ENCLOSURE

50-438
50-439

BELLEFONTE NUCLEAR PLANT UNITS 1 AND 2
WELDING IN WASTE DISPOSAL SYSTEM
NCR'S 1001, 1053, AND 1054
10 CFR 50.55(e)
REVISED FINAL REPORT

Description of Deficiency

Butt welding of the ASME III-3 stainless steel piping in the waste disposal system was performed with insufficient internal argon gas purge in violation of detailed weld procedure GT88-0-1. The insufficient purge resulted in a varying degree of oxidation on the inside or root side of the weld joint. This type of oxidation is commonly known as "sugaring" because its appearance is similar to burnt sugar.

This condition was identified when a steamfitter welder made Allegation A-004 to the site management that he had knowledge of nine stainless steel butt welds in the waste disposal system made without internal gas purge. This welder stated that the reason the welds were made without the gas purge was that at the time the welds were made there was not enough argon to supply all crews so only enough argon was used to satisfy inspection points.

The initial investigation into this allegation involved retrieving and reviewing some information type radiography examination records that were made on portions of the waste disposal system in 1977. This review indicated some evidence of sugaring. The NRC investigation team which was on site from April 25 to May 11, 1979, was appraised of this allegation and the results of the review of the radiography examination. The investigation team directed that five waste disposal system welds be cut out. These cutouts confirmed the presence of sugaring that was noted on the radiography examinations.

Following this initial investigation, approximately 150 welds in the waste disposal system were either radiographed or visually inspected using a boroscope. This investigation indicated that the sugaring problem is confined to welds performed between June and November 1977. Thirty-five welds made during this period show gross sugaring and twenty-two show lesser degrees, mainly a sugared tack weld condition.

To determine if the sugaring was confined to the waste disposal system or if the condition occurred in any other systems, welding performed during the period of June through November 1977 in the stainless steel piping of the eight additional safety-related systems listed below was also investigated.

1. Essential Raw Cooling Water System, unit 1

2. Essential Raw Cooling Water System, unit 2

3. Chemical Addition and Boron Recovery System, common

4. Chemical Addition and Boron Recovery System, unit 1

5. Reactor Building Spray System, unit 1

6. Decay Heat Removal System, unit 1

7. Spent Fuel Cooling and Cleanup System, unit 1

8. Spent Fuel Cooling and Cleanup System, unit 2

For all these systems except the Essential Raw Cooling Water System, unit 2, the investigation consisted of an inspection by information radiography and/or boroscopic inspection of 10 percent of the welds made during the period of interest. For the Essential Raw Cooling Water System, unit 2, all 11 welds made during the period of interest are embedded in concrete and are inaccessible for inspection. However, two welds made before the period of interest were examined by boroscope.

The results of this investigation indicated additional sugaring in the Spent Fuel Cooling and Cleanup System, unit 1 and unit 2. The other systems investigated showed no signs of sugaring.

For the Spent Fuel Cooling and Cleanup System, unit 1, 86 butt welds were made in the period from June through November 1977 in Class III-3 piping ranging in size from 1 to 12 inches in diameter. Of the nine welds inspected, four exhibited gross sugaring, four exhibited lesser degrees of sugaring, and one was acceptable. The remainder of the welds in this system made during the period of interest are embedded in concrete and are inaccessible for inspection.

For the Spent Fuel Cooling and Cleanup System, unit 2, 93 butt welds were made in the period from June through November 1977 in Class III-3 piping ranging in size from 1 to 12 inches. Of the nine welds initially inspected, five exhibited gross sugaring and four were acceptable. The remaining welds in this system are embedded in concrete and all but four are inaccessible for inspection. The four accessible welds were also inspected and one exhibited sugaring.

<u>Safety Implication Statement</u>

The waste disposal system piping involved is small diameter (2 to 3-inch) piping, and though it is classified ASME III-3, it serves no safety-related function. The waste disposal system is a low pressure system and the probability of a failure in this piping system is low even considering the improper welding. Should a failure of the waste disposal system piping occur, the released radioactive water would be collected in the Auxiliary Building sump and any gaseous releases would be processed by the charcoal adsorbers and HEPA filters in the ventilation system before release to the environment.

The Spent Fuel Cooling and Cleanup System, unit 1 and unit 2, piping involved ranges from 1 to 12 inches in diameter. A failure of this piping would release radioactive water which would be collected in the Auxiliary Building sump. Any gaseous releases from the sump would be processed by the charcoal adsorbers and HEPA filters in the ventilation system before release to the environment.

A failure of unembedded welds on the Spent Fuel Cooling and Cleanup System, unit 1 or unit 2, piping could not drain the respective spent fuel pool level lower than 16 feet, 6 inches above the top of the stored spent fuel elements. Such a failure could interrupt normal spent fuel cooling in the affected spent fuel pool. However, the spent fuel can be adequately cooled by boiling of the water in the spent fuel pool. Though this is not a design basis mode of spent fuel cooling, the spent fuel pool is capable of withstanding the elevated temperature. Makeup to the spent fuel pool to replace water inventory boiled off would be provided by a fire hose connected to a permanently installed connection to the Essential Raw Cooling Water System. The ventilation system including the charcoal adsorbers and HEPA filters is not capable of performing its design functions in the high humidity conditions caused by boiling of the spent fuel pool. A conservative analysis has shown that in the event of pool boiling, releases at the site boundary are approximately 11 percent of 10 CFR part 100 allowables. Thus, the spent fuel would remain adequately cooled and any radioactive releases would be within limits.

Therefore, a failure of the waste disposal system piping or the Spent Fuel Cooling and Cleanup System, unit 1 or unit 2, piping would not adversely affect the safe operation of the plant or result in an unacceptable release of radiation to the environment.

Corrective Action

Approximately 85 welds were made on the waste disposal system in the period June to November 1977 of which 57 were questionable. All questionable waste disposal system welds made during this period will be cut out and rewelded.

The 13 accessible welds in the Spent Fuel Cooling and Cleanup System, unit 1 and unit 2, piping which exhibited evidence of sugaring will be cut out and rewelded.

The 161 welds in the Spent Fuel Cooling and Cleanup System, unit 1 and unit 2, piping which are embedded in concrete and, therefore, are inaccessible will be used "as is." This determination is based on the following reasons.

1. The Spent Fuel Cooling and Cleanup System piping was designed, constructed, and tested according to ASME Boiler and Pressure Vessel Code, Section III.

2. The piping to be used "as is" is embedded in the concrete building structure. It is continually supported and moves as a single structure. Since the flexure or bending deformation of concrete is insignificant, the embedded pipe cannot experience deflection or bending stress unless the concrete flexes or bends.

As the pipe is heated by fluid flow, tension will be developed in the adjacent colder concrete and compression will be developed in the hot pipe wall. Internal pressure in the pipe will be restrained by the pipe and adjacent concrete. Also, dead load, seismic, or pressure stress experienced by embedded pipe is limited to negligible values by the encasing concrete.

3. Conservative calculations were used to demonstrate that the embedded welds were acceptable "as is." The minimum wall thicknesses required to maintain the pressure boundary were calculated according to ASME Section III, Subection ND-3641.1, Equation 3. The maximum depth of affected weld metal was determined by reviewing the radiographs of 39 "sugared" welds removed from the exposed piping affected by this nonconformance. Five of these specimens were polished, etched, and the maximum depth of unacceptable root condition was determined to be 0.062 inch. A copy of the laboratory report which provides specific details on determining this maximum defect is being transmitted under separate cover. However, for conservatism, the calculations assumed a defect depth of 0.10 inch. This allows for the possibility that the worst defect depth was not found by examination of the accessible welds. The 0.10-inch depth is conservative because the average GTA weld root thickness, exclusive of internal reinforcement, as measured on the photomacrographs in the laboratory report, does not exceed 0.08 inch. Accounting for 0.10-inch maximum weld defect, the actual net wall thickness for both piping and fittings is greater than necessary minimum wall thickness by at least 0.07 inch. Table 1 provides a summary of calculation results for various size pipings and fittings.

4. Once the Spent Fuel Cooling and Cleanup System is placed into operation, the piping will withstand what is effectively a constant temperature. Therefore, thermal cycling effects are considered negligible.

5. Before being embedded, the piping was hydrostatically tested to 1.5 times the design pressure.

The corrective action will be complete by October 31, 1980.

In November 1977, a quality assurance training program was initiated to promote awareness in craft employees, including welders, of the quality and procedural requirements for nuclear plant construction. All certified welders and foremen onsite at that time participated in this program and have participated in and will continue to participate in annual retraining programs.

TABLE 1

PIPE SUMMARY

Pipe Size	t_m Required	t_{min} Available	Weld Defect	t* Excess	Times** t_m Required
2-1/2"	0.0025	0.1774	0.1	0.0774	31
3"	0.0031	0.1889	0.1	0.0889	28
4"	0.0314	0.2074	0.1	0.1074	3.4
6"	0.0058	0.2449	0.1	0.1449	25
8"	0.0076	0.2814	0.1	0.1814	24
12"	0.0224	0.3279	0.1	0.2279	10

FITTINGS SUMMARY

2-1/2"	0.0025	0.1774	0.1	0.0774	31
3"	0.0031	0.1733	0.1	0.0733	23
4"	0.0341	0.1918	0.1	0.0918	2.9
6"	0.0058	0.2293	0.1	0.1293	22
8"	0.0076	0.2658	0.1	0.1658	22
12"	0.0224	0.2810	0.1	0.1810	8

*t_{excess} = weld defect − $t_{min\ available}$

**Times t_m required = $\frac{t_{excess}}{t_m \text{ required}}$