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License No. NPF-39

U.S. Nuclear Regulatory Commission
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SUBJECT: Limerick Generating Station, Unit 1
Plans for the Ultimate Disposition
of the Recirculation Inlet Nozzle
to Safe End Weld Indication

Gentlemen:

During the 1989 Limerick Generating Station (LGS) Unit 1 Refueling Outage, a number of normally required and augmented In-Service Inspections (ISI) of austenitic stainless steel piping welds were performed in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, and NRC Generic Letter 88-01, "NRC Position on IGSCC In BWR Austenitic Stainless Steel Piping," dated January 25, 1988. As a result of these inspections, an indication was discovered in one of the reactor vessel nozzle (identified as the N2H nozzle) to safe end welds. Our letter dated April 3, 1989, submitted a summary report of our evaluation of the N2H nozzle to safe end weld indication, and the justification for proceeding with cycle 3 operation of Unit 1 with the indication in the "as found" condition, for NRC review and approval. Our April 3, 1989 letter also stated that the corrective action that will be taken to ultimately dispostion the N2H nozzle to safe end weld indication will be established prior to shutdown of Unit 1 for the third refueling outage. NRC letter dated May 2, 1989, forwarded the Safety Evaluation Report (SER) approving cycle 3 operation of Unit 1 with the indication in the "as found" condition, and stated the NRC's understanding that the final corrective action will be established prior to or during the third Unit 1 Refueling Outage. Currently, the third Unit 1 Refueling Outage is planned to begin on September 8, 1990. Accordingly, this letter provides our plans for the ultimate disposition of the N2H nozzle to safe end weld indication. As discussed below, there are a number of corrective actions that can be taken, and the specific corrective action will be selected based on the results of the N2H nozzle to safe end weld ultrasonic (UT) inspection that will be performed during the third Unit 1 Refueling Outage.

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Background

A seven inch circumferencial flaw indication was found in the N2H nozzle to safe end weld as a result of UT inspections performed during the 1989 Unit 1 Refueling Outage. As shown in Figure 1, the indication is located on the nozzle side of the weld in the alloy 82 weld and/or the Inconnel 600 that was left in place after the original Inconnel 600 safe end was removed. With the wall thickness being 1.40 inches, the average depth of the indication is 0.25 inches (i.e., approximately 18% through wall), and a part of the indication, 0.5 inches in length, is 0.40 inches deep (i.e., approximately 29% through wall). The indication is located 31.8 inches to 38.8 inches from top dead center of the nozzle, clockwise with flow. Since actual visual inspection of the indication could not be performed, whether the indication is due to intergranular stress corrosion cracking (IGSCC) or is a pre-existing construction flaw could not be confirmed.

A crack growth rate analysis and structural margin assessment using conservative assumptions was provided to the NRC by our letter dated April 3, 1989. The structural margin assessment was performed assuming that the indication was in fact a crack, and that it was connected to the weld internal diameter (ID). Two crack growth rates were used in this assessment. The lower crack growth rate of $1X10^{-5}$ inches/hour represents the expected crack growth rate assuming a target reactor water conductivity of 0.1 uSiemens/cm, and a higher crack growth rate of $5 X 10^{-5}$ inches/hour reflecting an upper bound growth rate value for "worst case" reactor water conductivity levels. Using the higher crack growth rate value, the depth of the crack was calculated to be 0.85 inches (i.e., 60% through wall) by the end of cycle 3 operation, starting from the average measured indication depth of 0.25 inches. Starting from the maximum indication depth of 0.40 inches, the end of cycle depth was calculated to be 1.0 inch (i.e., 71% through wall) using the higher crack growth rate. The allowable crack size was then calculated in accordance with the ASME B&PV Code, Section XI. The results showed that the calculated crack growth by the end of cycle 3 was acceptable, even when the higher crack growth rate was assumed.

In order to confirm the results of the crack growth analysis, and to provide additional assurance that the structural margin of the N2H nozzle to safe end weld would be maintained during cycle 3 operation, a Crack Advance Verification System (CAVS) was installed and put into operation prior to Unit 1 startup from the 1989 Refueling Outage. The CAVS, which has continued to operate during cycle 3, provides inferential monitoring of cracks by using a pre-loaded specimen with a known flaw which is placed in an autoclave through which reactor coolant flows. The specimen is thereby subjected to the same reactor coolant conditions as the crack, and the crack growth of the specimen is electronically monitored using a reversing DC potential. Based on the CAVS data, we committed to perform the following inspections of the N2H nozzle to safe end weld.

- If after nine months of cycle 3 operation, the CAVS specimen indicates a crack growth greater than or equal to 0.2 inches, the N2H nozzle to safe end weld will be inspected if the plant is shutdown for a forced outage that is planned to last for greater than two weeks

- If after nine months of cycle 3 operation, the CAVS specimen indicates a crack growth greater than or equal to 0.3 inches, the plant will be shut down and an inspection of the N2H nozzle to safe end weld will be performed.

CAVS Results

A thorough evaluation of the CAVS data for the first nine months of cycle 3 operation has been performed. The data show a small crack growth at the end of nine months of operation of only 0.018 inches in the CAVS specimen. This represents a maximum average specimen crack growth rate of 2.72×10^{-6} inches/hour, significantly less than the higher crack growth rate of 5×10^{-5} inches/hour used in the structural margin assessment. Since neither crack growth threshold value was reached (i.e., 0.2 inches or 0.3 inches after nine months of operation), the additional inspections were not performed.

The difference between the predicted crack growth rate (i.e., 1×10^{-5} inches/hour and 5×10^{-5} inches/hour) and the crack growth rate determined from the CAVS data can be attributed to the excellent reactor water chemistry maintained during cycle 3. During the first nine months of cycle 3 operation, the CAVS operated 95.8% of the time, and Unit 1 operated at or near full power conditions for almost all of the period. When the CAVS was occasionally shutdown, however, the resulting transient may have caused additional crack growth not experienced by the N2H nozzle to safe end weld indication. Accordingly, the CAVS data most likely represents a more conservative (i.e., higher) crack growth rate than may have been experienced by the nozzle to safe end weld indication.

Corrective Action Plans

The following four corrective action alternatives for dispositioning the N2H nozzle to safe end weld indication have been identified and evaluated. The selection of the corrective action that will be implemented will be based on the results of the inspection of the N2H nozzle to safe end weld during the upcoming Unit 1 refueling outage currently scheduled to begin on September 8, 1990.

1. Leave in the "as-found" condition with continued CAVS monitoring
2. Apply the Mechanical Stress Improvement Process (MSIP) with or without CAVS monitoring
3. Repair with weld overlay with or without continued CAVS monitoring
4. Replacement of the N2H nozzle safe end

Each of these corrective action alternatives was evaluated based on various factors which included maintaining an acceptable structural margin, viability, cost, worker radiation exposure, and time required for implementation. The safe end replacement alternative was eliminated since it did not satisfy most of the evaluation acceptance criteria.

The 1989 UT inspection results for the N2H nozzle to safe end weld have been reviewed again. We consider that there is a possibility that the indication is not due to IGSCC, but instead is an original construction flaw and not IP connected. This possibility would be further supported if the upcoming UT inspection results show no change in the dimensions of the indication. Accordingly, the identical UT inspection which resulted in the identification of the N2H nozzle to safe end weld indication during the 1989 Refueling Outage will be repeated to the extent possible (i.e., use of the same UT technique, equipment, and technicians) during the upcoming Unit 1 Refueling Outage.

With respect to the corrective action alternatives, CAVS monitoring would not be continued if either the application of MSIP or weld overlay is selected due to the fact that the CAVS specimen would no longer represent actual nozzle to safe end weld conditions. With respect to the selection of MSIP without monitoring as the corrective action, section 4.2 of NUREG 0313, Revision 2, "Technical Report on Material Selection and Process Guidelines for BWR Coolant Pressure Boundary Piping," recommends that MSIP be applied only if the flaw indication is less than 30% through wall and 10% of the circumference. The dimensions of the N2H nozzle to safe end weld indication are not within these bounds. We expect, however, that an elastic-inelastic finite element analysis will demonstrate that the MSIP variables can be controlled such that application of the MSIP to a flaw of greater depth than 30% and a circumfrential length greater than 10% can be put into an arrested state. We have recently initiated this analysis and expect to discuss the results with the NRC once they are available.

The bounding conditions for application of the MSIP and weld overlay to the N2H nozzle to safe end weld will be established prior to the upcoming Unit 1 Refueling Outage. We have also established conditions for determining whether there has been any growth of the indication. These conditions were derived from the anticipated uncertainty band of depth resolution of the UT inspection technique. If the change in the length and depth of the indication is within the tolerances for repeatable UT inspections, the conclusion that there has been no growth is justifiable.

If the change in the indication length and depth is consistent with a crack growth rate of 1×10^{-5} inches/hour or less, we may request NRC approval to allow Unit 1 to operate for additional cycles with the indication in the "as found" condition. If the change in the indication length and depth shows a crack growth rate of 2.5×10^{-5} inches/hour or less, we may request NRC approval to allow Unit 1 to operate for only the next cycle with the indication in the "as found" condition since the size of the indication at the end of next (i.e., fourth) cycle would not exceed the ASME Code allowable flaw size.

If the UT inspection results show no growth of the indication, as explained above, or if the indication size has increased but is within the bounding conditions for the application of the MSIP, we may request NRC approval to apply the MSIP to the N2H nozzle to safe end weld. If the change in the length and depth of the indication is greater that the established conditions for "use as is," or the bounding conditions for the application of the MSIP, we would request NRC approval to repair the N2H nozzle to safe end weld using weld overlay.

As described above, the alternative corrective actions to disposition the N2H nozzle to safe end weld indication include continued operation in the "as found" condition with CAVS monitoring, application of MSIP without continued monitoring, or repair by weld overlay without continued monitoring. The selection of the specific corrective action to be implemented will be based on the established bounding conditions, and the results of the UT inspection of the N2H nozzle to safe end weld that will be performed during the upcoming Unit 1 Refueling Outage, currently scheduled to begin on September 8, 1990. Figure 2 provides a flowchart depicting the selection process that will be followed once UT inspection results have been obtained.

If you have any questions, or require further information, please contact us.

Very truly yours,

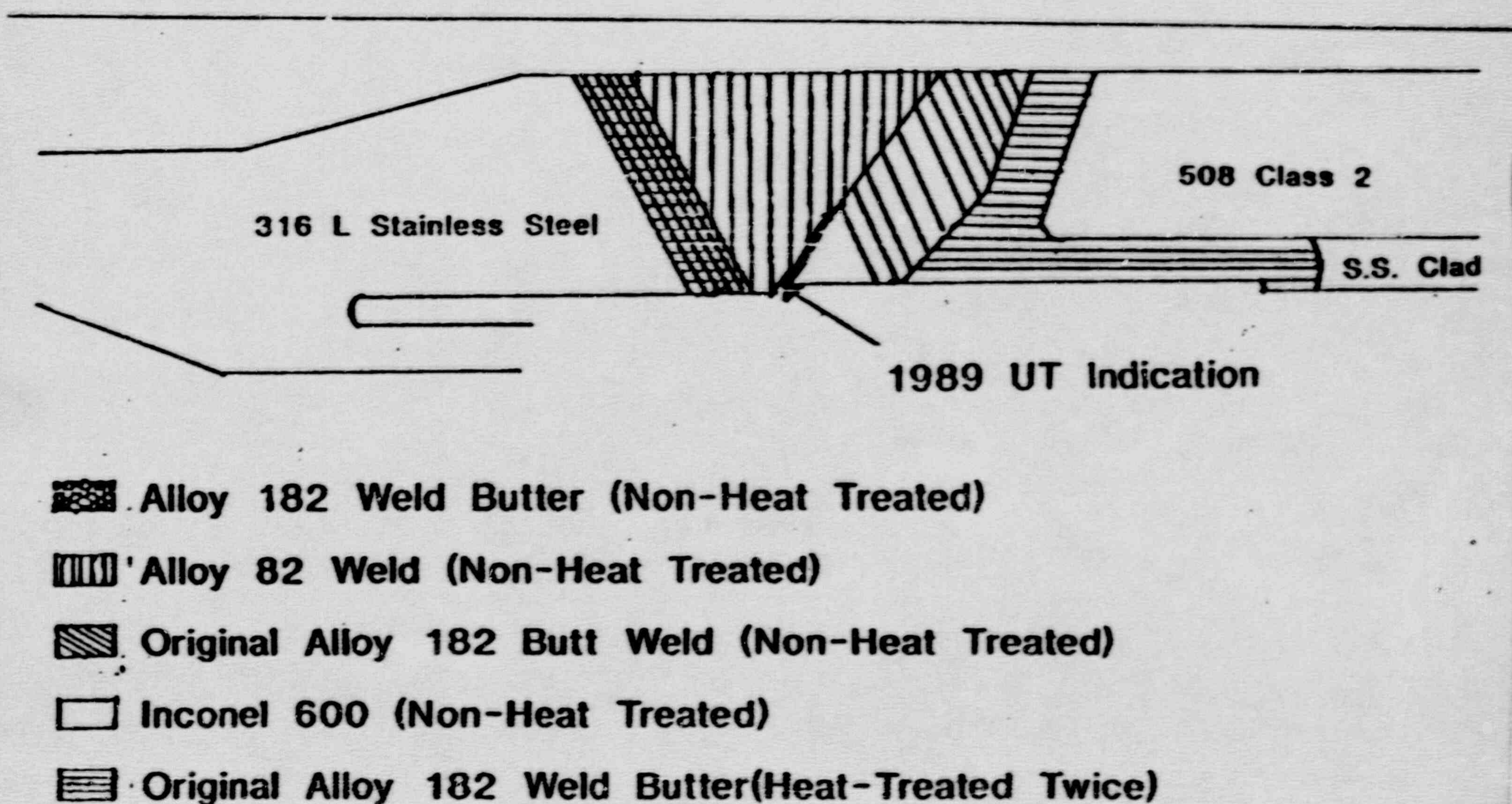
R M Krich for

G. A. Hunger, Jr.
Manager
Licensing Section
Nuclear Engineering and Services

cc: T. T. Martin, Administrator, Region I, USNRC
T. J. Kenny, USNRC Senior Resident Inspector, LGS

FIGURE 1

LGS Unit 1 Recirculation Nozzle (N2) Weld Details



DISPOSITION ALGORITHM FOR THE N2H INDICATION

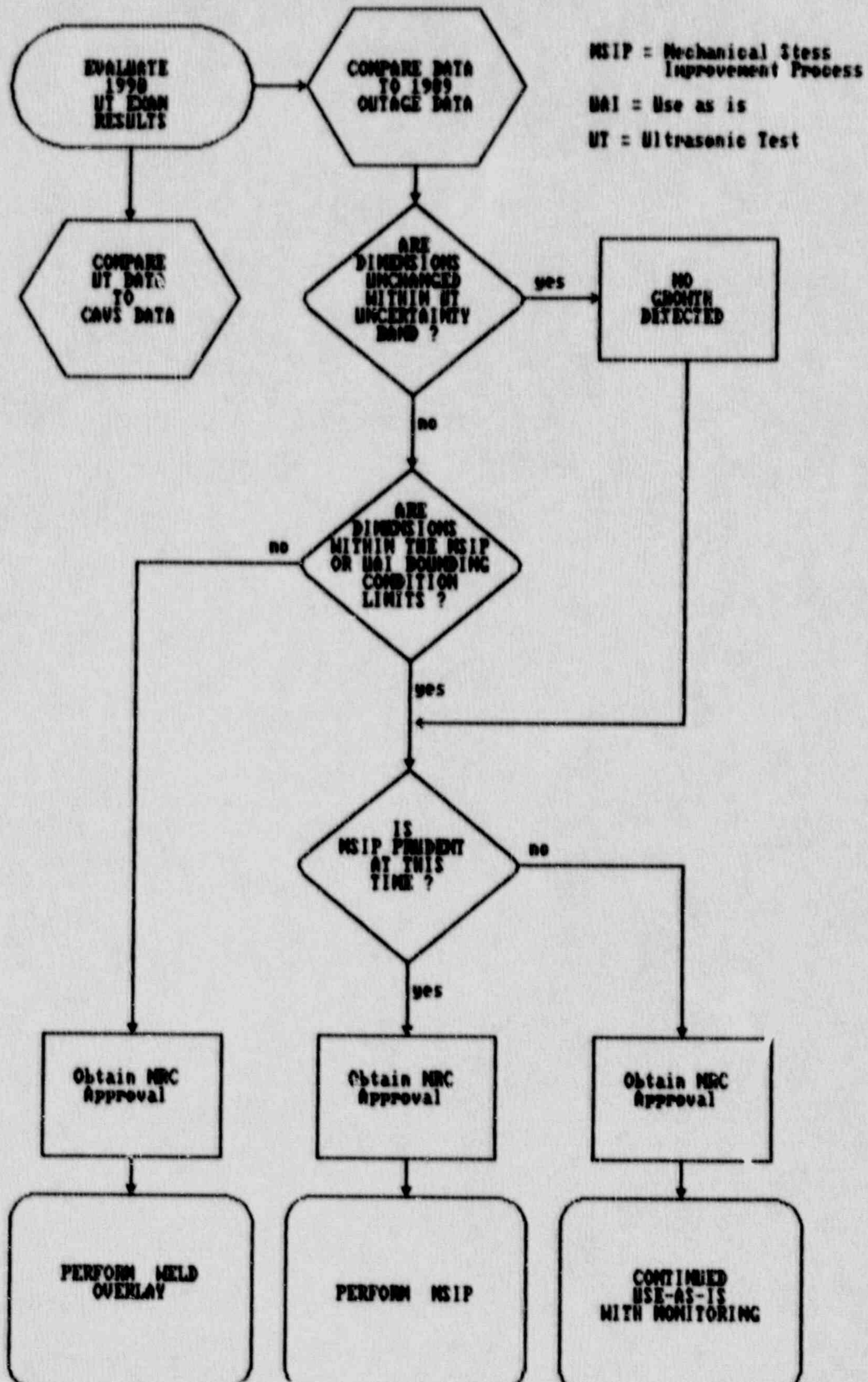


FIGURE 1