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U.S. Nuclear Regulatory Commission
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Attention: Rulemakings and Adjudications Staff

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Subject: HI-STORM® 100 Leak Testing.

Dear Sir or Madam:

These comments relate to the leak testing procedure, described in Section 8.1, used to demonstrate MPC closure. As discussed below, the leak testing procedure can not be performed as described and performance of the test is not generally consistent with ANSI N14.5-1997 ("Leakage Tests on Packages for Shipment") ("Standard"). Consequently, containment of the radioactive material to the stated criteria can not be demonstrated.

The principal reason the tests cannot be performed as described is that the nominal concentration of helium in air is 5 parts per million (CRC). This atmospheric concentration masks any leakage from the MPC using the specified test conditions. In addition, while the TSAR mentions the Standard several times, there is no direct reference to definitions, equations, formula, methodology or criteria of the Standard in the text. When terminology from the Standard is given, it is (for the most part) used incorrectly.

Specific Comments

These comments address MPC leak testing that is described in:

- Step 26 of Section 8.1.5 of the HI-STORM® operating procedures presented in Chapter 8. Step 26 includes the activities numbered "a" through "k." Leak testing includes activities numbered "h" through "j." The page containing these activities is appended as Attachment A.
- Step 31 of Section 8.1.5 of the HI-STORM® operating procedures presented in Chapter 8. Step 31 includes the activities numbered "a" through "c." Leak testing is performed in activity "b." The page containing these activities is appended as Attachment B.
- LCO 3.1.1 of Section 3.1 of Appendix 12A. The pages containing LCO 3.1.1 are appended as Attachment C.
- SR 3.1.1.3 of LCO 3.1.1.

Leak Testing at Step 26 of Section 8.1.5 of the HI-STORM® TSAR

Step 26 includes the activities numbered "a" through "k." Leak testing of the MPC lid to shell weld includes activities numbered "h" through "j." Activities "h" through "j" require that the MPC be pressurized to 10 psig (minimum) with helium and that a "sniffer" type helium detector probe be used to search for leaks above the lid to shell weld. The allowable leak rate is specified as ≤ 5.0E-6 std cc/sec (helium). Activity "j" specifies that this test is performed in accordance with ANSI N14.5.

PDR PR 72 64FR51271

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If properly done, the helium leak detector would be calibrated in a vacuum (or other gas environment free of helium), using a leak test standard. The detector so calibrated would indicate a "leak" of the allowable leak rate when turned on in air because of the nominal helium concentration in ambient air. Further, also because of the nominal concentration of helium in air, the sensitivity agreed to for the detector (2.5E-6 std cc/sec) can not be achieved.

Note that it is common for this type to test to be performed incorrectly by calibrating the detector in air, essentially "zeroing out" the helium present in the ambient air. When this is done, it is not unusual to find a leak only if it is on the order of 1E-4 cc/sec or greater, using the pressure difference specified in the procedure.

It is also noted that the target leak rate is within the detection range of sniffer type probes as shown in Table A-2 of the Standard. However, detection at the lower range (1E-6 cc/sec) for standard conditions is possible in air only if the tracer gas is not a gas that is present in air.

A final observation about the specified leak rate compared to the Standard - The allowable leak rate is specified as "5.0E-6 std cc/sec (He)." This is a misuse of "std," as "std" implies that the test is performed with a one atmosphere pressure differential between the upstream and downstream pressures at a temperature of 25°C. This is clearly not the test condition since a one atmosphere pressure differential is not specified (and is not required by the procedure) and the helium inside of the MPC is expected to suffer heatup to an unknown temperature above 25°C. Note that, because of heatup, the pressure is also uncertain, regardless of its initial value. Consequently, the allowable leak rate would be specified as: "5.0E-6 cc/sec (He)." This would be the allowable leak rate for the test conditions – whatever those conditions are.

Absent an assured pressure differential of at least 1 atmosphere (15 psig), a leak greater than the allowable leak rate may not be detected even if it existed. Referring to the operating procedure at Step 26, Activity "h," the MPC is pressurized to 10 (+10/-0) psig. If the MPC is pressurized to 10 psig, then:

Using Equation B-2 of the Standard: $L_a = (F_c + F_m) (P_u - P_d)$. Where the variables are as defined in the Standard.

We see that if L_a = 6.0E-6 cc/sec (helium), which exceeds the allowable leak rate, and (P_u-P_d) = 1 atmosphere. Then $(F_c + F_m)$ = 6.0E-6 cc/sec, which is primarily a function of the hypothetical leak path diameter, as well as other constants and (variable) parameters.

If we pressurize the MPC to 10 psig (rather than to 15 psig) then the effective value of (P_u) is (10+15)/15 = 1.66 atm. The effective value of P_d is 15/15 = 1.0 atm. So (P_u-P_d) = (1.66-1.0) = 0.66 atm. This means that the MPC leak rate that exceeds the allowable leak rate requirement, adjusted for test pressure, is (6.0E-6 cc/sec) (.66) = 3.96E-6 cc/sec

Since this leak rate is ≤ 5.0E-6 cc/sec, then the MPC would "pass," even though the test acceptance criteria are not actually being met.

However, as previously noted, the proposed test can not be performed in air, even if the test pressure was increased.

Leak Testing at Step 31 of Section 8.1.5 of the HI-STORM® TSAR

Step 31 includes the activities numbered "a" through "c." Leak testing is performed in activity "b." This test purports to leak test the welds joining the cover plates to the MPC lid. The test is to be performed in accordance with the Standard.

This proposed test suffers defects which preclude its use for the stated purpose.

The first defect is, as discussed above, that the allowable leak rate (5.0E-6 cc/sec) can not be measured by a qualified operator using a properly calibrated instrument because of the nominal concentration of helium in ambient air.

The second defect is that there is no pressure difference that drives the tracer gas. As shown in Equation B-2 of the Standard, a pressure difference must exist across the test boundary in order to drive the tracer gas. No pressure difference, or a very low pressure of unknown value, exists in this test configuration (See Activity "d" of Step 30). If a nominal pressure difference of 0.0 psi is applied in Equation B-2, then the leak rate is also 0.0 cc/sec.

The third defect is that there is no assurance of tracer gas concentration as required by paragraph A 3.6 of the Standard. Even if a concentration could be determined, there is no correction for the reduced concentration of tracer gas applied to the allowable leak rate used in Activity "b" of Step 31 as is required by the Standard. Further, the idea that any significant amount of free helium would remain in the port cavities after its introduction by "spraying" at Activity "d" of Step 3, is genuinely unique.

If the test strategy is not reconsidered, then is suggested that the steps and activities associated with helium leak testing of the port covers be deleted. This test adds operator rem burden without commensurate public benefit (i.e., the performance objective of the test can not be met by the test methodology and test acceptance criteria applied.)

LCO 3.1.1, Condition C

This LCO addresses the helium atmosphere within the sealed MPC after loading.

Condition C ("MPC Helium leak rate limit not met.") has associated "REQUIRED ACTION" C1 which requires an engineering evaluation of consequences, and C2 which requires returning the MPC to an analyzed condition. The Operating Procedure (at Step 26, Activity "k," and at Step 31, Activity "c,") requires that the weld be repaired and retested if the leak rate limit is not met.

Since LCO 3.1.1 is invoked at the point of the test, the proposed remedy provided in the procedure (repair and retest) must also be included in the LCO REQUIRED ACTIONS. Consequently, there should be a C1 which is weld repair and retest OR C2 which is analyze consequences AND a C3 which is the return to an analyzed condition. If REQUIRED ACTION C2 is intended to include weld repair, then the order of C1 and C2 should be reversed, and the BASES for LCO 3.1.1 should describe the repair and retest condition.

SR 3.1.1.3

SR 3.1.1.3 requires that the total helium leak rate be within the limits specified in Table 3-1 (emphasis added). This surveillance requirement can not be achieved since the method of leak testing, even if it could be performed, does not permit the user to determine a total leak rate. The proposed test method allows identification only of discrete leaks in the area tested.

For example, if a leak existed that leaked at a rate of 1.0E-6 cc/sec, the leak condition would be acceptable since it is << 5.0E-6 cc/sec, if it was even detected (as it is below the specified sensitivity of the detector). However, if six such leaks existed, none may be detected, but the "total" leak rate is 6 x 1.0E-6 cc/sec = 6.0E-6 cc/sec, which exceeds the allowable leak rate.

The allowable leak rate in Table 3-1 (referenced by LCO 3.1.1) is specified as ≤ 5.0E-6 atm cc/sec. The use of "atm" is inappropriate since the allowable leak rate is not specified as a "reference" leak rate (See Paragraph B 1.3 of the Standard), and no argument is (or can be) made that the pressure difference between upstream and downstream pressures is 1 atm. Consequently, "atm" should be deleted.

Conclusion

The leak test specified does not provide confirmation of the level of confinement specified by the TSAR. It is suggested that a leak test be specified that can be performed as described by the procedure, or that a revised leak test strategy be used. Increasing the allowable leak rate so that the existing procedure is used may be expected to require revision to the calculated release consequences, and may also apply, as appropriate, to Sections 7.2.1 and 9.1.3, and to Chapter 10.

Thank you for the opportunity to comment.

Sincerely,

Larry Danese

Larry Danese
Consultant

References

CRC Components of Atmospheric Air, "CRC Handbook of Chemistry and Physics," 60th edition, CRC Press, Inc. Boca Raton, Florida

Enclosures:

Attachment A: Page 8.1-18, HI-STORM® TSAR, Revision 8.
Attachment B: Page 8.1-23, HI-STORM® TSAR, Revision 8.
Attachment C: Pages 3.1.1-1 and 3.1.1-2, HI-STORM® TSAR, Revision 8.

Floppy Disk: Contains this letter, without attachements, as a Word® file, as a WordPerfect® file, and as a pdf® file.

Attachment A.

1. Close the drain valve and pressurize the MPC to 125 +5/-0 psig.

2. Close the inlet valve and monitor the pressure for a minimum of 10 minutes. The pressure shall not drop during the performance of the test.

3. Following the 10-minute hold period, visually examine the MPC lid-to-shell weld for leakage of water. The acceptance criteria is no observable water leakage.

d. Release the MPC internal pressure, disconnect the water fill line and drain line from the vent and drain port RVOAs leaving the vent and drain port caps open.

1. Repeat the liquid penetrant examination on the MPC lid final pass.

e. Attach a regulated helium supply (pressure set to 10+10/-0 psig) to the vent port and attach the drain line to the drain port as shown on Figure 8.1.21.

f. Reset the totalizer on the drain line.

g. Verify the correct pressure (pressure set to 10+10/-0 psig) on the helium supply and open the helium supply valve. Drain approximately twenty gallons as measured by the totalizer.

h. Close the drain port valve and pressurize the MPC to 10+10/-0 psig helium.

i. Close the vent port.

Note:
The leakage detector may detect residual helium in the atmosphere. If the leakage tests detects a leak, the area should be flushed with nitrogen or compressed air and the location should be retested.

j. Perform a helium sniffer probe leakage rate test of the MPC lid-to shell weld in accordance with the Mass Spectrometer Leak Detector (MSLD) manufacturer's instructions and ANSI N14.5 [8.1.2]. The MPC Helium Leak Rate shall be ≤ 5.0E-6 std cc/sec (He) with a minimum test sensitivity less than 2.5E-6 std cc/sec (He). See Technical Specification LCO 3.1.1.

k. Repair any weld defects in accordance with the site's approved weld repair procedures. Reperform the Ultrasonic (if necessary), PT, Hydrostatic and Helium Leakage tests if weld repair is performed.

27. Drain the MPC as follows:

Note:
It is necessary to completely fill the MPC with water to get an accurate measurement of the MPC internal free space.

Attachment B.

Note:
ASME Boiler and Pressure Vessel Code [8.1.3], Section V, Article 6 provides the liquid penetrant inspection methods. The acceptance standards for liquid penetrant examination shall be in accordance with ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Article NB-5350 as specified on the Design Drawings. ASME Code, Section III, Subsection NB, Article NB-4450 provides acceptable requirements for weld repair. NDE personnel shall be qualified per the requirements of Section V of the Code or site-specific program.

j. Perform a liquid penetrant examination on the vent port cover weld.

k. Repeat Steps 30.a through 30.j for the drain port cover plate.

31. Perform a leakage test of the MPC vent and drain port cover plates as follows:

Note:
The leakage detector may detect residual helium in the atmosphere from the helium injection process. If the leakage tests detects a leak, the area should be blown clear with compressed air or nitrogen and the location should be retested.

a. Flush the area around the vent and drain cover plates with compressed air or nitrogen to remove any residual helium gas.

b. Perform a helium leakage rate test of vent and drain cover plate welds in accordance with the Mass Spectrometer Leak Detector (MSLD) manufacturer's instructions and ANSI N14.5 [8.1.2]. The MPC Helium Leak Rate acceptance criteria is provided in the Technical Specification LCO 3.1.1.

c. Repair any weld defects in accordance with the site's approved code weld repair procedures. Reperform the leakage test as required.

32. Weld the MPC closure ring as follows:

ALARA Note:
The closure ring is installed by hand. No tools are required.

a. Install and align the closure ring. See Figure 8.1.8.

b. Tack weld the closure ring to the MPC shell and the MPC lid.

c. Visually inspect the tack welds.

d. Lay the root weld between the closure ring and the MPC shell.

e. Lay the root weld between the closure ring and the MPC lid.

f. Lay the root weld connecting the two closure ring segments.

Attachment C. (Page 1 of 2)

3.1 SFSC INTEGRITY

3.1.1 Multi-Purpose Canister (MPC)

LCO 3.1.1 The MPC shall be dry and helium filled.

APPLICABILITY: During TRANSPORT OPERATIONS and STORAGE OPERATIONS.

ACTIONS

----------NOTE----------
Separate Condition entry is allowed for each MPC.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. MPC cavity vacuum drying pressure limit not met.	A.1 Perform an engineering evaluation to determine the quantity of moisture left in the MPC. AND	7 days
	A.2 Develop and initiate corrective actions necessary to return the MPC to an analyzed condition.	30 days
B. MPC helium backfill density limit not met.	B.1 Perform an engineering evaluation to determine the impact of helium differential. AND	72 hours
	B.2 Develop and initiate corrective actions necessary to return the MPC to an analyzed condition.	14 days

Attachment C : (Page 2 of 2)

ACTIONS
(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. MPC helium leak rate limit not met.	C.1 Perform an engineering evaluation to determine the impact of increased helium leak rate on heat removal capability and offsite dose. AND C.2 Develop and initiate corrective actions necessary to return the MPC to an analyzed condition.	24 hours 7 days
D. Required Actions and associated Completion Times not met.	D.1 Remove all fuel assemblies from the SFSC.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.1.1	Verify MPC cavity vacuum drying pressure is within the limit specified in Table 3-1 for the applicable MPC model.	Once, prior to TRANSPORT OPERATIONS
SR 3.1.1.2	Verify MPC helium backfill density is within the limit specified in Table 3-1 for the applicable MPC model.	Once, prior to TRANSPORT OPERATIONS
SR 3.1.1.3	Verify that the total helium leak rate through the MPC lid confinement weld and the drain and vent port confinement welds is within the limit specified in Table 3-1 for the applicable MPC model.	Once, prior to TRANSPORT OPERATIONS