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October 30, 1984

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Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

Re: Catawba Nuclear Station
Unit 1
Docket No. 50-413
SD 413/84-01

Dear Mr. O'Reilly:

Please find attached a final report on the subject deficiency concerning ND System socket weld failures on Catawba Unit 1.

Very truly yours,

H.B. Tucker /HBT

Hal B. Tucker

LTP/mjf

Attachment

cc: Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

NRC Resident Inspector
Catawba Nuclear Station

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FINAL REPORT

CATAWBA NUCLEAR STATION

REPORT NUMBER: SD 413/84-01

REPORT DATE: October 26, 1984

FACILITY: Catawba Nuclear Station - Unit #1

IDENTIFICATION OF DEFICIENCY:

During the cool-down stage of the hot functional test, Nuclear Production Department detected an increase in the coolant makeup requirements. A search was made, and a leaking socket weld was found in the Residual Heat Removal System (ND) in the Auxiliary Building. The leaking line was the 2" crossover between the two main 8" ND headers. The 2" line provides water to the chemical and volume control system for cleanup during shutdown periods. This specific deficiency was identified on 1/3/84.

REPORTS:

On January 13, 1984, G. Nejfelt, NRC Region II, Atlanta, Georgia, was initially notified of the subject deficiency by W. O. Henry, L. M. Coggins, J. K. Berry, and R. L. Williams of Duke Power Company, Charlotte, North Carolina, 28242. Subsequently, Duke forwarded an Interim Report to NRC dated April 20, 1984. This 10/26/84 report represents Duke's third and final report documenting findings and resolution to the deficiency.

DESCRIPTION OF DEFICIENCY:

Duke's investigation found that a 2" socket weld (IND66-35) had developed a crack in the weld metal extending approximately 300° around the circumference of the weld. This weld is a socket weld joining 2" pipe to a socket weld half coupling which connects the 2" line to the 8" ND header. As part of investigating this problem in the "A" Train, a similar problem was found in the "B" Train. In the latter case, another 2" socket (IND66-6) had developed a crack. This weld joined 2" pipe to a socket weld valve. This crack extended approximately 70° around the circumference of the pipe and was at the juncture of the weld metal and pipe base material.

Similar deficiencies have occurred on 3 occasions at McGuire Nuclear Station (MNS). The deficiencies and other specific details of the MNS and CNS piping failures are listed on Table 1 and deficiency locations are illustrated schematically on Figure 1. Schematically, the affected portions of ND Systems in both units at CNS and MNS are the same; however, actual piping layout varies, as do support locations and other physical arrangement details.

As illustrated on Figure 1, all of the failures have occurred in the cross-over line between the 8" lines, at socket welds. Except for the 1" vent line break at MNS, all failures were in 2" lines. Piping layouts and specific location of the failed welds are different for all 5 cases at the two stations.

EVALUATION OF DEFICIENCY:

The two CNS socket welds were removed and a metallurgical evaluation performed. The evaluation consisted of metallography and fractography using a scanning electron microscope. Similar examinations were performed on the McGuire failed welds.

Metallurgical failure analysis concluded that the failure mode for both CNS welds was fatigue. The "A" Train weld crack initiated at the root of the weld as opposed to the "classic" fatigue crack location at the toe of the weld for the "B" Train. This was attributed to an internal stress riser caused by the combination of a tight fitting tack weld and adjacent incomplete penetration of the fillet weld root pass. No striations on the fracture face were visible, making a confirmed conclusion about the fatigue cycles impossible. However, the nature of the fracture face and the operating history of the system suggested high stress, low cycle fatigue. This was determined by the failure analysis and vibration testing performed on the MNS Unit 2 failure in late August, 1984.

Each of the two CNS lines in question contain a motor operated valve. There are spring supports on the motor operators to support the weight of the valves; and on the "A" Train motor operator, there is a restraint to control seismic vibration. The supports on both valves had been disconnected for valve maintenance and were not reconnected for HFT. Stress Analysis reviewed the system with and without the supports.

Conclusions of Duke's evaluations for CNS are as follows:

1. System piping is adequately supported for all normal design loads, i.e, piping stress allowables were not exceeded with the spring supports removed from the 2 valve operators. (Spring supports are not utilized for seismic and other dynamic type loadings).

2. The socket welds met code requirements. Four of the five weld failures initiated at the ID and were aggravated by some incomplete penetration which would not have been a problem in the absence of severe vibration.

3. Cause of the weld failures was low cycle fatigue induced by vibration within the system. This condition may have been aggravated by the absence of the valve supports mentioned above. The same mechanism appears to have contributed to the MNS weld failures, aggravated by construction damage in the 1" line failure on 6/2/80 and by water hammer in the 2" line break on 8/5/84.

4. Due to insight derived from the 8/84 MNS deficiency and subsequent associated MNS and CNS testing, root cause for both the MNS and CNS deficiencies has been determined. The low cycle fatigue vibration definitely occurs from reverse flow through the 2" crossover Kerotest valves (refer to Figure #1). Testing of the CN initial pressurization transient on 10/10/84 conclusively demonstrated this root cause.

ANALYSIS OF SAFETY IMPLICATIONS:

The pipe breaks at CNS took place prior to operation of the station; therefore, no safety consequences have occurred. Had the leaks occurred during station operation, any potential contamination would have been contained in the Auxiliary Building. The safety function of the Residual Heat Removal System would have been adversely affected only if similar leaks developed concurrently in both trains during operation.

From an environmental consideration, fluid temperature of the subject 2" ND line at both MNS and CNS was less than 212°F at the time of the pipe failures. Consequently, the current environmental qualification temperature for this area of the Auxiliary Building, 212°F, was not exceeded during the pipe failure events. In addition, any equipment potentially receiving water spray from these events has been qualified for an environment in excess of that experienced during these events.

As MNS is an operating station, LER 370-84-17 should be referenced for further detail relative to safety implications.

CORRECTIVE ACTION:

Based on the information derived from the 8/84 MNS pipe break and vibration monitoring conducted to determine the source of low cycle fatigue, corrective action proposed in Duke's 4/20/84 Interim Report is no longer fully applicable. Vibration testing conducted during mid October, 1984 at CNS as a confirmatory measure supported root cause of the deficiencies defined for both MNS and CNS.

Environmentally, based on analysis of safety implications, no potentially affected equipment requires any corrective action as qualification requirements were not exceeded.

Preventative corrective actions have already been implemented at CNS, based on the combined MNS and CNS analysis of the problem including vibration monitoring results. Since the root cause of the deficiencies has been determined, operating/test procedures have been revised to preclude operations that would reverse flow through the Kerotest crossover valves. In addition, crossover isolation valves for Unit 1 and Unit 2 will be changed out with a valve design suitable for reverse flow such that any proposed future operational/test modes which could produce reverse flow will not produce unacceptable vibration.

Since the extent of vibration at both McGuire and Catawba and the remaining life in other unfailed weld joints is not known, the following corrective actions have been implemented as defined below.

Failure Number	Plant & Unit	Pipe Size	Corrective Action
1	McGuire U-1 Thru wall crack	1"	Section of pipe cut out and both welds between branch fitting and vent valve have been replaced.
2	McGuire U-1 Thru wall crack	2"	Cracked weld cut out and replaced. All other welds between branch fitting on each 8" header and 2" isolation valves have been repaired temporarily by weld overlay buildup
3 & 4	Catawba U-1 Thru wall crack	2"	All welds between branch fitting on each 8" header and 2" isolation valves have been replaced.
5	McGuire U-2 Pipe break	2"	All welds between branch fitting on each 8" header and 2" isolation valves have been replaced.

All cracked or suspect welds which cannot be isolated from the 8" headers have been either replaced or strengthened with a weld overlay. Please refer to LER 370-84-17 for a full description of corrective actions taken with regard to McGuire Nuclear Station.

Some welds downstream of the 2" isolation valves have also been subjected to some degree of vibration; thus, they may have experienced some damage. Since these welds can be isolated from the system without imparement of system function, any leaks would be a maintenance problem rather than a safety concern. To date, there has been no evidence of leakage in any of these welds. Six of the downstream welds were cut out on McGuire Unit #2, sectioned and examined with no evidence of cracking found; thus no problems are anticipated at CNS. A study has been initiated to establish a boundary for potentially affected piping and downstream welds. By the first scheduled refueling outage for CNS the scope of this piping and proposed corrective action will be formulated and any required repairs will be initiated. This action is considered appropriate in that if any cracks have been initiated, they should not propagate through the wall due to the material being ductile stainless steel and because the driving force, vibration has been eliminated.

SUMMARY OF MNS AND CNS ND SYSTEM PIPE FAILURES

The following is a tabulation of the failures in the ND System. Failure locations are illustrated on Figure 1.

Failure Number	Plant & Unit	Pipe Size	NCI Number & Date	Reported to NRC	When Found	Basis for Failure
1)	McGuire U-1 Thru wall crack	1"	11,172 6/2/80	No (See Note 1)	After HFT	High stress and low cycle fatigue. High stresses produced by bending (construction damage) and fatigue resulted from vibration during hot functional testing
2)	McGuire U-1 Thru wall crack	2"	11,211 6/8/80	No (See Note 1)	After HFT	Low cycle fatigue. Fatigue resulted from vibration during hot functional testing
3)	Catawba U-1 Thru wall crack	2"	17,741 1/3/84	Yes 1/13/84 (290.1 CA-84-1)	After HFT	Low cycle fatigue. Fatigue resulted from vibration
4)	Catawba U-1 Thru wall crack	2"	17,807 1/16/84	Yes 1/13/84 (290.1 CA-84-1)	After HFT	Low cycle fatigue. Fatigue resulted from vibration
5)	McGuire U-2 Pipe Break	2"	No NCI Broke 8/5/84	Courtesy Call by NPD 8/6/84	During Startup	Low cycle fatigue and water hammer. Crack was formed and propogated by vibration. Failure occurred during operation as a result of water hammer

Notes: 1) The two 1980 MNS socket weld cracks were the first observed for either of the two Nuclear Stations. Design Analysis, metallurgical examinations and physical examination of the station all concluded the deficiencies were isolated cases probably attributable to erection events. Based on the MNS-2 pipe break and CNS-1 failures it is now concluded these failures occurred due to reasons stated above.

TABLE 1

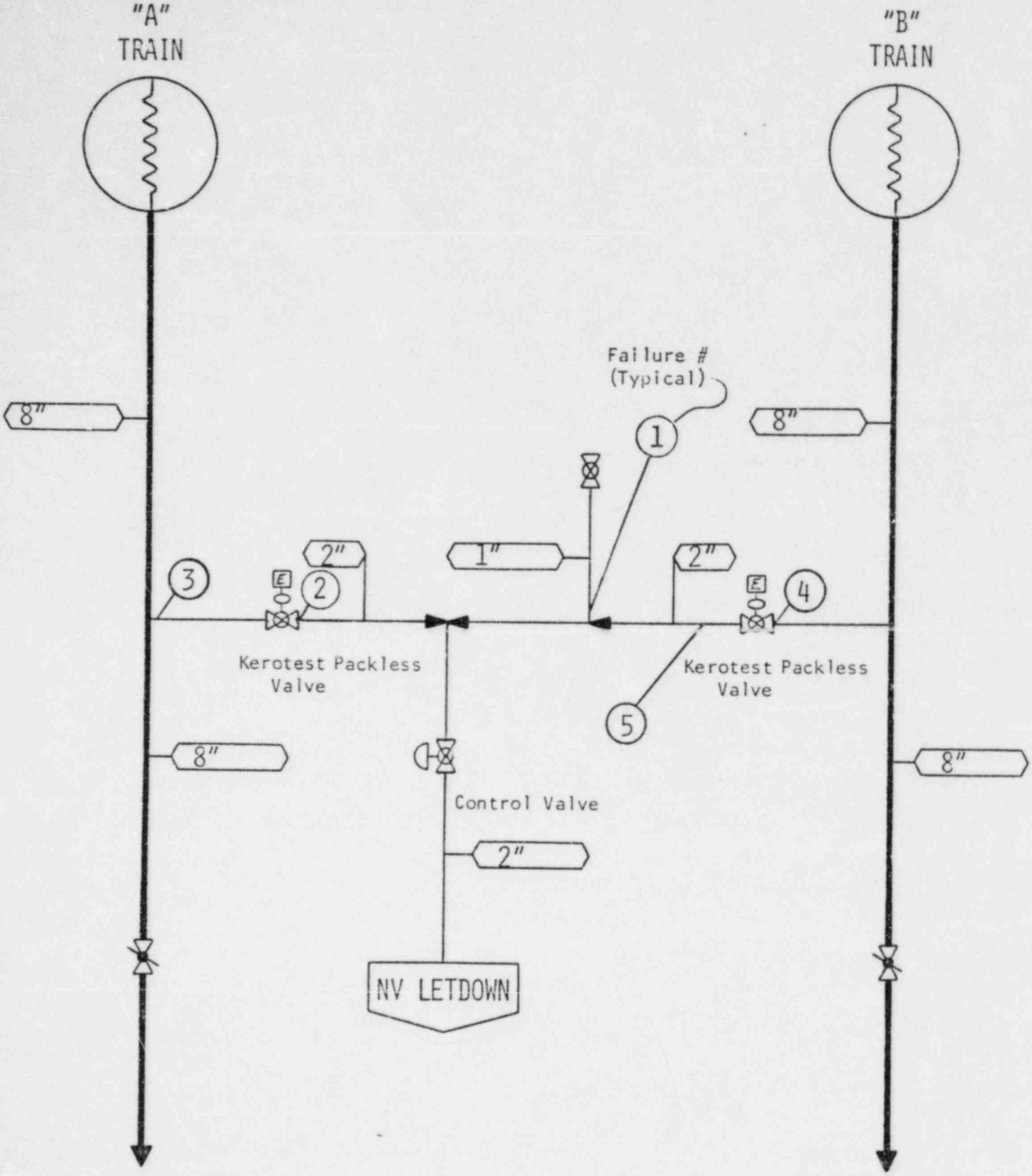

FIGURE 1
PARTIAL SCHEMATIC OF
MNS & CNS ND SYSTEM