Portland General Electric Company

Donald J. Broehl Assistant Vice President

July 9, 1982

Trojan Nuclear Plant
Docket 50-344
License NPF-1

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert A. Clark, Chief
Operating Reactors Branch No. 3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Clark:

Degradation of RCS Thermal Sleeves

The Trojan plant has experienced degradation of thermal sleeves in certain piping nozzles of the Reactor Coolant System. Mr. R. H. Engelken's letter of June 18, 1982 conveyed the NRC's understanding that power operation of the Trojan Nuclear Plant would not resume until this matter is resolved to the satisfaction of the NRC staff.

This letter is to report our resolution of this matter. A report of PGE's experience with degraded thermal sleeves is submitted as Attachment A. Our safety evaluation supporting resumption of power operation is submitted as Attachment B. A description of Trojan's Vibration and Loose Parts Monitoring System is provided as Attachment C.

We request your prompt review of this matter. Our current schedule, if met, would allow us to resume power operation on August 15, 1982.

Sincerely,

Donald J. Broehl

A001

Attachments

c: Mr. Lynn Frank, Director
State of Oregon
Department of Energy

Institute of Nuclear Power
Operations

121 SW Salmon Street, Portland, Oregon 97204

DESCRIPTION OF DEGRADED THERMAL SLEEVES IN TROJAN REACTOR COOLANT SYSTEM

Degradation of several thermal sleeves in piping nozzles of the Reactor Coolant System (RCS) at Trojan was discovered during the 1982 refueling outage. A description of the affected thermal sleeves together with a summary of this occurrence is outlined below.

RCS Nozzle Thermal Sleeves Description

Thermal sleeves were utilized at several piping nozzle locations in the Reactor Coolant System. The locations of these thermal sleeves are shown in Figure 5.1-1 of the Trojan FSAR. A summary of the size and location of thermal sleeves associated with RCS components is given in Table A-1, attached. A schematic drawing of representative 3-in., 10-in., and 14-in. thermal sleeve designs is shown in Figure A-1.

The thermal sleeves are made of Type-304 stainless steel. Each sleeve is attached by two attachment welds on the upstream end, 180 degrees apart, in line with RCS loop flow. Four spot welds on the nozzle base metal are positioned downstream of a collar on the downsteam end of the sleeve to hold it in place. The purpose of the thermal sleeves was to protect the area on system piping nozzles where thermal stresses could develop due to differences in fluid temperatures during normal operation and transients. Current Westinghouse PWRs no longer utilize thermal sleeves in these locations, as they have been found to be unnecessary.

Degraded RCS Nozzle Thermal Sleeves

During the 1982 refueling outage, while all fuel assemblies were removed from the vessel, an inspection was conducted of the Trojan lower reactor internals using a remotely operated underwater camera. Several loose objects were found beneath the lower core plate. The loose material in the lower reactor internals was remotely manipulated free of the internals and deposited in the bottom of the reactor vessel. The lower reactor internals were removed from the vessel to permit retrieval of the material.

The objects were identified as whole and partial thermal sleeves from the 10-in. safety injection-to-RCS cold leg piping nozzles. Three of these sleeves were found essentially intact. The remaining loose pieces were sufficient to constitute approximately another sleeve. A comprehensive visual examination of the entire lower reactor internals was conducted to ensure that all material was found and removed.

Ultrasonic examination of the piping nozzles indicated that all four 10-in. safety injection line thermal sleeves were missing, but revealed no details of the nozzle area condition. Radiographs using the double wall technique were taken of the 3-in., 10-in., and 14-in. nozzles in each reactor coolant loop utilizing thermal sleeves.

The radiographs confirmed that all four 10-in. sleeves were missing and gave additional details concerning the condition of the base piping. The 10-in. sleeve welds were broken flush with the nozzle inside diameter in Loops A and C, leaving no trace of sleeve or weld. A very small piece of weld metal (approximately 3/8" x 3/4" x 30-60 mils) was left in place at one of the Loop B nozzle attachment weld locations. Additionally, a small amount of base metal (<10 mils deep) is missing from the other Loop B attachment weld location. A small piece of weld metal (approximately 7/16" x 7/8" x <17 mils) is also left on the Loop D nozzle.

Radiographs of the 3-in. charging lines showed both thermal sleeves in place. Welds for the 3-in. charging line sleeve in Loop D have not degraded since the original construction examination was performed. One attachment weld in the Loop A nozzle has a small crack approximately 1/8-in. long, which was not visible in the original radiograph.

The 14-in. surge line RCS nozzle sleeve was originally held in place by two attachment welds located on the horizontal center line, one of which (the upstream side weld) has broken. The sleeve now appears to be slightly tilted in the downstream direction and pivoted on the intact weld with the gap in the broken weld opened approximately 3/64 in. This 14-in. sleeve will be removed and attachment welds ground flush with the interior of the nozzle prior to resumption of operation.

No evidence of pipe nozzle cracking was found in any of the radiographs of the weld connections of the thermal sleeves.

Several potential mechanisms of failure have been postulated, but none has been isolated for certain as the cause. The most likely candidate mechanism is flow-induced vibration of the sleeves. A defect in the weld process or design could also have been the cause.

Pressurizer Nozzle Thermal Sleeves

The thermal sleeves at the 4-in. spray line and the 14-in. surge line connections to the pressurizer are attached in a different manner than those which failed, as shown in Figures A-2 and A-3. The upstream end of each sleeve is welded over a total arc of 45 degrees. The sleeves themselves are of larger diameter than the nozzle safe ends, thus preventing sleeve movement away from the pressurizer. A flow distribution basket inside the pressurizer at the surge line connection prevents that sleeve from entering the pressurizer. Similarly, the spray header traps the sleeve on the spray line connection. Due to their method of attachment, these sleeves are not subject to breaking loose within the Reactor Coolant System, and hence were not radiographed.

Summary

In summary, PGE has found evidence of degradation of six RCS thermal sleeves. The four 10-in. SI/RCS junction sleeves are missing and have been recovered from the reactor vessel. The 3-in. Loop A normal charging line sleeve has a 1/8-in. long crack in one weld. As evaluated in Attachment B, consequences of resuming power operation with all sleeves and piping nozzles in their as-found condition has been found to be acceptable; however, the 14-in. pressurizer surge line sleeve is being removed for economic reasons.

TABLE A-1

THERMAL SLEEVES

Sleeve Location	Nominal Size (Inches)	Nominal Fluid Temperatures* (Upstream/Downstream) or ΔT
Loop A Cold Leg - SI Nozzle	10	$\Delta T \simeq$ 20°F (Normal) $\Delta T \simeq$ 520°F (Upset)
Loop B Cold Leg - SI Nozzle	10	$\Delta T \simeq$ 20°F (Normal) $\Delta T \simeq$ 520°F (Upset)
Loop C Cold Leg - SI Nozzle	10	$\Delta T \simeq$ 20°F (Normal) $\Delta T \simeq$ 520°F (Upset)
Loop D Cold Leg - SI Nozzle	10	$\Delta T \simeq$ 20°F (Normal) $\Delta T \simeq$ 520°F (Upset)
Loop A Cold Leg - Normal Charging	3	500°F/557°F**
Loop D Cold Leg - Alternate Charging	3	500°F/557°F**
Loop B Hot Leg - Pressurizer Surge Line	14	659°F/616°F***
Pressurizer - Surge Line Connection	14	616°F/659°F***
Pressurizer - Spray Line Connection	4	557°F/659°F

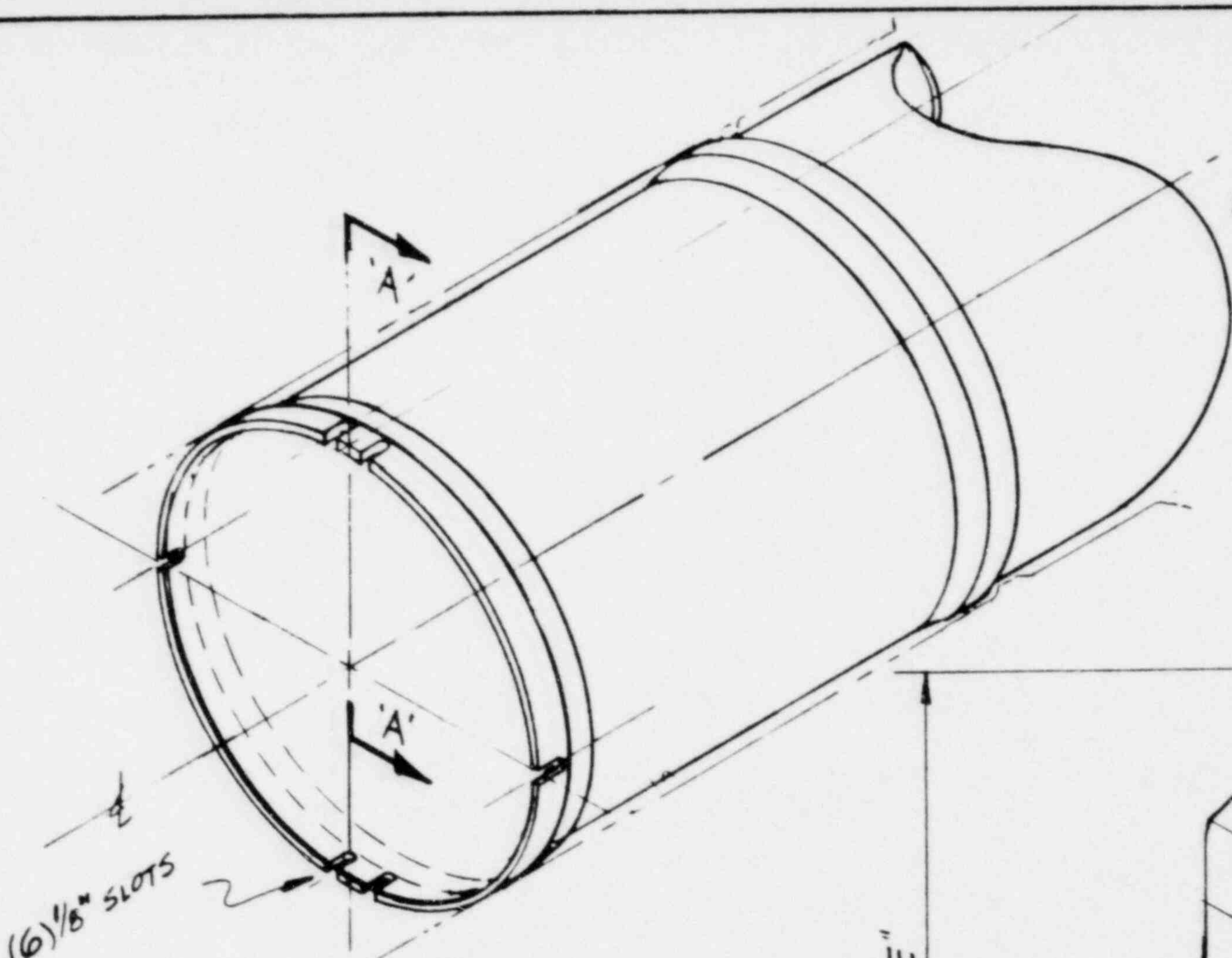
* Based on normal full power conditions.

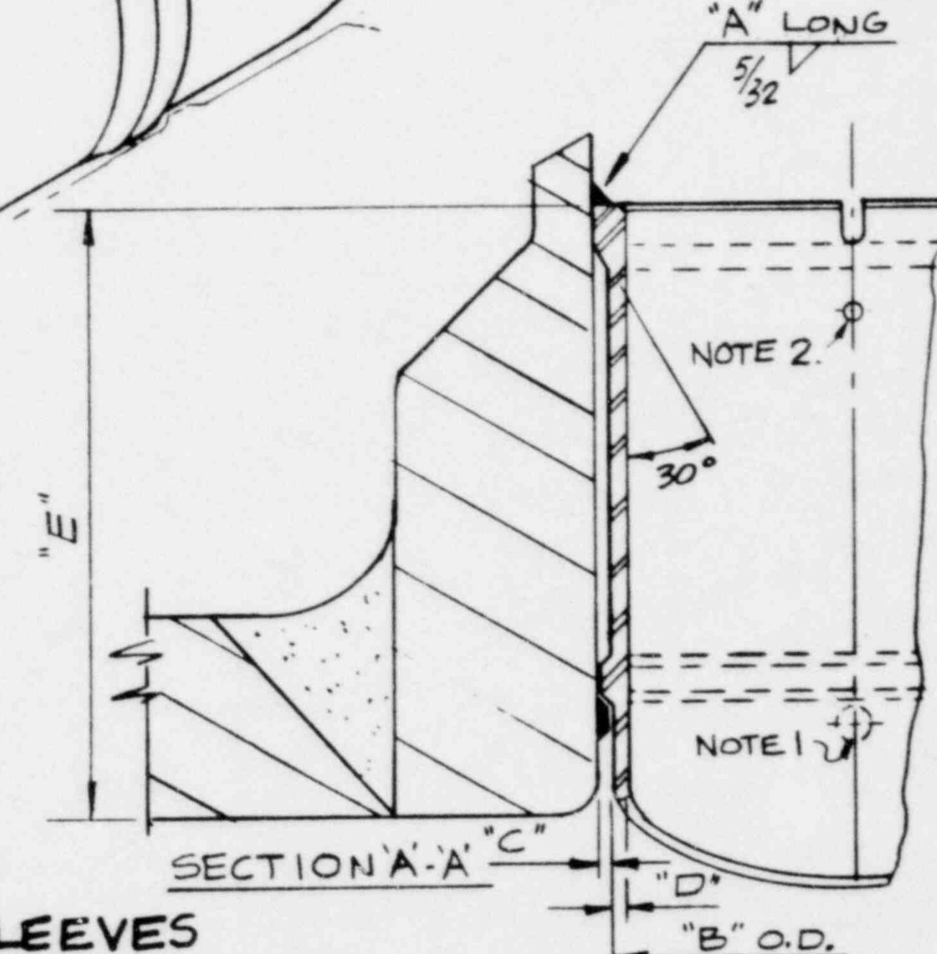
** Applicable for charging line in service.

*** Temperature element TE-450 on the surge line normally reads 615-630°F.

NOTES

1. (4) SPOT WELDS AT 90° ON HDR. GROUND FOR TIGHT FIT TO SLEEVE
2. (2) 5/32" DIA. VENT HOLES AT 180°





NOMINAL DIMENSIONS

SIZE \ DIM.	"A"	"B"	"C"	"D"	"E"
3"	3/8"	2 1/2"	3/32"	3/16"	6 9/16"
10"	5/8"	8 5/8"	.162"	.148"	13 15/16"
14"	7/8"	11 1/4"	1/8"	.180"	17 3/16"

FIGURE A-1

RCS THERMAL SLEEVES

TYP. DET. FOR 3", 10" & 14"

PRESSURIZER
SURGE NOZZLE SAFE END CONFIGURATION

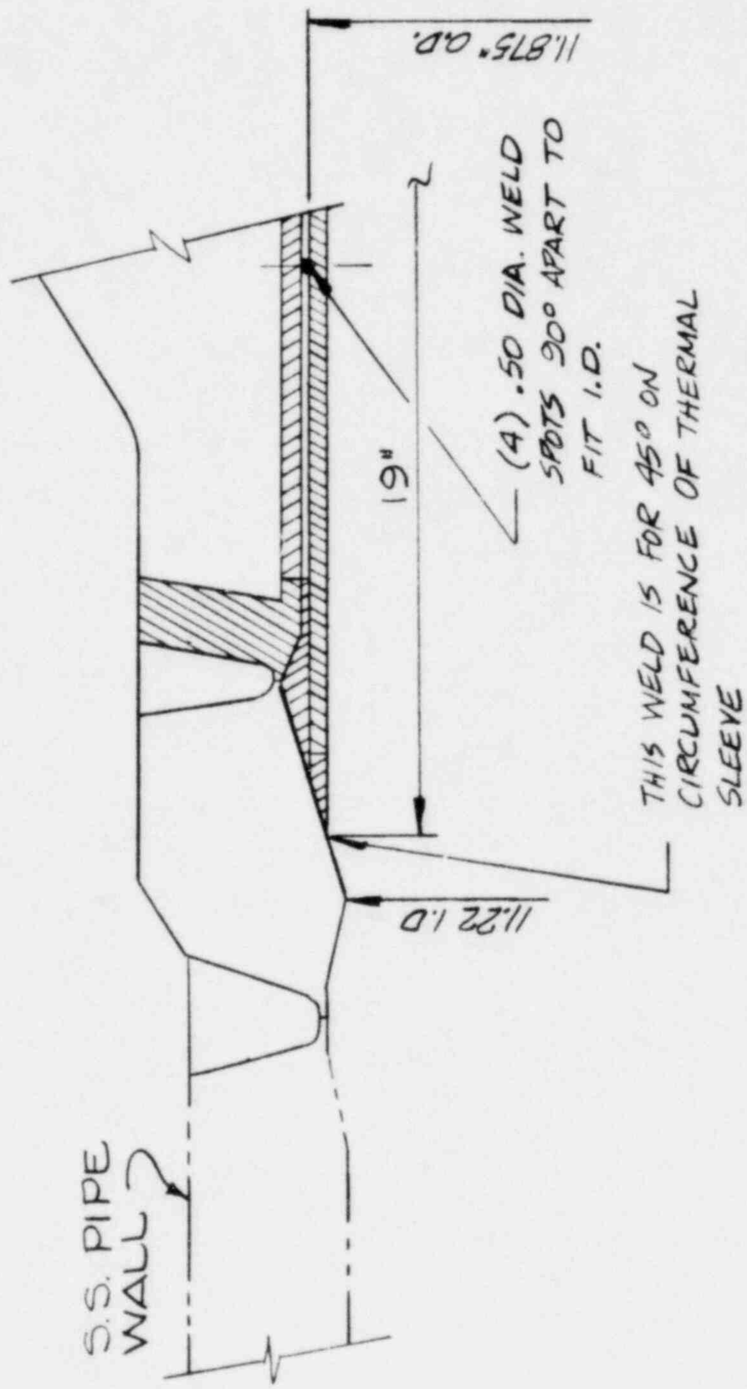


FIGURE A-2

Trojan Nuclear Plant
Docket 50-344
License NPF-1

Robert A. Clark
July 9, 1982
Attachment A
Page 7 of 7

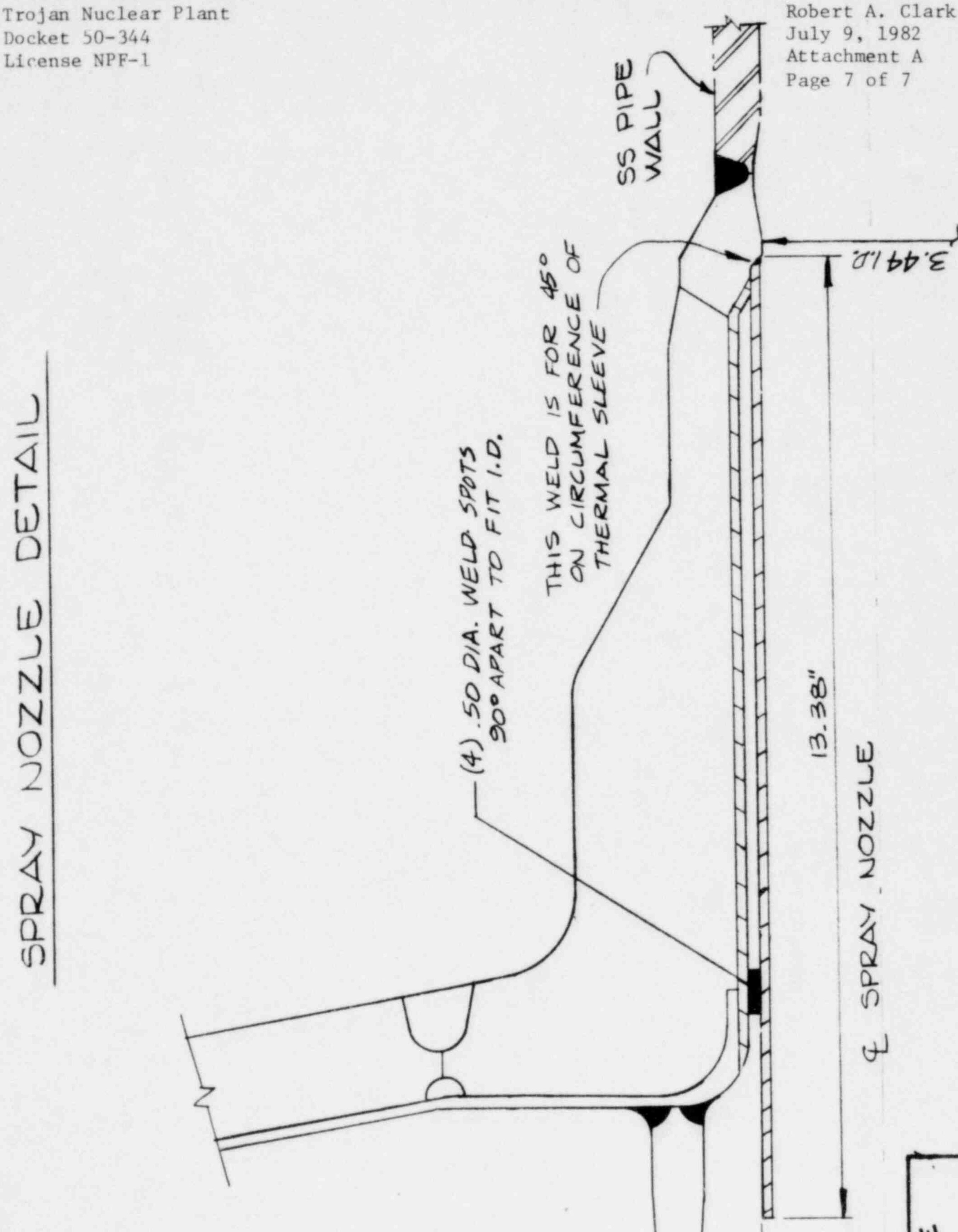


FIGURE A-3

SAFETY EVALUATION OF THERMAL SLEEVES IN TROJAN REACTOR COOLANT SYSTEM

An evaluation has been performed of the safety aspects of returning to power operation with the conditions of the Reactor Coolant System (RCS) thermal sleeves and piping nozzles as described in Attachment A. This safety evaluation also considers potential effects assuming that the remaining thermal sleeves suffer further degradation in the future. This evaluation considers the structural aspects of operation without thermal sleeves, and the effects of loose thermal sleeves on the core and RCS components from both impact and flow blockage viewpoints.

Piping Nozzle Structural Integrity

Original analyses qualifying the 3-in. nozzles are applicable to the as-found condition with thermal sleeves in place.

New bounding structural analyses have been performed for the 3-in. and 10-in., piping nozzles which demonstrate their capability to maintain structural integrity over the design life of the Plant. These analyses assumed the worst-case configurations from the as-found conditions of the 10-in. nozzles. The bounding analyses for the 3-in. nozzles assumed that their thermal sleeves degrade in the future leaving the nozzles in a condition equivalent to the worst-case 10-in. nozzle.

Existing analyses performed for newer plants showing the 14-in. nozzle to be acceptable without a thermal sleeve will be applicable to Trojan when the thermal sleeve and attachment welds are removed.

Loose Thermal Sleeve Evaluation

There is a baseline of experience with loose thermal sleeves in the cold legs of the RCS at Trojan, since four 10-in. sleeves were dislodged from the cold leg and then located within the lower reactor internals. Extensive underwater video camera inspections of core barrel, lower reactor internals, in-core instrumentation guide tubes and lower head on the reactor vessel have been performed during the current refueling outage at Trojan. There is no evidence of damage from the impact of the loose 10-in. thermal sleeves on any RCS components, nor have there been any core physics or core thermal hydraulics anomalies at Trojan to indicate core flow blockage by loose thermal sleeves.

Although no safety problems were identified regarding dislodging of the 14-in. thermal sleeve on the pressurizer surge line during operation, after consideration of the potential economic impacts PGE decided to remove that thermal sleeve.

For purposes of this safety evaluation, the remaining 3-in. thermal sleeves on the cold legs of Loops A and D are conservatively assumed to be dislocated from their respective piping nozzles and transported into the RCS loops.

Based on recent past experience at Trojan with 10-in. thermal sleeves, a loose 3-in. thermal sleeve entering the RCS cold leg is not expected to cause damage to lower core internals or the in-core instrumentation guide tubes. It is improbable that thermal sleeves would impact directly upon an in-core instrumentation tube with sufficient energy to cause penetration. Even if one were to assume that a sleeve of this size was able to impact and sever the pressure boundary of an in-core instrumentation tube, the break flow through the 0.2-in. diameter guide thimble would be less than high-pressure makeup flow. Therefore, it would not constitute a loss of reactor coolant accident. No other type of violation of the RCS pressure boundary would be possible from a loose 3-in. sleeve. Were a 3-in. sleeve to become wedged between the reactor vessel and the lower internals structure, forces due to thermal expansion of these structures during heat up would be within acceptable limits.

A loose 3-in. thermal sleeve would not pass through the lower core plate into the core or cause an unacceptable blockage of coolant flow through the core due to its size and geometry.

In the event that a 3-in. thermal sleeve were to drop into an RCS loop during a backflow period when the reactor coolant pump for that loop was not in operation, the sleeve would pass through the pump when started. This is not expected to cause damage to the pump or to cause violation of the RCS pressure boundary. At worst, a locked reactor coolant pump rotor could potentially result upon pump startup. This could only occur during shutdown conditions and would not cause a safety concern.

Since a small crack has been observed in the radiograph of the normal charging line, and not in the alternate charging line, the alternate charging line will be used whenever practical in the future.

Inservice Inspections

In order to maintain surveillance of the status of remaining thermal sleeves at Trojan, radiographs will be performed of the 3-in. RCS thermal sleeves during annual refueling outages. This will serve to indicate if further degradation is occurring.

Summary

The 10-in. and 14-in. nozzles have been found acceptable without thermal sleeves. Based on the results of this evaluation, it is considered safe to resume power operation with the 3-in. thermal sleeves remaining in their current condition. Neither the current condition nor further degradation of the sleeves is expected to adversely affect safety by either impairing the integrity of the RCS pressure boundary or by affecting the operability of any of the RCS or core components. Continued operation in the current condition is not expected to result in any new type of potential accident, nor to increase the probability or consequences of any previously analyzed accident, nor is there expected to be a decrease in any current safety margins. Continued surveillance will be maintained of the remaining thermal sleeves.

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Trojan Nuclear Plant
Docket 50-344
License NPF-1

Robert A. Clark
July 9, 1982
Attachment C

DESCRIPTION OF VIBRATION AND LOOSE PARTS MONITORING SYSTEM

Trojan utilizes an Atomics International Vibration and Loose Parts Monitoring System (VLPMS) consisting of 21 sensors/channels. Twelve piezoelectric accelerometers are mounted on various locations of the reactor vessel, main reactor coolant pumps and steam generators. The lower vessel sensors consist of two accelerometers positioned on instrument guide tubes not more than 2 ft from the vessel bottom. Two sensors are mounted on the reactor vessel lifting lugs for monitoring the upper vessel. Each reactor coolant pump has an accelerometer mounted on the motor stand. The steam generators are each instrumented with one sensor located on a seismic support column. The remaining sensors consist of four ex-core nuclear detectors and four pressure sensors located on the steam generator feedwater lines. According to Atomics International specifications, the VLPMS is sensitive to accelerations of 0.01 g and impact energies of 0.05 ft-lb_f. Each of the 12 piezoelectric accelerometer channels have alarm trip settings of 2 g for vibration and 0.5 ft-lb_f for loose parts.

VLPMS spurious alarms occur at an approximate rate of one per day. In addition, a continuous chattering noise is always present on one of the lower vessel accelerometers. Evidence indicates this chattering is due to a vibrating flux thimble positioned within the guide tube containing the accelerometer. No abnormal noise or evidence of loose thermal sleeves was detected by the VLPMS during previous operation at Trojan.

Surveillance of the VLPMS will be maintained on each shift during operation. New baseline tapes of background noise levels will be prepared for various modes of reactor operation for use in investigating and clearing alarms.

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