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MEMORANDUM FOR: E. L. Jordan, Deputy Director, Division of Resident and Regional Reactor Inspection, IE

THRU: R. W. Woodruff, Acting Section Chief, Mechanical, Structural and Metallurgical Section, REB, RRRI, IE

FROM: W. J. Collins, Sr. Metallurgical Engineer, Mechanical, Structural & Metallurgical Section, REB, RRRI, IE

SUBJECT: RESULTS OF IE BULLETIN 79-17 REVISION 1

During the period of November 1974 to February 1979 a number of stress corrosion cracking (SCC) incidents have been identified in austenitic stainless steel piping material of secondary PWR systems not part of the primary reactor coolant system. Service experience indicates the cracking resulted in small leaks which were found during routine plant inspection and were observed to have occurred with no significant fluid loss or ability of system to maintain function. The systems affected include the safety injection, residual heat removal, containment spray and spent fuel cooling systems, as well as various cross-connect lines between systems and line connections to the boron injection and refueling water storage tanks. These systems essentially contain borated water which is subject to relatively stagnant or low flow conditions for extended periods of time during normal plant operations. However, many of these systems are part of the engineered safeguards matrix and, while having no normal operating function, must be maintained ready for actuation during normal power operations. The domestic PWR plants that have experience cracking to date are listed in Table 1 along with the systems and pipe sizes involved (enclosed).

Metallurgical investigations by the licensees and NRC have shown the SCC occurred from the piping I.D. surface, and in most instances, initiated in the weld sensitized heat affected zones at circumferential butt welds and propagated through this zone in a preferential manner so as to cause the small leaks observed. Chemical analysis also disclosed the piping material carbon content to be in the high range (0.05 - 0.08C) of material specification limits (0.08C max.) for the majority of cases examined. Although no definitive corrosion species were found by the analysis, various traces of CL^- and/or widely dispersed sulfur traces were identified with the oxidation products associated with the failures. Laboratory studies on SCC mechanisms have indicated that O_2 CL^- and Sulfides when coupled with residual stresses, as may occur in welding and/or fabrication, can cause SCC of sensitized (grain boundary carbide formation) stainless steels at relatively low temperature.

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In view of these incidents IE Bulletin 79-17 (Rev. 1) was issued in October 1979 to all operating PWR plants to determine, by nondestructive inspections on a sampling basis, if a generic problem might exist in conjunction with secondary water chemistry programs being exercised. The results are summarized below.

A review of the licensees' responses indicate that the inspections required by IEB 79-17 (Rev. 1) items 2(a), 2(b) and 2(c) have been satisfactorily completed with favorable results being reported. Except for the cracking found at San Onofre Unit 1 and ANO-1, which appears to be of a localized nature, no further evidence of a SCC problem was reportedly observed in the PWR plants beyond those previously identified in Table 1.

At ANO-1, the licensee reported discovery of cracking recurrence in three (3) containment spray system welds in January 1980. Subsequently, all spray system welds and at least 25% of the welds in normally accessible noninsulated piping within the scope of IEB 79-17 were inspected. A total of 189 welds were reportedly examined during these supplement inspections with no indication of a generic SCC problem.

At San Onofre Unit 1, cracking was found in the heat affected zones of two welds in the refueling water pump suction line, in early September 1979 (Ref. Table 1). Results of an extensive metallurgical analysis showed that the cracking was due to stress corrosion cracking which originated from the Outside Diameter of the pipe and was attributed to the chloride-bearing environment. Subsequently, a total of 687 welds were examined by ultrasonic methods and, additionally, 336 welds were liquid penetrant examined. These welds were located in system lines 2-1/2" and larger in diameter outside containment. No further indication of cracking to suggest a generic SCC problem was found by these examinations.

The inservice secondary water chemistry surveillance reported by the licensees indicate that the chemical parameters, such as B, CO^{-}, F^{-}, O_2, pH and conductivity, are monitored on a system-by-system basis. The chemistry of the contained fluid is periodically sampled on a daily, weekly or monthly basis depending on system function to assure that specific acceptance limits on element concentrations established by the NSSS and technical specifications for operation is maintained. In addition, the required ISI pump testing does serve to provide flushing and recirculation through portions of these systems at system pressure on a regular basis.

Based on the results of the Bulletin, the SCC experience in several operating PWR plants to date does not appear to be generically widespread. Despite this reassuring fact, a sufficient number of instances have occurred to emphasize the need for (1) continued control of secondary water chemistry with respect to trace impurities, particularly caustics, halogens and sulfide contaminants of system fluids to minimize the potential for additional incidents in conjunction with (2) development of specific inservice inspection criteria to ensure that further cracking, should it occur, doe not go undetected. In

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recognition of the latter need, the main ASME Code Committee on Section XI ISI rules has assigned a working group to develop ISI requirements for both BWR and PWR Class 2 piping systems including ECCS, RHR and CHRS, consistent with current 10 CFR 50.55(a) provisions. A final draft of the working group's proposed ISI rules is expected to be presented to the respective code committees for Section XI rules consideration later this year. In view of the above measures being taken, no further action with respect to subject bulletin appears warranted and it is proposed it be closed out.

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Enclosure: Table 1

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TABLE 1

REPORTED PIPE CRACKING INCIDENTS AT PWR PLANTS

FACILITY	SYSTEM	PIPE SIZE
Haddam Neck	Boric Acid Pump Suction Line	4-in. Sch. 10
Arkansas Nuclear One Unit 1	Reactor Building Spray (Containment)	8-in. and 10-in. Sch. 10
	Decay Heat Removal	10-in. Sch. 10
	Spent Fuel Pool Cooling	3-in. to 2-in. Reducer
Crystal River 3	Containment Spray	8-in. Sch. 40
Ginna	Safety Injection	8-in. Sch. 10
H. B. Robinson 2	Boron Injection	4-in. Sch. 40
San Onofre 1	Containment Spray	6-in. Sch. 10
	Refueling Water Pump Suction	8-in. Sch. 10
Surry Unit 1	Containment Spray	10-in. Sch. 40
Surry Unit 2	Containment Spray	10-in. Sch. 40
Three Mile Island-1	Spent Fuel Cooling	8-in. Sch. 40
	Borater Water Storage Tank to Residual Heat Removal Suction	10-in. Sch. 40