PY-CEI/NRR-1264 L
Attachment 2

SUMMARY TECHNICAL REPORT

EVALUATION OF THE INDICATION(S) IN THE PERRY FEEDWATER TO SAFE-END WELDS

November 21, 1990

Cleveland Electric Illuminating Company

Prepared by: Homer S. Thornton — 11/21/90 Date

Reviewed by: W. C. Hemby — 11-21-90 Date

Approved by: J. E. Lipka (for CLA) — 11-21-90 Date

ABSTRACT

As part of Perry's Inservice Inspection (ISI) Program, all six Feedwater (FW) nozzle to safe end welds were ultrasonically examined (UT) during the second refuel outage (RFO-2). Flaws were detected in nozzles N4E and N4C that were outside of the acceptance criteria of IWB 3514.3 of ASME XI (reference Nonconformance Reports #90-S-270 and 90-S-277 dated November 9, 1990 and November 13, 1990, respectively).

Both flaws were 0.15" deep, with the flaw in nozzle N4C being 2.9" long, versus 1.6" long for nozzle N4E. Since both flaws are the same depth, and very nearly the same location (although one was oriented at 6:00 O'Clock and the other @12:00 O'Clock - see Figure #1), justification for the larger flaw will serve as technical justification for both.

The UT indications were not identifiable as characteristic of IGSCC. However, the current limited size of the indications may be such that IGSCC characteristics would not be sufficiently pronounced to be apparent. Consequently, CEI has taken a conservative approach and included an appropriate IGSCC contribution in conjunction with cyclic fatigue growth when determining the "final" flaw size. The final flaw size is fully acceptable within the criteria of ASME XI, Tables IWB 3641-5 and 3641-6 for the full duration of Operating Cycle 3 for Perry (nominal 18 month cycle).

The subject nozzles will be UT re-inspected during Refueling Outage #3 (RFO-3) and further engineering evaluation will be performed at that time. The current conservative projected results, however, indicate that some additional action (i.e., other than a "use-as-is" condition) would be required beyond RFO-3.

STRESS HISTORY

The stress history for this location was taken from CBIN Stress Report #4 (S4, T4, S4 and F4), as analyzed for the modified sparger configuration. (GE had changed the sparger attachment from being welded to a "freeze fit" configuration to remove a "cyclic" fatigue weld problem in the attachment weld). A residual stress was added to the stress profile. The value of residual stress added was a function of percentage of crack depth (a/t). The equation used was taken from NUREG-0313/Revision 2 with a suggested value for Sy of 30 ksi, which closely approximates the value for Inconel 182 of 28.4 ksi at temperature.

CRACK GROWTH

The initial crack of 0.15" deep X 2.9" long was projected to grow for 1148 operating cycles, assuming worst case cycle combination to determine "Delta" K_I. From Figure C-3210-1 of ASME XI, the projected cyclic fatigue growth increased the flaw depth to only 0.16". The growth attributed to the GSCC contribution for the 12000 operational hours during Operating Cycle 3 is 0.29". This is based on a crack growth rate of 2.41×10^{-5} in/hr, which came from EPRI NP-5884M, Project 1566-1 "Stress Corrosion Cracking Resistance of Alloy 600 and 690 and Compatible Weld Metals in BWRs". (In conversations with personnel at River Bend, this value is comparable to what was used in their evaluation).

The reported crack growth rate is associated with a K_I value of 46.0 MPa$\sqrt{m}$ (41.9 ksi$\sqrt{in}$). This compares favorably with the actual K_I expected for normal operating conditions (26.9 ksi$\sqrt{in}$). Since the crack growth rate is a function of K_I, the actual rate would be expected to be less than the value used, and the calculated growth is conservative. Concurrent with the crack growth to a depth of 0.45" is the circumferential growth to 9". This growth was based on the 20:1 (maximum) aspect ratio (or circumferential growth) as specified in NUREG-0313/Revision 2. See Figure 2 for the projected crack growth for Operating Cycle 3. The contribution of emergency or faulted conditions on the crack growth produced a negligible effect (on the final projected crack depth).

ACCEPTANCE CRITERIA

Although the flaw location is at or close to the Inconel 182 buttering and the SA-508 Class 1 interface, it was assumed (as dictated by ASME XI) that the crack growth would occur in the buttering. The buttering was applied by using SMAW procedures; consequently Tables IWB 3641-5 and 3641-6 are the basis of the acceptance criteria. Figure 2 shows the acceptance envelopes based on a stress ratio of 0.81. This value considers the Primary Membrane and Primary Bending contribution to be 13.0 ksi as determined by CBIN in Report D4, and an expansion stress (Pe) value of 16.0 ksi for RFE stress, based upon GE specified design thermal loads for the Feedwater nozzle.

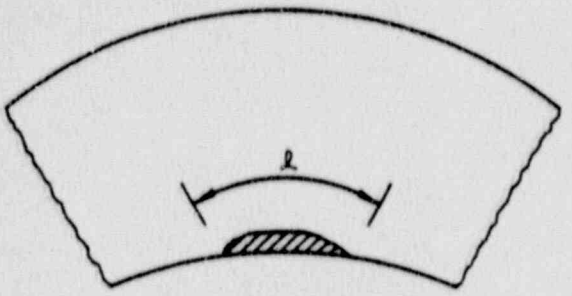
The acceptance criteria determines an allowable crack depth value of 0.65", versus the projected (calculated) growth to 0.45". This difference of 0.20" supplies almost a 50% margin at the end of the next operational cycle for Perry.

CONCLUSIONS

1. The subject indications have been evaluated and shown to be acceptable as-is for continued full service operation during Perry's next operating cycle (Cycle #3).

2. Subsequent to UT inspection of the subject welds during RFO-3, an engineering evaluation will be performed to determine additional corrective actions (if any).

3. The subject nozzle welds will be treated as Category "F" weldments per Generic Letter 88-01/Revision 0, Table 1 until such time as further inspection/evaluation justifies otherwise.



ℓ = 2.9" NOZZLE N4C

ℓ = 1.6" NOZZLE N4E

a = 0.15" BOTH NOZZLES

SECTION "A-A"

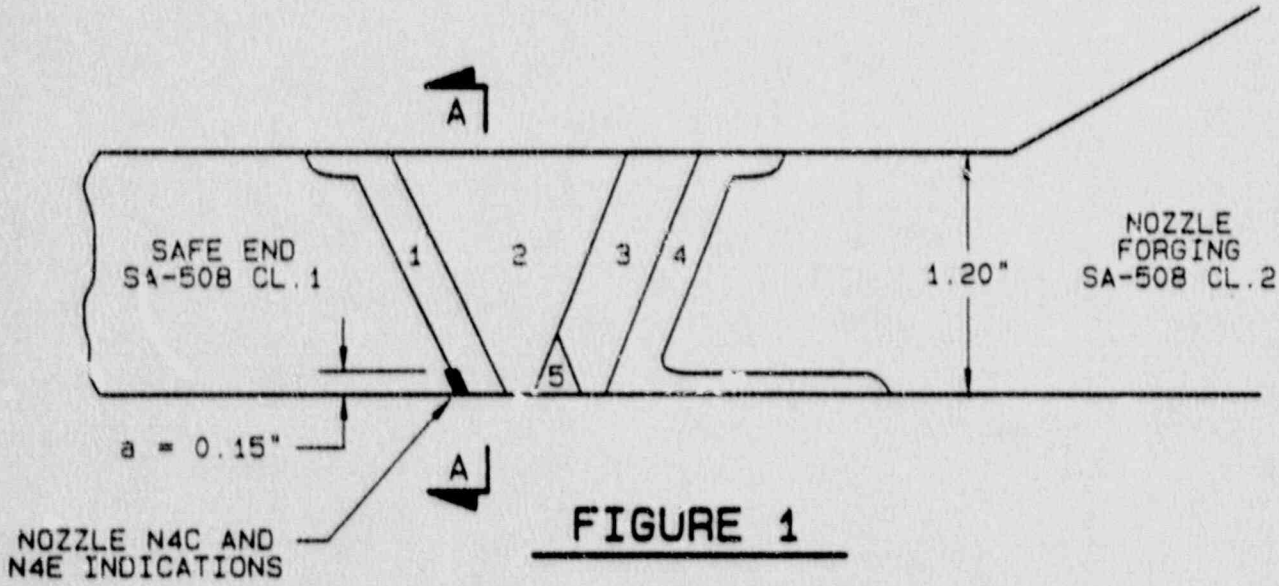


FIGURE 1

1. SAFE END BUTTERING
   - INCONEL 182
2. FIELD WELD
   - IN82 ROOT PASS WITH INCONEL 82 HOT PASSES* AND INCONEL 82 FILL PASSES
3. PORTION OF ORIGINAL FIELD WELD
   - SAME AS #2 ABOVE
4. NOZZLE BUTTERING
   - INCONEL 182
5. ORIGINAL SAFE END
   - INCONEL 600

* IN82 AND INCONEL 82 HAVE IDENTICAL CHEMICAL COMPOSITION REQUIREMENTS AS SPECIFIED BY ASME SECTION II PART C SFA 5.30 AND SFA 5.14, RESPECTIVELY.

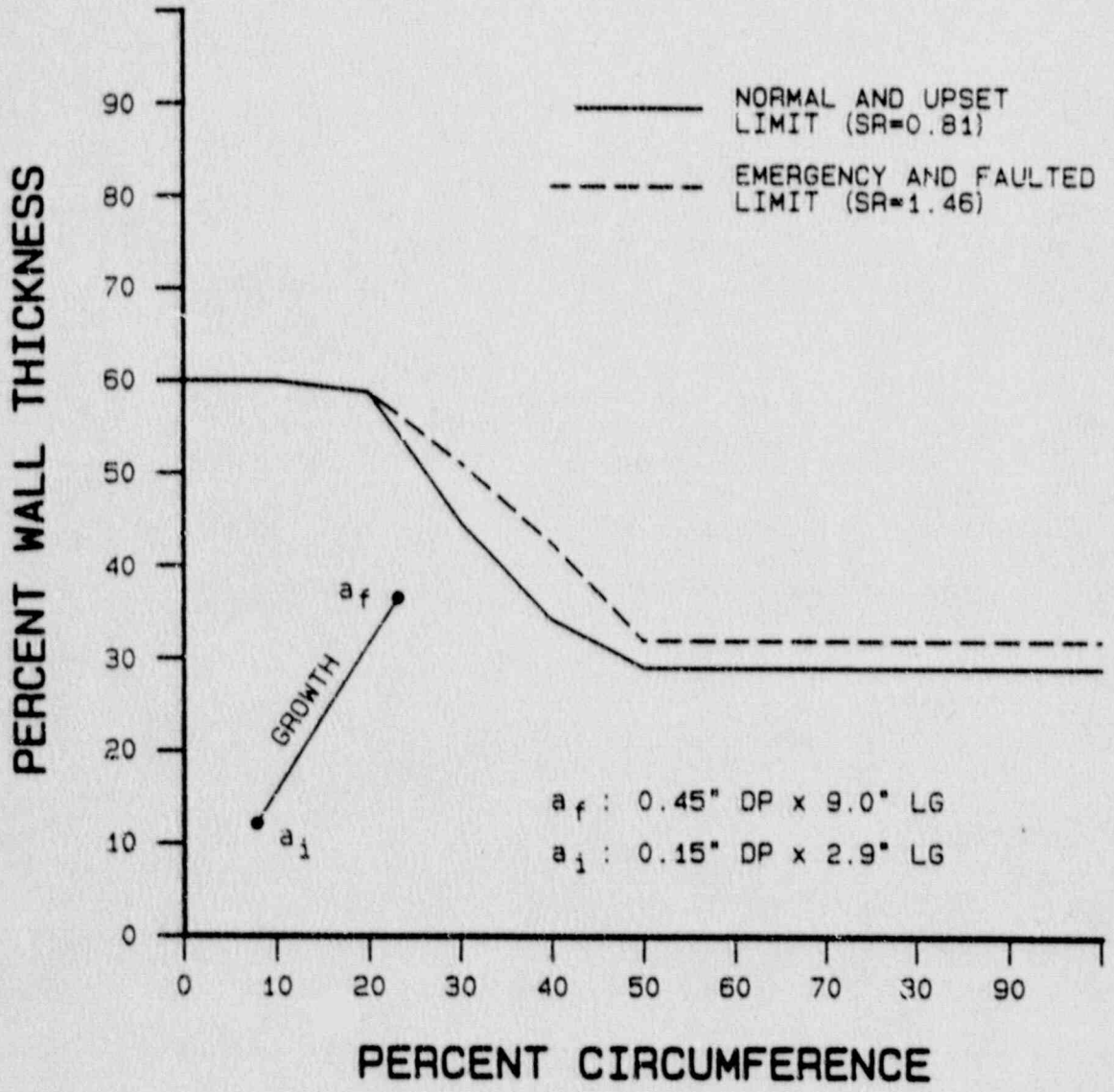

NORMAL AND UPSET
LIMIT (SR=0.81)
EMERGENCY AND FAULTED
LIMIT (SR=1.46)
PERCENT WALL THICKNESS
90
80
70
60
50
40
30
20
10
0
a_f
GROWTH
a_i
a_f : 0.45" DP x 9.0" LG
a_i : 0.15" DP x 2.9" LG
0
10
20
30
40
50
60
70
30
90
PERCENT CIRCUMFERENCE

FIGURE 2