# SAFETY GUIDE 19

# NONDESTRUCTIVE EXAMINATION OF PRIMARY CONTAINMENT LINER WELDS

## A. Introduction

General Design Criterion 1, "Quality Standards and Records," of Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants," requires that components important to safety be fabricated to quality standards commensurate with the importance of the safety function to be performed. The leaktight integrity of the primary containment liner and its penetrations is an important consideration in safety evaluations. This guide describes acceptable procedures for implementing this criterion by the use of nondestructive methods to examine the welds in the liners and penetrations of primary reactor containments of concrete construction.

## B. Discussion

There are no directly applicable industry codes that cover the nondestructive examination of containment steel liner and penetration welds in concrete containments. Current industry practice is generally based upon the application of provisions of Sections III and VIII of the ASME Boiler and Pressure Vessel Code and ANSI B31.7, "Nuclear Power Piping," for comparable welds. Because of the lack of specifically applicable standards, these practices have differed significantly.

After reviewing a number of applications for construction permits and operating licenses for nuclear power reactors, the AEC regulatory staff has developed acceptable standard procedures for the nondestructive examination of such leaktight membranes. These procedures will provide a uniform quality level consistent with the safety function of containment liners.

## C. Regulatory Position

Seam welds in the steel liners of conventionally reinforced or prestressed concrete reactor containment structures should be nondestructively examined using the following procedures:

1. Nondestructive Examination of Liner Seam Welds

   a. For each welder and welding position (flat, vertical, horizontal, and overhead), the first 10 feet of weld, and one spot (not less than 12 inches in length) in each additional 50 foot increment of weld (weld test unit) or fraction thereof should be examined radiographically in accordance with the techniques prescribed in Section V, "Nondestructive Examination," of the ASME Boiler and Pressure Vessel Code (ASME B&PV Code). In any case, a minimum of 2 percent of all liner seam welds should be examined by radiography.

   b. Where radiographic examination of liner seam welds is not feasible or where the weld is located in areas which will not be accessible after construction, the entire length of weld should be examined by the magnetic particle method or by the ultrasonic method in accordance with the techniques prescribed in Section V of the ASME B&PV Code for such examination methods.

   c. All liner seam welds should be tested for leak tightness in accordance with the following method (or other methods of equivalent sensitivity):

      Immediately preceding the test, a soap solution (or other appropriate solution) should be applied to the weld. A

vacuum box containing a viewing window should be placed over the area to be tested and evacuated to produce at least 5 psi differential with the atmospheric pressure. Leaks in welds, if present, should be detected by formation of bubbles. The solution used for the test should have bubble formation properties adequate for identification of leaks. The test solution should be checked every hour with a suitable test leak to verify the bubble formation property of the solution used.

d. Where leak-chase-system channels are installed over liner welds, channel-to-liner-plate welds should be tested for leak tightness by pressurizing the channels to containment design pressure. If any indicated loss of channel test pressure occurs within 2 hours, as evidenced by a test gauge, the channel-to-liner welds should be soap bubble tested in accordance with the above procedures.

2. **Nondestructive Examination of Penetration, Airlock, and Access Opening Welds**

a. All welds in penetrations, airlocks, and access openings that are not backed by concrete, such as welds between penetrations and flued fittings, and flued fittings and pipe lines, should be fully examined in accordance with the examination methods of NE-5120 of Section III of the ASME B&PV Code employing the techniques prescribed in Section V of that Code.

b. All welds in the vicinity of penetrations, airlocks, and access openings that are backed by concrete, such as welds between penetration and reinforcing plate[1], penetration and liner reinforcing plate and liner, liner insert and liner, reinforcing plate and frames for airlocks and access openings, and liners and frames for airlocks and access openings, should be fully examined (1) in accordance with paragraph a. above or (2) by magnetic particle or liquid penetrant when a non-magnetic weld is used, in accordance with the techniques prescribed in Section V of the ASME B&PV Code.

c. All welds in bellows type expansion joints provided in penetration assemblies or appurtenances to the containment vessel should be magnetic-particle or liquid-penetrant tested when a nonmagnetic weld is used, in accordance with the techniques prescribed in Section V of ASME B&PV Code for such examination methods.

3. **Qualification of Welders and Welding Procedures**

The qualification of welders, welding machine operators, and welding procedures should be in accordance with Section IX, "Welding Qualifications," of the ASME B&PV Code.

4. **Qualification of Nondestructive Examination Personnel**

Nondestructive examination should be performed by personnel designated by the licensee or his agent and qualified in accordance with the provisions of Section V of the ASME B&PV Code.

5. **Selection of Spots for Radiographic Examination**

The spots of liner seam welds to be radiographically examined should be randomly selected but no two spots in adjacent weld test units should be closer than 10 feet and their locations should be recorded.

[1] Thickened liner insert which provides local reinforcement.

6. **Time of Examination**

All examinations should be performed as soon as practicable after the lineal increment of weld to be examined is completed.

7. **Acceptance Standards**

a. **Containment Liner Seam Welds Examined by Radiography**

Where a spot in the seam weld is judged acceptable in accordance with the referenced standards of NE-5120 of Section III of the ASME B&PV Code, the entire weld test unit represented by this spot radiograph is considered acceptable.

b. **Containment Liner Seam Welds Examined by Ultrasonic or Magnetic Particle**

Seam welds examined by ultrasonic or magnetic particle methods are considered acceptable provided the examinations meet the acceptance standards referenced for such examination methods in NE-5120 of Section III of the ASME B&PV Code.

c. **Soap Bubble Leak Tests of Containment Liner Welds**

Liner welds are considered acceptable provided no leakage is detected by soap bubble tests (or by other methods of equivalent sensitivity).

d. **Penetration, Airlock, and Access Opening Welds**

Penetration, airlock, and access opening welds are considered acceptable provided the examinations meet the acceptance standards referenced in NE-5120 of Section III of the ASME B&PV Code. Welds in bellows type expansion joints are considered acceptable if the examinations meet the acceptance standards referenced for magnetic particle and liquid penetrant methods in NE-5120 of Section III.

8. **Repair and Reexamination**

a. **Containment Liner Seam Welds Examined by Radiography**

When a radiographed spot fails to meet the specified acceptance standards, two additional spots should be radiographically examined in the same weld test unit at locations at least one foot removed (on each side) from the original spot. The locations of these additional spots should be determined by the examiner using the same procedure followed in the selection of the original spot for examination and the examination results should determine the following corrective actions:

(1) If the two additional spots examined meet the specified acceptance standards, the entire weld unit represented by the three spot radiographs is considered acceptable. However, the defective welding disclosed by the first of the three radiographs should be repaired by welding.

(2) If either of the two additional spots examined fails to meet the specified acceptance standards, the entire weld test unit is considered unacceptable. The entire weld should be removed and the joint should be rewelded or, optionally, the entire weld unit may be completely radiographed and defective welding only need be repaired.

(3) Repair welding should be performed using a qualified procedure as specified under regulatory position 3 above. The weld repaired areas in each weld test unit should be spot radiographed at one selected location to meet the acceptance criteria specified in regulatory position 7.a. or 8.a.(1) above.

b. **Containment Liner Seam Welds Examined by Ultrasonic or Magnetic Particle**

When a weld which has been examined does not comply with the specified acceptance standards, the weld should be repaired and reexamined in accordance with the provisions of Section III of the ASME B&PV Code.

c. **Soap Bubble Tests of Containment Liner Welds**

Welds judged unacceptable because leakage is detected by the soap bubble test (see regulatory position 7.c. above) should be repaired. Repair welding should be performed using a qualified procedure as specified under regulatory position 3. above. The weld repaired areas should be reexamined by soap bubble leakage retesting.

d. **Penetration, Airlock, and Access Opening Welds**

Welds judged unacceptable in accordance with regulatory position 7.d. should be repaired and reexamined in accordance with the provisions of Section III of the ASME B&PV Code.

9. **Records**

Records of radiographs and other nondestructive examinations including those for repaired defective welds should be retained by the licensee in compliance with the provisions of Section XVII, "Quality Assurance Records," of Appendix B to 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."