821-02 to contribute the largest improvement in the crack initiation usage factor.

Position 4.3.2.5(1) — We require performance of PT in each nozzle prior to installation of sparger.

Response: At the time this request was issued, WNP-2's welded sparger had already been installed. A PT of all accessible areas was performed. No reportable indications were found.

Position 4.3.2.5(2) — We require performance of baseline UT of each nozzle after installation of the sparger. The results are to be made part of the plant's permanent records for future reference.

Response: A UT examination will be performed prior to fuel load on each feedwater nozzle using a full sized mockup of the nozzles as a reference standard.

Position 4.3.2.2	Routinely inspect feedwater nozzles and spargers as indicated in Table 2 of NUREG-0619.
Response:	WNP-2 with unclad nozzles and welded sparger-thermal sleeve design, will perform routine non-destructive examinations at the following intervals:

Examination	Inspection Interval Refueling Cycles
UT(4)	1(5)
Visual Inspection of Sparger(6)	4
Routine PT(7)	6(8)

A complete description of the preservice and inservice examination programs for these nozzles is included in the Supply System's response to FSAR question 121.8 which is provided as Appendix 2 of this document.

(4) UT examination to consist of external examination of feedwater nozzle safe end, bore and inside blend radius.
(5) One (1) nozzle will be inspected each refueling outage.
(6) Visual inspection of flow holes and welds in sparger arms and sparger tees and accessible portions of the nozzle inner radius.
(7) Accessible areas only.
(8) A surface examination will be performed on the nozzle inner radii only if an indication has been discovered by ultrasonic testing and if the indication is suspected to have resulted from service induced cracks.

ADMINISTRATIVE REQUIREMENTS

Position 4.1(1) 4.4.2 — Modifications to the nozzle and sparger/thermal sleeve must be complete prior to receiving an operating license.

Response: WNP-2's nozzle and sparger/thermal sleeve modifications are complete.

Position 4.2 — All plants that will not have received an operating license by June 30, 1983 must complete the modifications before issuance of the license.

Response: WNP-2 system modifications and commitments described previously will be completed prior to receipt of an operating license.

Position 4.4.2 — Operating Procedures should include applicable GE recommendations.

Response:

(1) Per WNP-2 operating procedures, the RWCU system is normally aligned to the feedwater lines during heatup, operations and cooldown.

(2) WNP-2 procedures provide for startup valve control of feedwater flow between 0 and 10% rated thermal power.

(3) It is anticipated that the extraction steam to the feedwater heaters will be cut in during normal power generation, operations (approximately 15% power and above).

(4) Operating procedures for turbine startup are not yet developed. GE's recommendation will be considered along with the turbine vendor's recommendations when the procedures are developed.

(5) Plant operating procedures will caution against extended periods of large subcooling (large reactor water-feedwater differential temperature), especially at high feed water flow rates. As far as is consistent with power generation requirements, operating procedures will minimize total time spent at large subcooling.

Position 4.4.3.2 Upon completion of sparger installation and system changes, the applicant must submit to NRC the information described in Sections 4.3.2.5 and 4.4.2 and provide information regarding a leak detection system (if installed). The report must include detailed information regarding systems modifications and procedures which serve to prevent crack initiation or crack growth. These data will be used in determining any possible changes to the inspection intervals of Table 2.

Response: Section 4.3.2.5 requires preservice PT and UT inspections of each feedwater nozzle. The results of these inspections will be included in the WNP-2 Preservice Inspection final report. A summary of this report is scheduled for submittal to the Commission by September 30, 1982.

Section 4.4.2 states that the Final Safety Analysis Report for each plant should be amended at the earliest date practicable to include all component and system modifications and operating procedures for NRC staff review and approval.

FSAR Figures 3.2-f and 3.2-11 currently reflect the re-routing of the RWCU piping. Figure 10.4-5 includes the startup valve, RFW-FCV-10. Additional FSAR changes will be made, as necessary, as system changes and operating procedures are finalized.

Summary: The Supply System believes that WNP-2's design features of high feedwater operating temperature, welded sparger/thermal sleeve design and unclad feedwater nozzles are sufficient to ensure no feedwater nozzle crack initiation within the design operating lifetime of the unit. Frequent inspections and additional system modifications such as RWCU re-routing and installation of the startup valve further reduce the likelihood of feedwater nozzle cracking becoming a significant problem at WNP-2.

CONTROL ROD DRIVE NOZZLES

Position 8.1(4)(g) Licensees with 251-inch vessel diameter BWR/5's will be permitted to cut and cap the Control Rod return line (CRDRL) nozzle without re-routing the CRDRL.

Response: WNP-2 is a 251-inch BWR/5 and has selected this option.

Position: 8.1(4)(a') The licensee will be required to install the following modifications:

- Equalizing valves between the cooling water header and the normal drive movement exhaust water header.

Response: This modification has been incorporated into the design of WNP-2's Control Rod Drive System and will be implemented prior to CRD system preoperational testing.

Position 8.1(4)(b') Flush ports must be installed at high and low points of the normal drive movement exhaust water header piping run <u>if carbon steel piping is retained</u>.

Response: WNP-2's exhaust water headers are stainless steel.

Position 8.1(4)(c') Licensee must replace carbon steel pipe in flow stabilizer loop with stainless steel and reroute stabilizerloop piping directly to the cooling-water header.

Response: This modification has been incorporated into the design of WNP-2's Control Rod Drive System and will be implemented prior to CRD system preoperational testing.

Position 8.1, 8.2 — Each of the applicable licensees will be required to demonstrate, by testing, concurrent two-CRD-pump operation (if necessary to fulfill required flow capacity), satisfactory CRD system operation, and required return-flow capacity to the vessel. Flow must be equal to or in excess of the requirements of the base case.

Response: Satisfactory operation of normal CRD System functions (drive, withdraw, settling, scram) will be demonstrated by preoperational testing. However, with regard to return flow, the NRC requested by letter of January 28, 1980, that GE recalculate the makeup flow capacity for the 251-inch BWR/5 without the CRD return line. This generic information has been provided by letter of May 2, 1980 from Mr. R. L. Gridly, GE, to Mr. D. G. Eisenhut, NRC. The results indicate that the 251-inch BWR/5 CRD System without a return line (capped Nozzle #10) can achieve a vessel makeup flow in excess of its calculated boiloff rate of 180 gpm. In view of the above generic information, and considering that the CRD system is not designed to typical ECCS standards, the Supply System does not believe that additional testing to demonstrate return-flow capacity is warranted and does not commit to performing such tests.

Position 8.1 — All licensees and applicants, regardless of the particular type of modification selected, must establish operating procedures for achieving CRD flow to the reactor vessel equal to or greater than the boiloff rate of the base case discussed in Section 7.3.

Response: The Supply System does not consider the CRD System as necessary to perform an emergency core cooling function in any accident condition credible at WNP-2. Hence, the Supply System does not commit to establishing operating procedures for aligning the CRD System in a core cooling mode.

APPENDIX 1

EVALUATION OF WNP-2 DESIGN WITH RESPECT TO NEDE-21821A ASSUMPTIONS AND CONCLUSIONS

Crack Initiation

GE's report(9) indicates that a plant with a welded sparger, 420^{o}F feedwater temperature rating, unclad nozzles, RWCU routed to all nozzles and 1000 psi turbine roll will have a fatigue usage factor of approximately 0.6. (A usage factor of 1.0 is equivalent to crack initiation.) WNP-2 has all these features in its design and operating procedures. Therefore, the Supply System concludes that crack initiation at WNP-2 is highly unlikely. Note: Since WNP-2 is preoperational, the Supply System must assume that the startup/ shutdown and scram cycles used in the GE analysis will be typical of WNP-2.

Crack Propagation

GE's best estimate for a base case crack growth yields a crack depth of one inch in 35 years, characterized by GE as "marginally acceptable". (Best estimate results are consistent with the worst crack depths found in any operating reactors and conservatively envelop the cracking observed in the balance of the plants.)[10]

The base case analysis assumes

- an improved sparger design
- 425^{o}F feedwater rating
- unclad feedwater nozzles
- an initial crack depth of 0.25 inch
- on/off feedwater cycling at 6 cycles/hour (CPH)
- an "average" operating history of startup/shutdown and scram cycles.

Since WNP-2 is preoperational, the average history must be assumed as typical for that plant. With regard to the other assumptions.

(1) WNP-2 has an improved (welded) sparger with a correspondingly low overall heat transfer coefficient, unclad nozzles and 424.8^{o}F feedwater temperature rating.

(2) WNP-2 feedwater nozzles bores and blend radii have been dye penetrant examined for cracks with no reportable indications found. Since crack initiation is highly unlikely at WNP-2, the 0.25 inch deep crack is, in itself, a conservative assumption made for analytical purposes.

(9) NEDE-21821-A, Section 4.7.2.6
(10) NEDE-21821-A, Pg. 4-297

(3) The 6 cph assumption is conservative since it allows for no type of low flow controller. WNP-2's startup valve will be used to control flow during low ($\leq$10%) power operations. With the exception of a rapidly (60 cph) cycled low flow controller, GE's analysis demonstrates that the use of a low flow controller decreases the crack growth rate. Hence, use of the startup valve will tend to extend the time required for a 1 inch deep crack to develop.

(4) NEDE-21821-A does not assume any efforts to detect and arrest cracks during the plant lifetime. The Supply System has committed to periodic non-destructive examination of the feedwater nozzles and will take corrective measures if any unacceptable cracks are observed.

The Supply System concludes that the current design and operating philosophy at WNP-2, the conservative nature of NEDE-21821-A calculations and the Supply System's commitment to non-destructive examination preclude unacceptable feedwater nozzle crack growth.

APPENDIX 2

SUPPLY SYSTEM RESPONSE

TO FSAR QUESTION 121.008

Q. 121.8

(In response to this item, refer to the responses to Items 121.15 and 121.18 on the Hatch-2 docket.) Additional information is required to demonstrate that: (1) the thermal sleeve/sparger design of the feedwater inlet nozzle has been evaluated with respect to potential nozzle cracking resulting from thermal cycling; and (2) a program of scheduled augmented inservice inspection has been developed.

These inservice inspections should be conducted with a method sufficiently sensitive to provide assurance that small cracks can be detected. Accordingly, we require you to supply the following information:

a. That technical basis to assure the structural integrity of both the feedwater inlet nozzle and the sparger.

b. An evaluation of the feasibility of installing automated ultrasonic testing (UT) fixtures on all feedwater inlet nozzles with particular attention focused on the examination of the nozzle bore region.

c. An evaluation of the feasibility of performing the internal surface examination by magnetic particle methods.

Your response should contain: (1) a description of the nozzle and sparger design including the significant dimensions, the materials of construction and the weld locations; (2) a description of the analyses and test data, referencing appropriate data previously submitted to the NRC staff if it is applicable for the WNP-2 facility; (3) the detailed projected crack growth rates, stress levels and usage factors for both the nozzle and the sparger; (4) any plant modifications that are planned to reduce the temperature differential between the feedwater and the water in the reactor pressure vessel during low power operation; and (5) a description of any instrumentation that will be installed in the reactor pressure vessel to verify the conclusions of your design analysis.

Several ultrasonic testing concepts and procedures have been used to examine the feedwater inlet nozzle regions in operating plants. Identify which of these ultrasonic testing procedures will be used in the WNP-2 facility. Discuss the influence on crack detection, using your ultrasonic testing method in the WNP-2 facility, of local grindouts.

In addition, provide a description of the augmented inservice inspection (ISI) program to be implemented including scheduled surface examination, ultrasonic testing and verification of the leak tight integrity of the joint between the thermal sleeve and the safe end on all nozzles. The essential elements of an acceptable program are given in the Appendix attached to this set of questions.

Response:

A description of the WNP-2 feedwater nozzle and sparger is presented on Figures 121.8-1 and 121.8-2.

The mechanisms which have caused a cracking in operating BWRs are understood. A summary discussion of problems and the solutions incorporated in the WNP-2 design is presented in the following.

A detailed evaluation of the problems of the feedwater nozzle and sparger is presented in NEDE-21821 "BWR Feedwater Nozzle/ Sparter Final Report" March 1978. The solution of the feedwater nozzle and sparger cracking problems involves several elements, including material selection and processing, nozzle clad elimination, and thermal sleeve and sparger redesign. The following summarizes the problems and solutions that have been implemented in the WNP-2 design.

PROBLEM	CAUSE	FIX
Sparger Arm Cracks	Vibration	Eliminate clearance between thermal sleeve and safe end.
RPV Feedwater Nozzle	Thermal Fatigue	Eliminate clad, eliminate leakage with a welded joint between the sparger and safe end.

The sparger vibration has been attributed to a self-excitation caused by instability of leakage flow through the annular clearance between the thermal sleeve and safe end. Tests have shown that the vibration is eliminated if the clearance is reduced sufficiently or sealed. The solution which has been selected for WNP-2 uses a welded joint to assure no leakage. This feature is also an essential part of the solution of the nozzle cracking problem. Freedom from vibration over a range of conditions has been demonstrated by the tests reported in NEDE-23604.

The cracking of the feedwater nozzles is a two-part process. The crack initiation mechanism as discussed above is the result of self-initiated thermal cycling. If this were the only mechanism present, the cracks would initiate, grow to a depth of approximately 0.25 inch, and arrest. This degree of cracking could be tolerated, but unfortunately there is another mechanism which supports crack growth. This mechanism is the system induced transients, primarily the startup/shutdown transients. The welded thermal sleeve arrangement also assists in this area because without leakage, the heat transfer coefficient between the feedwater and the nozzle are reduced to the point where the thermal stresses in the nozzle are not high enough to cause a significant crack growth. Analyses presented in NEDE-21821, Section 4.7, demonstrates the benefits of the welded thermal sleeve and of using unclad nozzles. With these demonstrated benefits, WNP-2 does not believe it necessary to install instrumentation for design verification.

WNP-2 has installed an automatic feedwater low flow control valve, RFW-FCV-10. This valve has the capabilitiy to control flow down to 362 gpm, or about 1.25% of total flow. This valve will substantially reduce the temperature differential between the feedwater and the water in the RPV during low power operation.

The following paragraphs address RPV feedwater nozzle examination questions other than Appendix A to Section 121.

Feasibility of Installing Mechanized Ultrasonic Scanners

All feedwater nozzle inner radii, safe-end, and bore regions are capable of automated ultrasonic examination. Both pre-service and inservice inspections of the inner radii and safe end welds will be performed using such equipment. Tooling has been contracted from the baseline examination agency that will allow nozzle inner radius scanning by contacting an angle beam transducer to the vessel plate surface adjacent to the nozzle to vessel weld. The scanner mechanism is removable and would be compatible with any of the six (6) feedwater nozzles. The Supply System is currently evaluating the benefit of performing an automated examination of the bore region versus a manual examination, in terms of radiation exposure (examination/setup time) and examination coverage. The technique providing the best balance of those two factors will be chosen. Adequate access exists for either technique.

See Note 1

See Note 2

Scanning of the nozzle bore region can be accomplished from the cylindrical section of the nozzle forging. A manual examination of this region is possible to accomplish in less than ten minutes of scanning time per nozzle by one operator supported inside the biological shield cut-out. Data recording, should it be necessary, can be accomplished by a second examiner positioned outside the shield using redundant electronic instrumentation and analog recorders. Assuming ten minutes examination time per nozzle and a radiation field of 150 mr/hr, the examiner would receive 25 mr per nozzle.

The automated examination devices would be mounted on temporary tracks, would be installed just prior to the examination and removed following the examination. It is not considered feasible to leave the equipment installed during plant operation as installation and removal time is minimal and would be quickly offset by equipment recalibration and maintenance costs considering the adverse environment such equipment would be subjected to during plant operation.

Feasibility of Magnetic Particle Examination

Handheld magnetic yokes will not readily fit in the envelope between the sparger body and the nozzle radius, and yet make good contact with the low alloy steel surface. Poor contact could result in arc-strikes below the electrodes, these surface defects are localized heat affected zones of higher hardness than the surrounding metal. If the arc-strike was accompanied by localized cracking, then surface grinding would be necessary to restore the nozzle to its original surface condition. Considering the above, magnetic particle examination methods are not considered feasible inside the reactor vessel with the present sparger configuration.

Ultrasonic Examination Methods

The nozzle inner radius examination will be made by pulse-echo ultrasonic techniques from the exterior of the reactor pressure vessel by contacting the vessel plate surface. This technique is similar to that used by the General Electric Company and the firm of Lambert MacGill and Thomas. Procedures for the examination will be in a format consistent with others used by the Supply System, but the technical content will be comparable to procedures previously qualified by the above referenced testing organizations.

Examination of the nozzle bore region will be performed by pulse-echo ultrasonic techniques from the cyclindrical section of the nozzle forging using sound beam geometry similar to that used by the General Electric Company. The Supply System plans to extend the coverage of this technique toward the inner radius by added sound beam refraction. Prior to use on the WNP-2 feedwater nozzles, a qualification check is intended to be made on a mock-up to demonstrate the techniques validity.

Should local grind outs be made in the examination surface creating a depression with definable sides, depth, and length, the ultrasonic techniques being used would obtain reflections from these cavities. Such reflections can be minimized by blending the grind cavity into the surrounding base metal. This would result in improved detection sensitivitiy to postulated thermal fatigue cracks propagating from the grind cavity.

The Supply System will implement the reactor feedwater (RFW) RPV nozzle inspection program described below, which addresses Appendix A to this question on an item-by-item basis. Justification for any deviations from the Appendix A requirements is presented following the response.

I. AUGMENTED INSERVICE INSPECTION PROGRAM

A. Preservice Examination

The Supply System will perform a PSI ultrasonic examination of RFW nozzle inner radii, bore and safe end regions as described in the WNP-2 PSI Program Plan. The personnel and UT procedures used will be qualified as described in II.C below.

In addition, a preservice liquid penetrant examination will be performed on the accessible areas of all RFW nozzle inner radius surfaces.

B. Inservice Examination

B.1 The Supply System will perform an ultrasonic examination of 1 of 6 reactor feedwater nozzle inner radii, bore and safe end regions each refueling outage using procedures and personnel subject to the same qualifications used during the PSI examinations. A different nozzle will be examined each outage. No surface examinations will be performed on the nozzle inner radii unless such a test is required to verify the nature of an indication discovered using the ultrasonic technique when the indication is suspected to result from service induced cracks on the nozzle inner surfaces. In the event an indication is discovered and found to result from service induced cracks propagating from the nozzle inner surfaces, the following actions will be taken:

a. All remaining feedwater nozzles will be examined using both ultrasonic (from the OD) and penetrant techiques during the refueling outage in which the cracking is verified.

b. All surface indications determined to be service induced cracks will be removed by local grinding.

c. An inspection method, such as a leak test, will be used to determine the integrity of each of the RFW thermal sleeve to safe end joints.

d. Appropriate corrective action will be taken as required and as practical to prevent recurrence of crack initiation. A program and schedule for implementing such corrective action will be prepared and submitted to the Commission prior to its implementation.

e. A RFW nozzle examination program for subsequent refueling outages will be modified to include an external ultrasonic examination of all feedwater nozzle inner radii, bore and safe end regions for each scheduled refueling outage for 3 consecutive outages. If no new indications are discovered, or if new indications are determined to not result from service induced cracks at the nozzle inner surfaces, the original Supply System program will be resumed. If after 3 additional outages no new indications resulting from surface induced cracks are detected, subsequent examinations will be performed in accordance with normal ASME Section XI requirements.

f. The conduct of surface examinations of accessible nozzle inner radius surfaces will continue to be used throughout plant life only to confirm or characterize new ultrasonic indications which are suspected to result from service induced cracks at the nozzle inner surfaces.

B.2 As stated in B.1 above, the Supply System will perform a surface (penetrant) examination of accessible inner surfaces on all RFW nozzles during the preservice examination program. Subsequent surface examinations of those surfaces will be performed only to verify the nature of an indication discovered using the ultrasonic technique when the ultrasonic indication provides evidence of previously unidentified service induced cracks.

B.3 See response to B.2 above.

If after the sixth planned refueling outage following commercial operation no indications resulting from service induced cracks are found, the subsequent inservice examinations will be performed in accordance with the normal ASME Section XI requirements. Any indications resulting from service induce cracks which are subsequently found will result in the corrective action described above.

C. Thermal Sleeve to Safe End Joint

As stated in B.1 above, the Supply System will perform an inspection of the thermal-sleeve-to-safe-end weld joint, such as a leak test, only if service induced cracks or some other anomoly is discovered which would bring the integrity of the joint into question. In that case, the feedwater piping will be filled with water and the area of the thermal-sleeve-to-safe-end joint will be inspected for indications of leakage.

II. ACCEPTANCE CRITERIA

A. The Supply System will comply with this criteria as stated in B.1 above.

B. The supply System will comply with this criteria as stated in B.1 above.

C. The Supply System will comply with option (b), in that both the examination personnel and the procedures to be used on the nozzles will be qualified on a full size nozzle mock-up. Supply System examiners will be trained by individual NDE specialists having previous experience with the General Electric Company procedures and their nozzle test program. These examiners will undergo further training, practice, and qualifications on a full size nozzle mock-up. The mock-up will be unclad if negotiations can be reached with a utility owning such a mock-up. As an alternative, the examiners will qualify on a clad mock-up owned by the General Electric Company. Following the qualification process, the examinations will be conducted under the direct supervision of the experienced NDE specialists responsible for ultrasonic technique and procedure development--for the Supply System. See Note 3

III. RECORDING AND REPORTING STANDARDS

The Supply System will record crack indications and report inspection results in compliance with the requirements stated in NUREG-0312.

121.8 JUSTIFICATION OF DEVIATION FROM APPENDIX A

I.B.1 Ultrasonic Examinations Frequency

The Supply System will examine only one RFW nozzle per refueling outage rather than all nozzles using an ultrasonic technique from the outside of the vessel. This is justified for the following reasons, which reflects a significant advance in the WNP-2 design and operating procedures towards the long term solution of the BWR nozzle cracking problems per NUREG-0312, Section 8.0, Part. 1.

a. Improved Design: The WNP-2 RFW welded thermal-sleeve-to-safe-end joint provides a "zero leakage" design. This design essentially eliminates the primary historical initiating source of nozzle cracking in BWRs.

b. No Nozzle Cladding: The WNP-2 RFW nozzle surfaces are not clad. The likelihood of crack initiation in unclad nozzles is more than a factor of a 5 less than for clad nozzles. All cracks in BWR feedwater nozzles have initiated in the clad metal.

c. Proven Examination Technique: The ultrasonic examination equipment and personnel to be used in performing both baseline and inservice ultrasonic examinations will be qualified on a full scale mock-up of the nozzle, simulating the nozzle geometry and anticipated fatigue crack defects. Since the WNP-2 reactor feedwater nozzles are unclad as stated in b) above, a more sensitive examination is possible due to lack of clad/basemetal interface.

d. Augmented Examination Frequency: The above stated program provides RFW nozzle examination coverage at nearly twice the frequency of the ASME Section XI requirements, i.e., all RFW nozzles will be examined within 6 years (approximately) rather than within 10 years.

e. Feedwater Temperature Controls: As previously stated, WNP-2 has incorporated a feedwater, low flow control valve. The advantages gained from low flow control are identified in Section 4.7 of NEDE-21821.

f. Projected Crack Growth Rates: As presented in Section 4.7 of NEDE-21821, the WNP-2 design should have greater than 35 years of operation, considering our low flow control, prior to an initiated crack reaching 1 inch in depth. This provides for a minimum of 4 examinations per nozzle before reaching a point requiring repair. Even if the extremely conservative (factor of 5) upper bound crack growth curve is applied, each RFW nozzle would be examined by the Supply System program prior to a crack becoming 1 inch in depth. It is clear that ample conservatism exists in the Supply System examination frequency of the RFW nozzles.

The above factors, when combined, provide a great deal of assurance that the factors which have led historically to BWR RFW nozzle cracking have been virtually eliminated. Furthermore, any cracking which might occur from unanticipated sources will be discovered before propogating to a significant depth due to low flow controls and an augmented examination schedule with state-of-the-art qualified ultrasonic examination techniques.

I.B.2&3 Surface Examinations

The Supply System will perform surface (penetrant) examinations of the accessible internal surfaces of RFW nozzles during the preservice inspection program. Inservice surface examinations will be performed only when indications of service induced cracking are found using the ultrasonic examination technique. This is justified as follows:

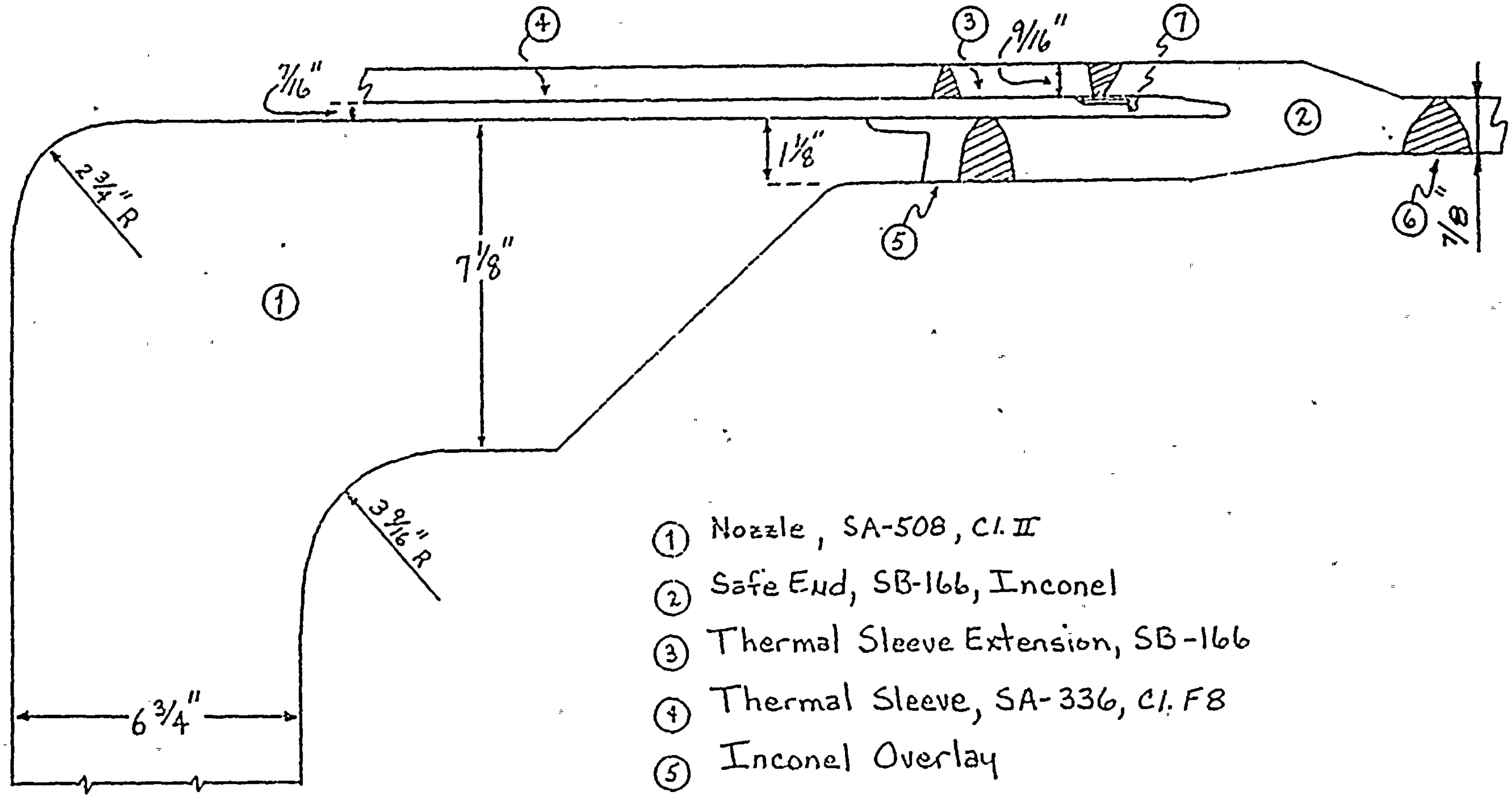
a. Reduced probability of crack initiation and growth as stated in the justification under I.B.1a) through f) above.

b. Access: In order to obtain access to perform a penetrant surface examination of the RFW nozzle surfaces during a refueling outage, the vessel water level would have to be lowered below the level of the spargers and hydrolaser decontamination performed. A special shielded work platform would have to be devised to minimize radiation exposure. This technique was performed at Vermont Yankee resulting in about 15 man rem.

I.C Leak Test

Thermal-Sleeve-to-Safe-End Joint: The Supply System will perform inservice inspection to determine the integrity of the thermal-sleeve-to-safe-end joint only when indications of service induced cracking are detected using the ultrasonic examination technique. The justification for this exception is similar to the justification for not performing inservice surface examinations cited above, with the following additional justification:

a. Test Effectiveness: The maximum pressure which could practically be placed on the subject weld joint would be that available from the static head of a filled sparger, or approximately 6" of water. The effectiveness of this test to reveal throughwall cracks in the weld joint is questionable, since the weld experiences significantly higher differential pressure and temperature during operation. Furthermore, this test would not provide evidence of other than gross throughwall cracks which, if and when detected via such a test, will in all likelihood have been resulting in some degree of leaking for a significant period of time. As was previously demonstrated, any cracks developing as a result of such leakage will be detected prior to the crack propagating to a depth which would jeopardize the nozzle integrity. There is, therefore, no appreciable benefit from performing the leakage test of the spargers other than to determine the status of their integrity in the event service induced cracks are confirmed. Since there is no appreciable benefit, and the cost in dollars and man rem exposure for such a test is quite high, the performance of this test on a routine basis is not justified.



① Nozzle, SA-508, Cl. II

② Safe End, SB-166, Inconel

③ Thermal Sleeve Extension, SB-166

④ Thermal Sleeve, SA-336, Cl. F8

⑤ Inconel Overlay

⑥ Weld Illustration

⑦ Back-up Ring, SB-168

Amendment No. 5
August 1979

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

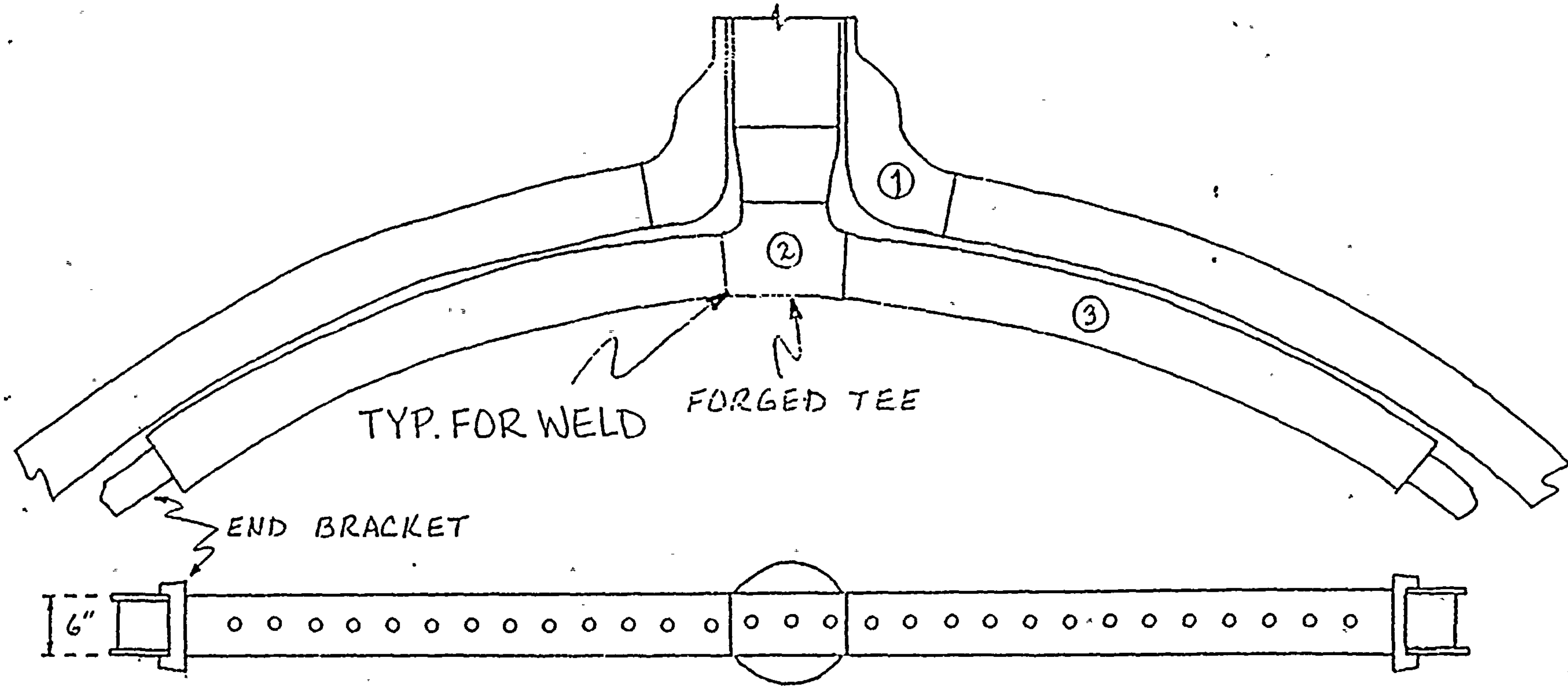
FEEDWATER NOZZLE

FIGURE
121.8-1

① NOZZLE, SA-508, Cl.II

② FORGED TEE, 304 S.S.

③ SPARGER HEADER, 304 S.S.



Amendment No. 5
August 1979

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

FEEDWATER SPARGER

FIGURE 121.8-2

NOTES

1. Preservice inspection of the safe end welds will be done manually. The mechanized equipment will be demonstrated capable of examining the safe end welds inservice. The inner radii weld examinations will be done using mechanized equipment.

2. Based on the experience of performing the baseline exam of nozzle to vessel welds, the Supply System has concluded that the radiation exposure examining the bore region manually would be less than if the exam was done mechanized.

3. The Supply System has secured an unclad feedwater nozzle from the scrapped Douglas Point Unit 1 reactor. The Supply System will use this nozzle to qualify the procedures and personnel for feedwater inner radii examinations.