UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUESTS FOR APPROVAL OF TEMPORARY REPAIR

OF FLAWS IN ASME CODE CLASS 2

EMERGENCY CORE COOLING SYSTEM PIPING FOR

ST. LUCIE NUCLEAR POWER PLANT, UNIT 2

1.0 INTRODUCTION

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Section 55a(g) requires nuclear power facility piping and components to meet the applicable requirements of Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (hereafter referred to as the Code). Section XI of the Code specifies Code-acceptable repair methods for flaws that exceed Code acceptance limits in piping that is inservice. A Code repair is required to restore the structural integrity of flawed Code piping, independent of the operational mode of the plant when the flaw is detected. Those repairs not in compliance with Section XI of the Code are non-Code repairs. However, the implementation of required Code (weld) repairs to ASME Code Class 1, 2 or 3 systems is often impractical for nuclear licensees since the repairs normally require an isolation of the system requiring the repair, and often a shutdown of the nuclear power plant.

Alternatives to Code requirements may be used by nuclear licensees when authorized by the U.S. Nuclear Regulatory Commission (NRC) if the proposed alternatives to the requirements are such that they are shown to provide an acceptable level of quality and safety in lieu of the Code requirements [10 CFR 50.55a(a)(3)(i)], or if compliance with the Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety [10 CFR 50.55a(a)(3)(ii)].

A licensee may also submit requests for relief from certain Code requirements when a licensee has determined that conformance with certain Code requirements is impractical for its facility [10 CFR 50.55a(g)(5)(iii)]. Pursuant to 10 CFR 50.55a(g)(6)(i), the Commission will evaluate determinations of impracticality and may grant relief and may impose alternative requirements as it determines is authorized by law.

Generic Letter (GL) 90-05, entitled "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2 and 3 Piping," dated June 15, 1990, provides guidance for performing temporary non-code repairs of ASME Class 1, 2, and 3 piping.

2.0 BACKGROUND

During routine monthly inspections, staff members of Florida Power and Light Company (FPL, the licensee) discovered degradation on the Emergency Core Cooling System (ECCS) piping. The degraded piping is located in the ECCS pumps' suction piping from the refueling water tank (RWT). The pipe degradation was documented in the licensee's condition report (CR) 99-0445, dated April 6, 1999. Specifically, CR 99-0445 identifies the existence of through-wall leaks on both Units' ECCS piping trains located within the RWT pipe trench. The identified leak rates were very small and they were discovered by observing the presence of small boric acid crystals on the outside surfaces of the pipe. A review of the plant drawings identified that the through wall leaks were located on Lines I-24"-CS-3 (Train A) and I-24"-CS-2 (Train B). The two lines are connected to a single nozzle on the RWT and provide suction to the ECCS pumps. The piping design pressure is 60 psig at 300°F, with a maximum normal operating pressure of 30 psig at 120°F. The pipe size is 24 inch schedule 10, with a wall thickness of 0.250 inches. The pipe material was identified as ASTM A-352, Class 1, Type 304 stainless steel. The piping was designed in accordance with the ASME Code, Section III, Class 2 requirements.

Since through-wall leakage was identified, an operability determination was required. GL 91-18, "Information to the Licensees Regarding NRC Inspection Manual Section on Resolution of Degraded and Nonconforming Conditions," contains guidance for operability determinations and resolution of degraded and nonconforming conditions. Following that guidance, the licensee determined that the ECCS suction piping had to be declared inoperable and because of that, Technical Specification 3.5.2 required that the unit be shut down.

The same day, April 6, 1999, in a telephone conference with the NRC staff, the licensee made a verbal request to use the provisions of GL 90-05 to evaluate the through wall flaws and the operability of the degraded piping using the guidance provided in GL 90-05 for Class 3 components. The request was based on the facts that: (1) the leaks were extremely small, (2) the pipe was 304 stainless steel which is very tough and corrosion resistant, and (3) the licensee had performed an engineering evaluation per the rules specified in IWB-3640 and Appendix C of ASME Code, Section XI, and the results indicated that the flaws were acceptable for a service up to 5.4 years and thus the structural integrity of the "as is" piping was adequate for all design loads and conditions. In addition, the piping is moderate energy. The licensee also committed to complete a permanent Code repair on the affected piping by April 21, 1999 (two weeks after flaw discovery). The NRC staff granted a verbal approval to evaluate the degraded piping in accordance with the provisions of GL 90-05 for Class 3 components.

In a letter dated April 7, 1999, the licensee submitted, pursuant to 10 CFR 50.55a(g)(5)(iii), a request for relief from the repair and/or replacement requirements of the ASME Code, Section XI, Articles IWA/IWC-4000 and IWA/IWC-7000. The relief request documented the conditions as committed to during the April 6, 1999, telephone conference with the NRC staff. The St. Lucie Unit 2 plant is currently in the second 10-year inservice inspection interval and the code of record for inservice inspection for the interval is ASME Code, Section XI 1989.

3.0 LICENSEE'S RELIEF REQUEST

Components for Which Relief is Requested:

ASME Section III, Class 2 ECCS Suction Piping at FPL St. Lucie Plant, Unit 2.

Code Requirement:

ASME Section XI, 1989 Edition with no Addenda, paragraph IWC-3132 requires that components whose examination reveals relevant conditions described in the standards of Table IWC-3410-1, shall be unacceptable for continued service unless such components meet the requirements of IWC-3132.1, IWC-3132.2, IWC-3132.3 or IWC-3132.4.

Relief Requested: (as stated)

"Pursuant to 10 CFR 50.55a (g)(5)(iii), FPL requests interim relief from the repair and/or replacement requirements of the ASME Boiler and Pressure Vessel Code, Section XI, 1989 Edition, Article IWA/IWC-4000 and IWA/IWC-7000. This would authorize the facility to operate with through-wall leaks in ASME Class 2 piping until a Code repair and/or replacement can be accomplished. FPL proposes to complete the Code repairs by April 21,1999."

Basis for Relief: (as stated)

"FPL has determined, based upon results of current observation and evaluation of the ECCS suction piping, that compliance with the repair and/or replacement requirements of ASME Section XI, within the time frame allowed by plant Technical Specifications, would be impractical, and would create a undue hardship on FPL, without a compensating increase in quality or safety. As discussed with the NRC on April 6,1999, FPL applied the guidance in NRC GL 91-18, NRC GL 90-05, and ASME Code Case N-513 to evaluate the functionality of the moderate energy ASME Class 2 ECCS piping.

The alternative actions discussed below will assure a continued level of quality and safety of the unit until a code repair/replacement can be made."

Alternative Actions: (as stated in part)

"In lieu of an immediate ASME Section XI Code repair and/or replacement, FPL proposes to apply NRC GL 91-18, NRC GL 90-05, and ASME Code Case N-513 for moderate energy Class 3 piping to the operability assessment of the ASME Class 2 ECCS suction piping. The ECCS piping has a maximum operating pressure of 30 psig and a maximum operating temperature of 120°F and therefore falls under the definition of moderate energy piping."

4.0 STAFF EVALUATION

The licensee determined that through wall leaks exist in the ECCS "A" train suction line I-24"-CS-3 and in train "B" suction line I-24"-CS-2 within the RWT pipe trench. As a result of these determinations, the licensee issued CR 99-0445 to document these pipe deficiencies.

CR 99-0445 identifies that the leak rates are extremely small and not quantifiable. The leaks were identified by discovering the presence of a small mound of boric acid crystals on the pipe and as such operational leakage is not an issue.

Because the licensee had previously identified pipe degradation involving the Unit 1 ECCS piping, the licensee initiated a review in November 1998 to evaluate the condition of the Unit 2 ECCS suction lines from the RWT. The evaluation developed the system piping design requirements, summarized past identification of indications and examination results, and identified the failure mechanism as chloride induced stress corrosion cracking (SCC). The evaluation developed a method for accepting the identified flaws for limited continued operation based on the rules of Section XI of the Code. As part of this evaluation, APTECH analysis AES-C-3566, Revision 0 was prepared to determine the allowable through-wall flaw lengths and expected service life of ECCS supply piping that is subject to corrosion on the outside surface. The allowable flaw length is based on the acceptance criteria of ASME Section XI, IWB-3640 for all design loading conditions. The evaluation concluded that the allowable flaw length for postulated through-wall cracks is 27.8 inches for circumferential flaws and 13.6 inches for axial flaws. To provide for flaw detection the licensee was conducting monthly inspections of the subject piping to look for through wall leakage. It was under this inspection surveillance that the boric acid crystals were identified on both I-24"-CS-2 and I-24"-CS-3 piping.

On April 6, 1999, the licensee performed ultrasonic examination of the flawed area on ECCS suction header CS-3 "A". The ultrasonic testing (UT) examination utilized Electric Power Research Institute developed Performance Demonstration Initiative qualified techniques designed for length and depth sizing of flaws. The area was also examined by the liquid penetrant (LP) examination method. The LP examination results revealed that the length of flaw identified with the LP examination was comparable with the length obtained with the UT examination. Based upon the results obtained by the LP and UT examinations, the licensee determined that the maximum flaw length at the inside diameter of ECCS suction header CS-3 "A" was 2 inches. Repairs of the flawed area on ECCS suction header "A" were completed on April 10, 1999.

The flawed area on ECCS suction piping CS-2 "B" was examined utilizing LP examination method. The LP was used to do the examination on the lower east lug fillet weld and upper north west lug fillet weld for support 2407-17. The LP examination did not identify any flaw indication within the examined area. The lug was removed and three flaws were identified underneath the lug. The maximum through wall indication length on train "B" was determined to be 2.75 inches. Repairs of the flawed area on ECCS suction header "B" were completed on April 16, 1999.

The licensee performed metallurgical examination on a sample removed from Unit 2 line I-24"-CS-2 in order to determine the cause for the identified ECCS pipe degradation. The examination photomicrographs revealed that the mechanism is typical of chloride induced outside diameter stress corrosion cracking. This mechanism is identical to the one identified in the root cause analysis associated with previously discovered ECCS pipe degradation in Unit 1. The identified root cause is attributed to the presence of chlorides that attach to the outside surface of the pipe. The licensee has initiated mandatory preventive maintenance activity to periodically pressure wash the piping once a month and will install a drip pocket underneath the manway with tygon

hose down to the floor. This will direct the water to the floor thereby minimizing the possibility of brackish water dripping directly onto the piping.

The NRC staff reviewed the calculations and documentation that was provided by the licensee in support for its request for interim relief from the repair and/or replacement requirements of ASME Code, Section XI. The staff finds that the licensee had adequately demonstrated that the structural integrity of the affected ECCS piping was not compromised during the period of operation from April 6, 1999, through April 16, 1999. This finding is based upon the licensee having adequately reviewed the problem by performing fracture mechanics calculations, metallurgical analysis, and nondestructive examinations on the degraded piping. However, the staff noted that the crack growth rate used by the licensee in its calculations to evaluate chloride induced stress corrosion cracking is a growth rate derived from data applicable for boiling-water reactor environments. Application of this rate to chloride induced SCC is not appropriate since it may not be conservative. Further, the establishment of initial crack size based on statistical analysis is not an appropriate method to evaluate an actual flaw. The initial flaw size should be defined as the maximum measured crack obtained from the degraded piping. In this case, the licensee determined that the maximum measured flaw length for train "A" was 2 inches and 2.75 inches for train "B." Although, there is no agreement on the use of an appropriate crack growth rate in this case, there is a sufficient margin between the actual measured crack sizes and the ASME Code limits to set aside concerns related to the affected piping for the short operating period that was considered. Therefore, the NRC staff finds that, in this case, the Code requirements resulted in a hardship or unusual difficulty without a compensating increase in the level of quality and safety, and that the licensee provided an acceptable alternative to the requirements of the ASME Code, Section XI, Articles IWA/IWC-4000 and IWA/IWC-7000. The licensee completed the Code required permanent repair by April 16, 1999, as they committed, and thus the integrity of the piping was restored as required by the ASME Code, Section XI.

5.0 STAFF CONCLUSION

The NRC staff evaluated the licensee's submittal and concluded that the licensee provided an acceptable alternative to the requirements of the ASME Code, Section XI. Furthermore, the staff finds that performing repair and/or replacement of the affected piping as required by the Code would result in hardship upon the licensee because the licensee would have to shut down the plant in order to perform Code required repairs. Shutting down the plant in order to perform the Code required repairs and/or replacement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. As an alternative, the licensee proposed to use the guidance of GL 90-05 provided for Class 3 components to evaluate the operability of Class 2 moderate energy piping in an 'as is' condition and perform permanent Code repair within 2 weeks of discovery of the through wall leaks. The staff finds this alternative acceptable. Further, the licensee has completed the Code required permanent repair by April 16, 1999, as committed, and thus the integrity of the piping was restored as required by the ASME Code, Section XI. The staff, therefore, concludes that compliance with the Code requirements resulted in a hardship or unusual difficulty without a compensating increase in the level of quality or safety during the period of April 6, 1999, through April 16, 1999. The staff further found that the proposed alternative provided a reasonable assurance of pressure boundary integrity. Pursuant to 10 CFR 50.55a(a)(3)(ii), the alternative is authorized.

Principal reviewer: George Georgiev, DE/EMCB
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cc:
Mr. T. F. Plunkett
President - Nuclear Division
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

Senior Resident Inspector
St. Lucie Plant
U.S. Nuclear Regulatory Commission
P.O. Box 6090
Jensen Beach, Florida 34957

Joe Myers, Director
Division of Emergency Preparedness
Department of Community Affairs
2740 Centerview Drive
Tallahassee, Florida 32399-2100

M. S. Ross, Attorney
Florida Power & Light Company
P.O. Box 14000
Juno Beach, FL 33408-0420

Mr. Douglas Anderson
County Administrator
St. Lucie County
2300 Virginia Avenue
Fort Pierce, Florida 34982

Mr. William A. Passetti, Chief
Department of Health
Bureau of Radiation Control
2020 Capital Circle, SE, Bin #C21
Tallahassee, Florida 32399-1741

J. A. Stall, Site Vice President
St. Lucie Nuclear Plant
6351 South Ocean Drive
Jensen Beach, Florida 34957

Mr. R. G. West
Plant General Manager
St. Lucie Nuclear Plant
6351 South Ocean Drive
Jensen Beach, Florida 34957

E. J. Weinkam
Licensing Manager
St. Lucie Nuclear Plant
6351 South Ocean Drive
Jensen Beach, Florida 34957

Mr. John Gianfrancesco
Manager, Administrative Support
and Special Projects
P.O. Box 14000
Juno Beach, FL 33408-0420

Mr. Rajiv S. Kundalkar
Vice President - Nuclear Engineering
Florida Power & Light Company
P.O. Box 14000
Juno Beach, FL 33408-0420

Mr. J. Kammel
Radiological Emergency
Planning Administrator
Department of Public Safety
6000 SE. Tower Drive
Stuart, Florida 34997