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December 5, 1978

Mr. D. L. Ziemann, Chief
Operating Reactors - Branch 2
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Dresden Station Unit 2
Feedwater Nozzle/Sparger and
Control Rod Drive Return Line
Nozzle Inspection Programs
NRC Docket No. 50-237

References (a): G. A. Abrell letter to D. L. Ziemann dated September 22, 1976

(b): G. A. Abrell letter to D. L. Ziemann dated October 18, 1976

(c): G. A. Abrell letter to D. L. Ziemann dated May 17, 1976

(d): M. S. Turbak letter to D. K. Davis dated November 28, 1977

(e): General Electric Report, NEDE-21821 dated March 1978, "Boiling Water Reactor Feedwater Nozzle/Sparger Final Report"

(f): M. S. Turbak letter to D. K. Davis dated June 23, 1977

(g): M. S. Turbak letter to D. L. Ziemann dated April 25, 1978

Dear Mr. Ziemann:

This transmittal presents the feedwater nozzle/sparger inspection program that will be implemented on Dresden Unit 2 during the upcoming refueling outage presently scheduled for March 1979. Also included in this letter is the status of the control rod drive (CRD) return line nozzle program. Justification for the programs is provided below, along with the long term plan for the modification of the feedwater nozzles on this unit.

Feedwater Nozzle Program

I. Feedwater Nozzle/Sparger Inspections

The feedwater nozzle/sparger inspection program for Dresden Unit 2 will consist of the following:

1. Examination of the visible portions of the four spargers using underwater television equipment.

2. Ultrasonic examination of the inner blend radius and bore of the four nozzles using Procedures NDT-C-24 and NDT-C-25.

3. Ultrasonic examination of the four feedwater nozzle safe ends and safe end welds.

4. Acceptance criteria for the ultrasonic examination shall be identical to that defined in Reference (a), i.e.:

   a. The calibration piece shall be a duplicate (same material and geometry) of the actual feedwater nozzle and the adjoining section of the vessel wall and associated weld.

   b. Instrument calibration shall be performed by setting the response of an 8 mm deep notch in the blend radius and bore of the duplicate nozzle to 80% of full screen height (FSH)

   c. The examination shall be conducted at a sensitivity equal to the calibration sensitivity plus an additional 6 db in accordance with ASME Code, Article I-5112 of Section XI.

d. All relevant indications with an amplitude greater than or equal to either 50% of the reference reflector (8 mm notch) or 10% FSH above the clad roll noise level shall be recorded and evaluated. This evaluation shall be in accordance with the methods defined in Reference (b). All evaluations will be made at calibration sensitivity.

e. If a relevant indication is evaluated as 80% FSH or more at calibration sensitivity, a dye penetrant examination will be made of the area containing the indication.

II. Justification for the Proposed Feedwater Nozzle/Sparger Inspection Program

In March 1979, Dresden Unit 2 is scheduled to begin its third refueling outage following the installation of the interference fit, forged-T, feedwater spargers. These spargers were installed during the refueling outage which ended in May 1975. A complete dye penetrant examination of the inner blend radius on the four feedwater nozzles was performed prior to the installation of the new spargers. All indications found were removed by grinding as reported in Reference (c), leaving no linear indicators. A reexamination of these nozzles was performed during the following refueling outage in Spring 1976. The unit had accumulated 19 startup/shutdown (SU/SD) cycles. An external ultrasonic examination was performed of the inner blend radius, using a technique developed in conjunction with Breda Thermomechanica. As reported in Reference (c), no unexplained indications were found. In an effort to validate the ultrasonic testing procedure, a dye penetrant examination was also performed of the accessible areas of the 240^{o} nozzle. Nine cracks were found with the longest two being ground out. Both grindouts were less than 0.070" in depth.

During the Fall 1977 refueling outage on Dresden 2, another inspection was performed on the feedwater nozzles. The unit had accumulated 33 SU/SD cycles since the original repair in 1975. As reported in Reference (d), an ultrasonic examination was performed of the inner radius and bore of all four feedwater nozzles using CECo. Procedures NDT-C-24 and NDT-C-25. One indication was found. It was located on the inner blend radius and was determined to be an existing grind-out. No other reportable indications were found. A dye penetrant examination was also performed on the accessible areas of three of the nozzles, and on the bore and inner radius of the 240° nozzles with its sparger removed. No linear indications were found on the three nozzles. However, nine linear indications were found on the 240° nozzle. Eight of the indications were removed by flapper wheel cleaning, and the ninth was removed by grinding to a depth of less than 1/16". This inspection program, performed in 1977, followed inspection guidelines as set forth in NUREG-0312.

At the present time, Dresden Unit 2 has had 11 SU/SD cycles since the Fall 1977 inspection. Based on previous cycle data for Dresden 2, an estimated 6 additional cycles will occur prior to the March 1979 refueling outage. Performance of the proposed inspection meets the inspection requirements as delineated in NUREG-0312. This document specifies a dye penetrant examination, for vessels which have undergone the original crack removal repair as per the General Electric FDI (performed in 1975 for Dresden 2), be performed at the earlier of (1) every other scheduled refueling outage, or (2) the next scheduled refueling outage occurring after 20, but prior to 40 SU/SD cycles after the last dye penetrant examination.

The CECo. ultrasonic testing procedures used for examination of the feedwater nozzles has been demonstrated to be capable of detecting flaws $\geq$4 mm in depth. However, for the purpose of the vessel examination, the procedure requires that an 8 mm notch be used as a calibration reference, which ensures the detection of flaws $\geq$8 mm in depth. The maximum crack, therefore, which might remain after an ultrasonic examination, would be $<$8 mm in depth. General Electric has had similar experience with their ultrasonic testing technique as reported in reference (e).

Crack growth curves developed by General Electric and CECo. were formulated assuming leakage flow past the thermal sleeve of the feedwater sparger as was the characteristic of the loose fit spargers. General Electric formulated a curve assuming a generic SU/SD cycle which was later found to be much more severe than the actual operating conditions. This was determined (Reference (f)) while reviewing operating data on Dresden 2 & 3 and Quad-Cities 1 & 2 for the purpose of constructing a plant unique cycle for the CECo. units. It is evident upon comparison of the two curves that the G.E. curve is much more prohibitive towards accumulating SU/SD cycles and continuing unit operation. An 8 mm crack would grow to critical flaw size after 43 SU/SD cycles using the G.E. curve, whereas it would take 68 cycles using the CECo. curve. Comparing the number of SU/SD cycles accumulated on Dresden 2 to the empirical crack growth curves, the unit is found to be well within the safe limits of either of the two curves.

Experience accumulated with the new interference fit sparger, however, has pointed out the conservatism even in the CECo. crack growth curves. Figure 1 contains data accumulated by General Electric on crack depth for up to 75 SU/SD cycles with the interference sparger in use. A curve established using the G.E. generic SU/SD cycle is compared to this actual interference fit data. It can be seen that the worst case of the 10 units with the interference fit sparger has a maximum crack depth of 0.2", with only one other unit having a maximum crack depth of 0.1". The remaining eight units, however, had maximum crack depths that were much smaller or nonexistent. The above data points out the effectiveness of the interference fit sparger in eliminating the leakage flow which is the mechanism initiating the cracking in the feedwater nozzles.

Previous inspections on Dresden Unit 2 and Quad-Cities Unit 2 have confirmed the above trend for plants with interference fit spargers. As reported above, Dresden 2 had cracks less than 1/16" after 33 SU/SD cycles. During the Spring 1978 refueling outage on Quad-Cities Unit 2, a dye penetrant examination was performed on the accessible areas of three nozzles, and the entire bore and inner radius of the fourth nozzle with the sparger removed. The unit had 44 SU/SD cycles since the original repair and sparger installation, and no linear indications were found. Based on the dye penetrant examination, data accumulated by General Electric for the 10 units and on CECo. data for Quad-Cities Unit 2 and Dresden Unit 2, and considering Dresden 2 will only have approximately 17 SU/SD cycles at the beginning of the refueling outage, it is our contention that no cracks, if any, are deeper than 0.2".

Finally, as part of the on-going program to provide a "final fix" solution to the feedwater nozzle cracking problem, CECo. will install the new G.E. double seal/triple thermal sleeve sparger and will remove the clad from the feedwater nozzles on Dresden Unit 2. At the present time, this work is scheduled to occur during one of the long outages associated with the Mark 1 containment work scheduled for the Fall 1980.

In summary, our technical evaluation of the Dresden Unit 2 feedwater nozzle indicates that:

1. All indications on the feedwater nozzle inner radius were removed during the original clad repair and interference fit sparger installation.

2. During the Fall 1977, after an accumulated 33 SU/SD cycles, a dye penetrant inspection in accordance with the guidelines of NUREG-0312 was performed on Dresden Unit 2.

3. The proposed inspection is in accordance with NUREG-0312 in that Dresden Unit 2 will only have an estimated 17 SU/SD cycles prior to the March 1979 outage.

4. The ultrasonic examination procedures used will ensure that any cracks $\geq$ 8 mm in depth will be detected.

5. Conservative crack growth curves still predict that a flaw remaining in the Dresden 2 nozzles subsequent to the previous inspection would be well below the critical flaw size.

6. Feedwater nozzle inspection data from GE and CECo. has proven the effectiveness of the interference fit sparger for providing an end to the effects of the thermal cycling on the feedwater nozzles in that after 75 SU/SD cycles, the deepest crack found to date has been 0.2" (approximately 25 percent of the critical flaw size).

Considering the above facts, plus our plan to install the GE double seal/triple sleeve sparge and to remove nozzle cladding on Dresden Unit 2 in Fall 1980, it is judged that the inspection program is adequate. This inspection program is in accordance with that specified in NUREG-0312 and will provide a safe and reliable inspection which will not compromise unit availability.

CRD Return Line Nozzle Program Status

As a result of cracking problems occurring with the CRD return line nozzle in BWR reactor vessels, an inspection of the Dresden Unit 2 nozzle was performed during the Fall 1977 refueling outage. As reported in Reference (g), the inspection consisted of an underwater TV camera examination of the thermal sleeve and an external ultrasonic examination of the inner radius and the wall below the nozzle. The nozzle thermal sleeve was found cracked and was subsequently removed. A dye penetrant examination was then performed on the inner blend radius and bore of the nozzle. Several indications were found in one of the thermal sleeve spacer pads and in the retainer ring pad. These were removed by grinding and were found not to penetrate vessel cladding. The thermal sleeve was not reinstalled.

Data on the CRD nozzle cracking has indicated that the cracking found in the BWR vessels has been due to thermal fatigue. A metallurgical analysis of the thermal sleeve confirmed that thermal fatigue was the failure mechanism.

Following the nozzle inspection and repair on Dresden Unit 2, the CRD return line was valved out, terminating the 50°-100°F condensate flow through the return line. Eliminating this cold flow puts an end to the source of the thermal cycling which has been determined to be the cracking mechanism.

Based on the above, it is the CECo. position that no further inspection of the CRD return line nozzle is warranted. Cracks that were present were removed, and the environment the nozzle will be exposed to will not include the cold condensate flow. However, considering the susceptibility of stagnant stainless steel lines to stress corrosion cracking, an augmented inservice inspection will be performed of the stainless steel welds on the reactor vessel side of the inboard valve used for isolation.

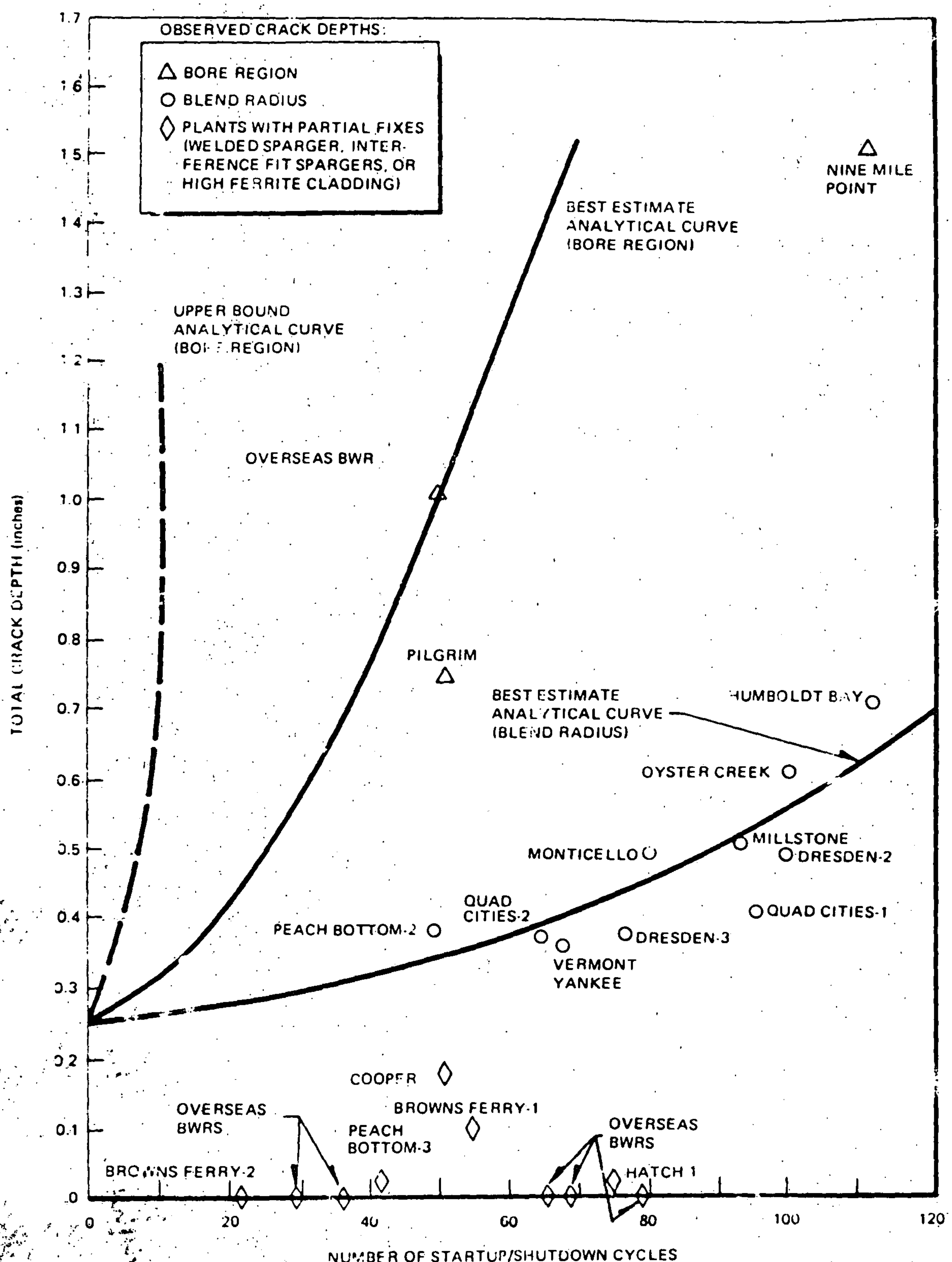
One (1) signed original and thirty-nine (39) copies of this letter are provided for your use.

Very truly yours,

L. O. DelGeorge

for/ M. S. Turbak
Nuclear Licensing Administrator
Boiling Water Reactors

attachment



OBSERVED CRACK DEPTHS:
BORE REGION
BLEND RADIUS
PLANTS WITH PARTIAL FIXES (WELDED SPARGER, INTERFERENCE FIT SPARGERS, OR HIGH FERRITE CLADDING)
UPPER BOUND ANALYTICAL CURVE (BORE REGION)
BEST ESTIMATE ANALYTICAL CURVE (BORE REGION)
NINE MILE POINT
OVERSEAS BWR
PILGRIM
BEST ESTIMATE ANALYTICAL CURVE (BLEND RADIUS)
HUMBOLDT BAY
OYSTER CREEK
MILLSTONE
DRESDEN-2
MONTICELLO
QUAD CITIES-2
PEACH BOTTOM-2
VERMONT YANKEE
DRESDEN-3
QUAD CITIES-1
COOPER
BROWNS FERRY-1
OVERSEAS BWRS
PEACH BOTTOM-3
OVERSEAS BWRS
BROWNS FERRY-2
HATCH 1
TOTAL CRACK DEPTH (inches)
NUMBER OF STARTUP/SHUTDOWN CYCLES
0
20
40
60
80
100
120
.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7

Figure 1