PDR

May 7, 1982

SECY-82-186

POLICY ISSUE
(Information)

For: The Commissioners

From: William J. Dircks
Executive Director for Operations

Subject: STATUS OF MAKE-UP NOZZLE CRACKING IN BABCOCK & WILCOX (B&W) PLANTS

Purpose: To inform the Commission of the current status of the make-up nozzle cracking problem in B&W plants.

Discussion: Since early February 1982, all eight of the B&W plants licensed to operate have completed inspections on the high pressure injection (HPI) and make-up nozzles for evidence of degradation initially discovered at the Crystal River Unit 3 (CR-3) plant. Cracking has been found in make-up nozzles of four of the B&W plants.

For all B&W plants, except Oconee, the normal make-up nozzle is one of four nozzles to the cold leg of the reactor coolant system that are used in the event HPI is required. At Oconee, two of the four lines are used for normal make-up. The make-up line is a "double-duty" line in that it is used for normal primary coolant make-up in addition to its HPI function. Thermal sleeves are installed within all of the HPI/make-up nozzles to protect the nozzles from the effects of cool water from the make-up tank or borated water storage tank thermally shocking the nozzles that are in contact with hot reactor primary coolant water. A typical thermal sleeve design for B&W plants is shown in Figure 1.

The make-up nozzle at CR-3 and Rancho Seco, and one of the two make-up nozzles at each of the Oconee Units 2 and 3 exhibited degradation. The other three nozzles to the reactor coolant system did not display cracks. Inspections have been completed at Oconee 1, Davis-Besse 1, Three Mile Island, Unit 1 and ANO-1 with no degradation detected in any of the nozzles. The cracks found in the make-up nozzle at CR-3, Oconee 2 and 3 and Rancho Seco were located near the upstream end of the

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safe end that connects the stainless steel HPI/makeup line to the carbon steel nozzle of the RCS cold leg pipe. The crack configurations appear to be transgranular, characteristic of thermally induced stress cracks. The safety concern was that a pipe break at the crack location could result in a non-isolatable small-break loss-of-coolant condition from the RCS corresponding to about a 2-inch diameter break.

Following the degradation initially discovered at CR-3 in early February 1982, and subsequently at Oconee 2 and 3, in early March 1982, it appeared likely that this problem may be generic to all B&W plants. Accordingly, the B&W Regulatory Response Group (RRG) was activated in early March 1982 to evaluate the investigation findings. A meeting with the B&W RRG and the staff was held on March 8, 1982 to discuss the findings at CR-3 and Oconee and the recommendations for the inspection actions needed at other operating B&W plants. At that time, the B&W units in operation included Davis-Besse 1, Arkansas Nuclear One, Unit 1 (ANO-1), and Rancho Seco. Although the NRC staff concluded that immediate shutdown of the operating B&W plants was not necessary, the staff requested and received letters from the licensees of these plants providing justification for continued operation to the scheduled planned shutdown when inspections would be made.

The staff found the scheduled shutdowns for Davis-Besse 1 and ANO-1, March 13 and 26, respectively, to be acceptable. For the Rancho Seco plant, the licensee proposed to operate until September 1982, and following subsequent meetings and discussions, the staff insisted and the licensee agreed that the facility be shut down before April 9, 1982 to make the inspections. The licensee subsequently shut down the Rancho Seco plant on April 3, 1982.

Although the affected licensees haven't determined the cause of the cracking, from the investigation findings to date, it appears that the cracking problem is related to the condition of the thermal sleeve. In each instance where nozzle cracks have been detected, the associated thermal sleeve has been loose or, for Rancho Seco, missing and has yet to be located elsewhere in the primary system. The sleeve repair being employed calls for hard rolling of the HPI/make-up line end of the sleeve in lieu of the contact roll which had been employed. All of the cracked nozzles in the safe end areas have been or will be replaced before restart of the plants involved. The through-wall crack discovered at the check valve/make-up nozzle interface at CR-3 which initiated the subsequent inspections was limited to CR-3.

The staff is continuing to evaluate this problem and the B&W Owners have established a Task Group to oversee followup action. That Group has been requested to expeditiously formulate plans to evaluate the cause of the cracking problem and develop long term solutions to prevent recurrence. The B&W Group expects to meet with the staff in early May 1982 regarding these plans.

A summary of the inspection findings and current status of CR-3, Oconee 2 and 3 and Rancho Seco is enclosed.

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Executive Director for Operations

Enclosures:
Figure 1 and
Summary of Inspection
Findings & Current Status
of B&W Plants

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TYPICAL B+W MAKE-UP/HPI NOZZLE THERMAL SLEEVE DESIGN

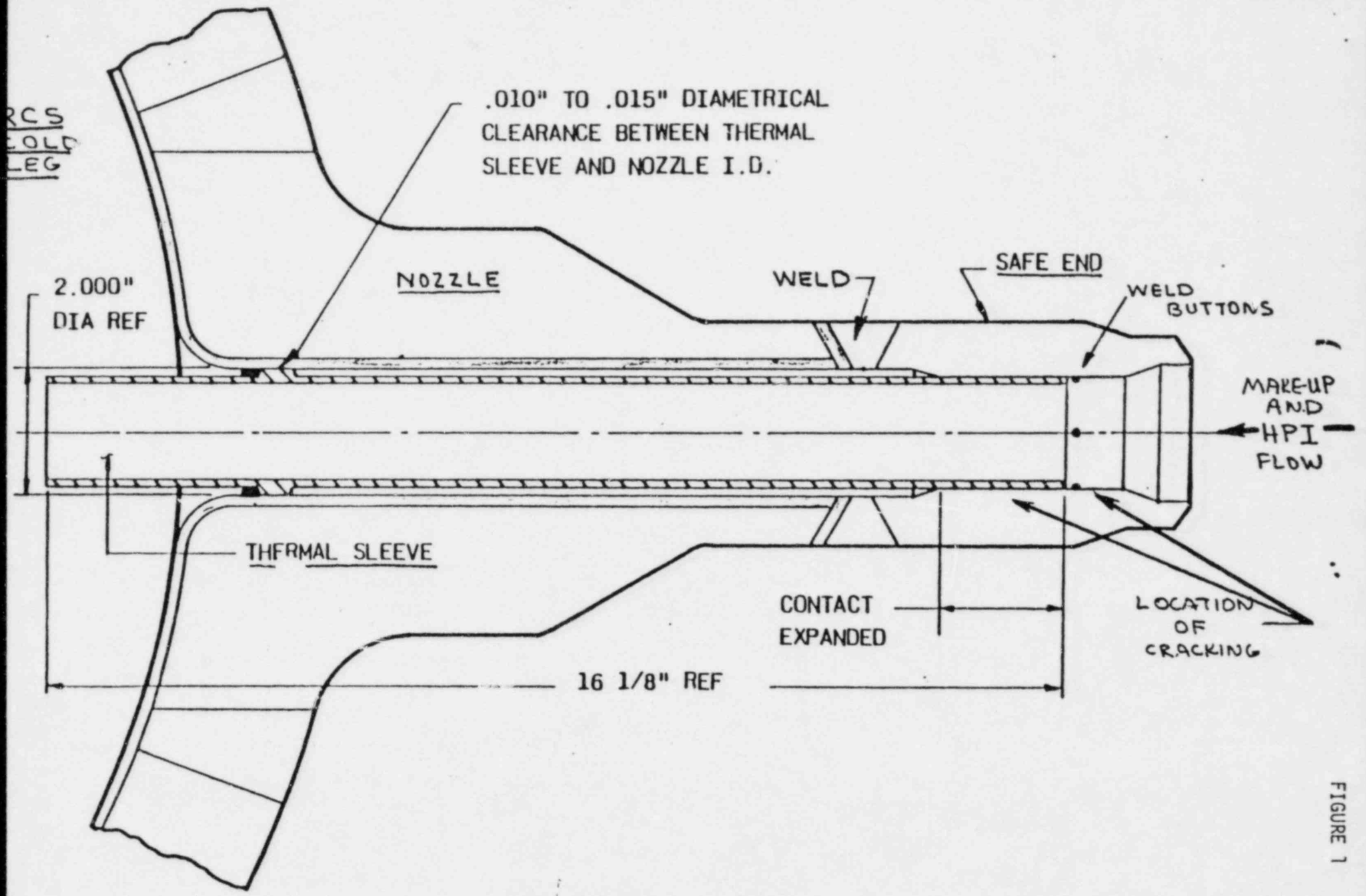

FIGURE 1

Enclosure

SUMMARY OF INSPECTION FINDINGS AND CURRENT STATUS

OF B&W PLANTS WHERE HPI/MAKE-UP NOZZLE DEGRADATION WAS DISCOVERED

Crystal River-3

On February 5, 1982 a visual inspection of the Crystal River-3 make-up system was being performed to determine the source of unidentified reactor coolant system (RCS) leakage. A crack was found in the interface between the normal make-up nozzle and the last check valve before the RCS cold leg pipe. The crack was circumferential, through-wall, and extended approximately 180°. Investigation of the crack surfaces indicated that the cracks initiated from both the I.D. and O.D. of the check valve, progressed inward, and met toward the center of the valve thickness resulting in a leakage path. Examination of an adjacent safe end part of the nozzle showed cracks in the order of 20% thru-wall with one up to 50%; the thermal sleeve inside of the make-up nozzle was loose and exhibited axial cracks. Abnormal wear had also occurred at the rolled joint. The nozzle cracks at CR-3 have been determined to be transgranular fatigue with no chemical attack. It is felt that the cracks resulted from thermal cycling and have been present for at least a year.

Examination of the other three HPI nozzles showed no cracks or other significant abnormalities.

It was noted that the as built design was not in accordance with the design assumptions used for the thermal stress analysis since the check valve was "butted" directly to the nozzle safe end and that the failure occurred at the NSSS/Architect-Engineer interface of design responsibility. As a result, the repair included moving the check valve back by inserting a short section of piping (about 5 inches long) between it and the safe end. All of the newly installed equipment in the area of interest were ultrasonically tested (UT) and penetrant tested (PT) before and/or after assembly.

Additional corrective actions at CR-3 consists of increasing the minimum bypass flow through the make-up line from approximately 1 gpm to 15 gpm to increase the flow velocity in the nozzle for cooling purposes; and to add instrumentation (strain guages and thermocouples) to the areas of the line in question to obtain additional operational information.

Oconee 2 and 3

At the Oconee Nuclear Station, during early March 1982, four thermal sleeves were determined to be loose (two in Unit 2 and two in Unit 3), an additional thermal sleeve was determined to be cracked in Unit 2, and pipe cracks were discovered in one line in Unit 2 and one line in Unit 3. The pipe cracks were in the make-up lines. No problems with either loose

thermal sleeves or pipe cracks were discovered in Unit 1 which utilizes a different thermal sleeve design.

For all nozzles, radiographic tests (RT) were used to indicate the position of the thermal sleeves; and the ultrasonic tests (UT) were used to determine the presence of cracks. In addition, Dye Penetrant tests (PT) and visual inspections were used for those areas needing either nozzle or thermal sleeve repair. The repair efforts at Oconee 2 and 3 have been completed. Oconee 2 is still shutdown for refueling; Oconee 3 returned to power on March 31, 1982.

Rancho Seco 2

As a result of make-up nozzle cracking experienced at CR-3 and Oconee plants, the staff required that the Rancho Seco facility be shutdown to permit UT and Radiographic Testing (RT) of the four high pressure injection nozzles. The plant was shutdown on April 3, 1982 to perform the nozzle examinations, and the results of the examinations are as follows:

For normal make-up nozzle "A" complete circumferential and longitudinal I.D. cracking of the nozzle safe end was found upstream of the thermal sleeve. The cracking was believed to have initiated at the I.D. of the safe end and progressed to a maximum of 20% through wall. RT examinations of the safe end showed the thermal sleeve weld "buttons" to be worn, but in place. The thermal sleeve appeared to be missing.

The configuration of the thermal sleeve is such that it could enter the RCS inlet nozzle and be carried downward to the bottom of the reactor vessel where it could be trapped below the flow distributor or between the flow distributor and lower grid support. B&W and the licensee are evaluating what effects the dislocated thermal sleeve might have on reactor operations. To date, no flow distribution effects have been noticed with the reactor at power.

For HPI nozzle "B", no nozzle or safe end cracking was detected. An RT examination indicated the thermal sleeve had moved 1" upstream toward the weld buttons, and two out of the eight buttons were missing.

For HPI nozzles "C" and "D", no nozzle or safe end cracking was detected. The positioning of the thermal sleeve was found to be satisfactory and all weld buttons were in place.

The licensee has scheduled and trained appropriate personnel to perform the repairs and has received the necessary replacement material.

Repairs are still proceeding on the make-up nozzle "A" which exhibited cracking; and on the HPI nozzle "B" regarding the loose thermal sleeve. Completion of repairs are expected to take several more weeks.