UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SERVICE WATER SYSTEM REPAIR

PUBLIC SERVICE ELECTRIC & GAS COMPANY

SALEM GENERATING STATION, UNIT NO. 2

DOCKET NO. 50-311

1.0 INTRODUCTION

In November, 1986, during the Salem Unit 2 third refueling outage, a leak was observed in the Service Water piping welds to the Containment Fan Coil Units. The degradation was identified as a pin hole leak due to pitting corrosion. Public Service Electric and Gas Company (the licensee) responded by a radiographic evaluation of all the welds (approximately 1200) in the piping. The pipe is 3-inches in diameter, schedule 40, Type 316 stainless steel. In a letter dated December 12, 1986, the licensee provided information to document the extent of degradation, their engineering analysis of the degraded piping, and the proposed method of repair.

The information was evaluated and a Safety Evaluation Report (SER) was provided by the Materials Engineering Section of the Engineering Branch, Division of PWR Licensing-A in a memorandum dated January 23, 1987. Although, the SER stated that the proposed repair procedure did not conform to the requirements of Section XI of the ASME Code, the staff concluded that weld overlay constituted an acceptable repair procedure, pursuant to criteria in 10 CFR 50.55a(a)(3). Weld overlay repair was considered acceptable for a period of sixteen months of plant operation, and, should similar degradation be observed, repair in accordance with the method evaluated may be performed. Further, justification for operation of the weld overlay, for periods in excess of sixteen months must be supported by the licensee and approved by the Commission.

Throughout the service life of a water-cooled nuclear power facility, 10 CFR 50.55a(g)(4) requires that components (including supports) which are classified as ASME Code Class 1, Class 2, and Class 3 meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in ASME Code Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(g)(5), if the licensee determines that certain Code examination requirements are impractical and requests relief from them, the licensee shall submit information and justifications to the Nuclear Regulatory Commission in support of that determination. Pursuant

to 10 CFR 50.55a(g)(6); the Commission will evaluate the determinations under 10 CFR 50.55a(g)(5). The Commission may grant relief and impose alternative requirements as it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest, giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility.

In a letter dated February 23, 1988, the licensee requested a service extension of six months in the current fuel cycle for the Service Water System (SWS) associated with Containment Fan Coil Units (CFCU) Nos. 21, 22, and 23, and of twenty-four months (an additional fuel cycle of eighteen months plus six months) for the SWS associated with CFCU Nos. 24 and 25. Justification for the extension was submitted in attachments to the February 23, 1988, letter. In addition, in a letter dated July 13, 1988, the licensee requested approval of the weld overlay procedure to repair a leak in the vent connection to the header supplying water to CFCU No. 25. Justification to use the repair method was provided in an attachment to the July 13, 1988, letter. As a result of questions from the staff, further information on hardship and the cause of corrosion was included in a letter from the licensee dated July 20, 1988.

2.0 EVALUATION

Relief Request No. 1 (February 23, 1988)

The licensee provided justification for a service extension of six months for CFCU Nos. 21, 22, and 23 and an extension of twenty four months for Nos. 24 and 25. Since the fourth refueling outage for Salem Unit 2 was rescheduled from April to September, 1988, justification for continued operation until the September refueling outage was submitted. Public Service Electric and Gas Company plans to replace the Service Water piping associated with CFCU Nos. 21, 22, and 23 during the fourth refueling outage and that associated with CFCU Nos. 24 and 25 during the fifth refueling outage.

a) Following the Salem Unit 2 third refueling outage, a service water project team was formed to address corrosion in service water piping. An extensive material testing program was initiated and a plan developed to systematically replace the subject piping with 6% molybdenum stainless steel prioritized according to safety, functional, and historical considerations. The three inch CFCU service water piping was assigned the highest priority.

b) The selection of 6% molybdenum stainless steel for replacement and repair of the Containment Fan Coil Units at Salem Generating Station Unit 2 has established formidable hardship and burden to the licensee. The 6% molybdenum stainless steel material was chosen because of its proven resistance to microbiological induced corrosion (MIC) and its ability to resist erosion in flowing water systems. The material was commercially available in tube form but

not in components used in the construction of high pressure pipe systems. The burden for obtaining high pressure pipe components and ensuring favorable corrosion and erosion properties has delayed the schedule for replacement of the Service Water piping associated with the Containment Fan Coil Units as indicated. The staff concurs that a hardship and burden has been presented to the licensee in repair of the CFCU systems.

c) A detailed stress analysis was performed to develop a minimum wall acceptance criteria for the CFCU Service Water piping. The most severe stress conditions were determined to take place in cold service water, causing contraction of the ten inch vertical supply and return headers, in combination with Loss of Coolant Accident (LOCA) temperatures in containment, causing upwards thermal growth of the CFCU nozzles. The individual pipe spool configurations were broken down by the elevation at which they were located since the differential thermal movement varied with elevation. Stress calculations were generated for each pipe spool configuration, considering stresses due to pressure, dead weight, thermal and Design Basis Event (DBE) seismic loads. An analysis of thermal loads was performed for the three inch distribution headers and ten inch vertical supply/return headers for both insulated and uninsulated cases. The uninsulated condition clearly demonstrated a significant advantage due to a reduction in the differential thermal movement by allowing the cement lined vertical ten inch pipes to be exposed to the hot containment atmosphere. As a result, all the thermal anti-sweat insulation was removed from the three and ten inch pipe (elevation 129 foot) to the CFCU nozzles. The minimum wall thickness was then calculated for each specific spool piece based on the ASME Code allowable stress.

The licensee has removed all the thermal anti-sweat insulation from the ten inch piping from the first anchor on the ten inch pipe (elevation 129 foot) to the CFCU nozzles and revised their previous stress analysis for the uninsulated condition. The result of the revised analysis has shown that the thermal stresses associated with the affected piping are significantly reduced.

d) The licensee has calculated the required pipe wall thickness for each affected pipe weld based on the revised stress analysis. The required pipe wall thickness for the uninsulated condition is substantially smaller than that for the insulated condition. The final pipe wall thickness at the end of the extended period of service was calculated based on a linear corrosion rate, derived from the worst pits found on the subject weld. Except for two welds (Nos. 1258-2 and 1276-1) in CFCU No. 25, the calculated final pipe wall thickness of each affected weld met the required pipe wall thickness. The licensee will continue to evaluate welds Nos. 1258-2 and 1276-1 including radiographic examination during the upcoming refueling outage to determine the need of overlay repair.

e) The licensee will perform radiographic examination on a representative sample of piping welds from CFCU Nos. 24 and 25 to verify the predicted flaw growth rates used in the analysis during the upcoming refueling outage.

f) The licensee has performed radiographic examination on ten as-flawed weld joints (not overlay repaired) after operating for about six months in the current fuel cycle. No detectable flaw growth was found.

We conclude from our review of the licensee's submittals that the request for service extensions of six months for CFCU Nos. 21, 22, and 23 and of twenty four months for CFCU Nos. 24 and 25 are acceptable. Our determination is based on the following considerations.

a) The licensee used the same methodology approved in our SER dated April 24, 1987 for stress analysis and for the calculation of minimum required pipe wall thickness.

b) Based on the results of inspection performed in the current fuel cycle and the revised stress analysis for the uninsulated pipe condition, we concur with the licensee's conclusion that, except for welds Nos. 1258-2 and 1276-1, the pipe wall thickness of all affected service water piping at the end of the extended period of service would meet the required piping thickness.

c) The licensee is committed to perform radiographic examination of piping associated with CFCU Nos. 24 and 25 during the upcoming refueling outage to confirm the flaw growth rate. This would provide added assurance that the integrity of the affected piping would be maintained during the extended period of service.

d) Further evaluation or mitigation will be performed on welds Nos. 1258-2 and 1276-1 to ensure that the remaining pipe wall thickness is adequate for the operation of one additional fuel cycle. To ensure the integrity of the welds is maintained until replaced, a representative sampling of welds (including Nos. 1258-2 and 1276-1) will be subjected to nondestructive examination (NDE) during the fourth refueling cycle to verify predicted growth rates. The results will be evaluated and further action taken if necessary by the licensee at that time.

Relief Request No. 2 (July 13, 1988)

The Public Service Electric and Gas Company requested approval of a weld overlay repair to a leak in the vent pipe to the Service Water header to Containment Fan Coil Unit No. 25. The regulations require that the Service Water piping be repaired and maintained in accordance with the requirements of Section XI of the ASME Boiler and Pressure Vessel Code. In letters dated July 13, 1988, and July 20, 1988, the licensee stated that performing the repair of

the pin hole leak to ASME Code requirements was impractical and presented an unnecessary hardship. Information was submitted in support of that determination.

Salem Unit 2 has experienced significant erosion and corrosion problems in the Service Water System. The supply water contains a high sediment content, and is extremely brackish. The vent to the header is located at the high point, and is an one inch carbon steel pipe venting the header to the Containment Fan Coil Unit (CFCU). After the initial venting, the line remains stagnant with oxygen that was entrained in the system eventually collecting in this area. Consequently, the corrosion rate is accelerated by the high oxygen-chloride environment in the stagnant carbon steel system.

The licensee organized a team in April, 1987, to identify problems, establish inspection programs, and develop repair, replacement, and upgrade plans for the Service Water System. One of the major upgrades is to replace much of the existing piping with 6% molybdenum stainless steel. The 6% molybdenum stainless steel was chosen because it is less susceptible to microbiologically induced corrosion (MIC) and chemical attacks than other suitable materials. The 6% molybdenum stainless steel is also more resistant to erosion. The material has been used successfully in European applications and has been used successfully for seven years in Salem condensers.

The licensee requested relief from the ASME Section XI Code requirement and the approval of the alternative repair procedure on the basis of impracticability and unnecessary hardship. The leak is located in the Containment Building in an irradiation zone under high temperature and humidity conditions. It is located 20 feet above the 130 foot elevation near the containment wall. The temperature at that location is about 120 degrees Fahrenheit with an OSHA stay time of 15 minutes. The weld overlay repair is considered a temporary repair to stop leakage until the permanent ASME Code approved repair can be made during the fourth refueling cycle.

We conclude from our review that a weld overlay procedure may be used to repair the leak in the vent pipe to the Service Water header to Containment Fan Coil Unit No. 25. We understand that this is considered a temporary repair to stop leakage until the permanent ASME Code approved repair can be made.

Pursuant to 10 CFR 50.55a(a)(3) and from our evaluation we conclude that relief from 10 CFR 50.55a(g)(4) for service extensions of six months for Containment Fan Coil Units Nos. 21, 22, and 23 and an extension of twenty four months for Containment Fan Coil Unit Nos. 24 and 25 are justified. Further, relief from 10 CFR 50.55a(g)(4) is granted for the weld overlay procedure used to repair the leak in Containment Fan Unit No. 25. The repair is a temporary repair to allow the plant to operate to the next scheduled outage when the permanent ASME Code approved repair can be made. Additionally, the staff has concluded that this relief does not involve a significant increase in the probability or consequences of accidents previously considered, and does not involve a significant decrease in a safety margin; and that there is a reasonable assurance that the health and safety of the public will not be endangered.

3.0 CONCLUSION

We have concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations, and the issuance of this relief will not be inimical to common defense and security, or to the health and safety of the public.

Date: October 1988

Principal Contributor: F. Litton