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

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CONCERNING CONTAINMENT LINER WELD LEAK-CHASE CHANNELS AT SURRY

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION, UNIT NOS. 1 AND 2

DOCKET NOS. 50-280 AND 50-281

1. BACKGROUND

During a Type A containment integrated leak rate test on Surry Unit 2 in November 1986, plugs were installed in the containment liner weld leak-chase channels. Therefore, the weld leak-chase channels were not vented to the containment atmosphere. The NRC position is that the containment liner weld leak-chase channels must be vented to the containment atmosphere during the Type A test on containment integrated leak rate test (CILRT), unless the channels are designed and built to the same criteria as that used for the containment shell.

In a letter dated February 8, 1988, Virginia Electric and Power Company (VEPCO), the licensee, submitted a technical evaluation of the containment liner weld leak-chase channels. The evaluation consisted of a comparison of the Surry Units 1 and 2 containments to the Beaver Valley Unit 1 containment, since these containments are of similar design (subatmospheric) and were constructed by the same company. However, the staff believes that the test results and design details are unique for each plant and it would not be appropriate to compare only the physical data with other plants. Additional information was requested from the licensee to demonstrate that the Surry leak-chase channels and the associated welds meet the design and quality assurance acceptance criteria.

On August 5, 1988, the licensee provided the requested additional information which included the technical basis and supporting calculations of the leak-chase channel system. Also included in this submittal was a summary of the inspection performed on the Unit 1 containment liner during the outage prior to the June 1988 Type A test.

2. EVALUATION

The staff has reviewed the licensee's submittals and the justification for not venting the liner weld leak-chase channels during Type A tests. It is the staff's position that the channels need not be vented if the licensee can demonstrate that:

(a) the channel welds are qualitatively equivalent to or better than those for the primary containment liner welds,

(b) the channels would maintain their integrity when subjected to the loading conditions of a postulated design basis accident as well as during normal operation, and

(c) the inspection and reporting of tests as required in 10 CFR Part 50, App. J has been implemented.

The containment structure basically consists of a cylindrical wall anchored at its base to a 10 foot thick circular mat and closed at the upper end with a hemispherical dome. The reinforced concrete shell varies in thickness from 4 1/2 feet in the cylinder to 2 1/2 feet in the dome. The inside diameter of the containment structure is 126 feet and the interior vertical height is 185 feet. The cylindrical portion of the liner is 3/8 inches thick, the hemispherical dome liner is 1/2-inch thick, and the flat floor liner covering the mat is 1/4-inch thick.

All liner seams are double-butt welded. All welded liner seams are covered with continuously welded test channels. The nondestructive examination (NDE) of the liner seam welds was performed in accordance with Specification No. NUS-56 and the erector's non-destructive testing (NDT) procedures.

The ASME Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1, Nuclear Vessels, 1968 edition was used as a guide for the design and construction practices of the containment steel liner. The liner material is ASTM A-442, Grade 60, having a specified minimum tensile strength of 60,000 psi, a minimum yield strength of 32,000 psi and a minimum elongation of 23 percent in a standard 2-inch specimen. The test channels are fabricated of ASTM-131, Grade C material, having a specified minimum tensile strength of 58,000 psi, a minimum yield strength of 32,000 psi, and a minimum elongation of 24 percent in a standard 2-inch specimen.

The test channels are attached to the liner with 1/4-inch fillet welds. All test channel to liner welds were made using ASTM E7018 electrodes or an approved alternate.

All applicable welding procedures and tests, as specified in Section IX of the ASME B&PV Code for Welding Qualifications, 1968 edition, were adhered to for qualifying the welding procedures, performance of the welding machines and welding operators who were engaged in the construction of the containment liner, including the test channels. These procedures ensure that the ductility of the welds is comparable to the ductility of the containment liner plate and test channel material. All test channel welds and liner butt welds were tested by either a halide leak detection test or a 2-hour pressure drop test. Leaks detected by either method were repaired using approved welding procedures, and the channel was retested.

All test channel welds were 100 percent visually inspected. In addition, 100 percent of all welds were inspected using magnetic particles or dye penetrants. The welds on the test channels were pressure tested simultaneously with the liner seam welds during the halide leak detection test and the pressure drop test. The pressure testing of the test channels provides assurance that the liner seam welds and the test channel welds are leak-tight.

Based on the above observations, we find that the channel welds are qualitatively equivalent to those for the primary containment liner welds and are therefore acceptable.

The licensee has reanalyzed the relative stiffness of test channels with respect to the liner and the embedded plates in order to determine the amount of restraint provided to the liner. The attachment of the leak chase channels to the containment liner creates a potential structural discontinuity which arises when the stiffness of an attached component differs significantly from the stiffness of liner. Stiffnesses are summarized as follows:

Cylindrical liner	10,875 kips/in.
Test channels, perpendicular to liner seams	864 kips/in.
Test channels, along liner seams	1,415 kips/in.
Dome liner	14,500 kips/in.
Test channels, in contact with concrete	8,345 kips/in.
Liner anchor	3,000 kips/in.

The test channels and liner anchors constrain the liner with stiffnesses ranging from 60 percent to less than 10 percent of the stiffness of the liner itself. It is clear that the leak test channels provide only a limited amount of restraint to the liner.

Stress and strain analyses have been performed to study the behavior of test channels under design load conditions. Four loading conditions have been considered:

(a) CILRT with pressure equal to 45 psig and no temperature rise in the liner.

(b) The structural acceptance test with pressure equal to 52.0 psig and no temperature rise in the liner.

(c) The postulated design basis accident with pressure of 45 psig, and liner temperature of 273°F equal to a temperature rise of 203°F.

(d) The factored design basis accident pressure equal to 67.5 psig and liner temperature of 273°F equal to a temperature rise of 203°F.

Both circumferential and meridional channels have been studied. Calculation of stresses includes the following:

(a) Weld shear stress at liner due to transverse channel bending,

(b) Bending stress in channel at liner,

(c) Bending stress in channel at web and flange,

(d) Axial stress in channel.

ASME B&PV Code Section III, paragraph N-1314 and Table N-421, have been referred to for basic primary allowable stress levels. For SA-442 Grade 60 liner plate, the allowable stress intensity is 18.9 psi. Except for certain aspects of quality assurance, SA-131 Grade C material, the leak chase channel material, has the same yield stress of 32,000 psi and a similar lower bound ultimate strength as SA-442; it is reasonable to use the same allowable stresses to the test channels. The allowable bending stresses and direct stresses for the test channels are determined by the allowable stress intensity, yield strength and the load combinations. All stresses in the test channels meet the ASME stress criteria. For the test channels, significant margins exist between the calculated bending stresses and the allowable stresses used for the liner. The weld stresses due to the transverse behavior of the channel are also less than the Final Safety Analysis Report (FSAR) liner allowables.

A general inspection of the accessible interior surfaces of the containment structure was performed prior to the recent Type A test (June 1988) for the purpose of identifying evidence of deterioration in the containment liner which may affect the containment integrity. The liner inspections did not identify any containment liner deterioration. The licensee committed to perform similar visual inspections of readily accessible areas prior to each subsequent Type A test at Surry to ensure the structural integrity of the containment liner plate and concrete. Based on this review, the staff believes that the CILRT, as required by the provisions of the 10 CFR Part 50, App. J, would not be downgraded when the CILRT is performed without venting the leak-chase channels.

3. CONCLUSION

On the basis of the above evaluation, the staff concludes that:

(a) the channel welds at the redefined pressure boundary are qualitatively equivalent to those for the primary containment liner welds and are acceptable,

(b) the channels are capable of withstanding the loading conditions of a postulated design basis accident as well as during normal operation and maintain their structural integrity at all times, and

(c) the commitment of visual inspection of readily accessible areas prior to each subsequent Type A test is in compliance with the intention of the inspection and reporting of tests as required in 10 CFR Part 50, App. J.

We therefore concur with the licensee that it is not necessary for Surry to vent the containment liner weld leak-chase channels during a Type A test.

Dated: March 6, 1989

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