EM Environmental Management

safety ❖ performance ❖ cleanup ❖ closure

DOE Packaging Certification Program

Safety Evaluation Report for Request to Amend Certificate of Compliance Number 9979 to Authorize Resetting the Shipping Periods of Condition 9 of the Certificate by Natural Diffusion or Nitrogen Purging

Docket No. 19-29-9979

Prepared by: James M. Shuler Date: 8/20/19

James M. Shuler
Manager, Packaging Certification Program
Office of Packaging and Transportation

Approved by: Joanne D. Lorence Date: 08/20/2019

Joanne D. Lorence
Headquarters Certifying Official
Director
Office of Packaging and Transportation

This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Packaging Certification Program (PCP) independent technical review of the application and supplements submitted for the Savannah River Operations Office (SR) by the Savannah River National Laboratory (SRNL) to amend DOE Certificate of Compliance (CoC) Number 9979 to authorize two methods for resetting the authorized shipping period for packages loaded with CoC Tables 2 or 4 contents. The hydrogen concentration in the 30-gallon drum void volume can be reduced by natural diffusion or by purging the void volume with nitrogen to reset the applicable shipping period.

Evaluation

By letter dated January 11, 2019, [1] as supplemented May 2, 2019, and July 9, 2019 [2, 3], SRNL prepared and submitted an application for SR to DOE PCP to amend DOE CoC 9979 to authorize two methods for resetting the shipping period for packages exceeding or likely to exceed Condition 5(d)(9) of the CoC for Tables 2 and 4 contents.

There were no changes to the package design or authorized contents to implement this change to package operations. The applicant provided page-changes [4] to add Section 7.4.3 to the Safety Analysis Report for Packaging (SARP) [5] to implement operations procedures for natural diffusion or purging with nitrogen gas, and Section 7.6 of the SARP to add the supporting calculation and test report to the list of SARP references.

Diffusion Method

The applicant demonstrated, by calculation [6], that the hydrogen concentration in the 30-gallon drum void volume can be reduced from 5 volume % to below 0.5 volume % in approximately 13 hours by natural diffusion. PCP staff reviewed and concurred with the inputs, assumptions, and equations used by the applicant to evaluate the minimum hydrogen diffusion time.

The diffusion method requires a package operator to remove both bung plugs from the 30-gallon drum lid to allow hydrogen gas to escape by passive molecular (i.e., natural) diffusion from the drum void space to the environment. The applicant used COMSOL Multiphysics ® Modeling Software to calculate a time of approximately 13 hours for the average hydrogen concentration in the drum void space to change from 5 volume % to 0.5 volume % by natural diffusion through the lid openings. The applicant's calculation assumed:

- the lower 75% by volume of the 30-gallon drum is filled with contents (note – the applicant used a reduced diffusion coefficient in the lower volume of the drum because of the tortuous path the gas must travel because of the contents (tortuosity effect = 2),
- the upper 25% of the drum volume is free gas space, and

- the 5% by volume initial hydrogen concentration is applied to the entire drum volume

The applicant added Section 7.4.3 to the SARP to address the operation procedure for the diffusion method and for additional safety margin requires a minimum of 15 hours to allow the hydrogen gas to diffuse through the lid openings.

PCP staff performed a confirmatory analysis using the ABAQUS computer code to calculate a time of approximately 10 hours for the average hydrogen concentration in the drum void space to change from 5 volume % to 0.5 volume % by natural diffusion through the lid openings. Staff's calculation assumed:

- the 30-gallon drum is empty,
- 5 volume % hydrogen homogeneously distributed in the vapor space, and
- tortuosity effect = 2

Therefore, PCP staff confirmed by independent calculation that the applicant's procedure in Section 7.4.3 of the SARP is sufficient to reset the shipping period for Tables 2 and 4 contents by diffusion.

Purging Method

The applicant demonstrated, by calculation [6], that the hydrogen concentration in the 30-gallon drum void volume can be reduced from 5 volume % to below 0.5 volume % in approximately 40 minutes by purging at a flow rate of 1 cubic foot/minute with air, nitrogen, or other nonflammable gas. PCP staff reviewed and concurred with the inputs, assumptions, equations, and results used by the applicant to calculate the minimum volumetric gas exchanges and purge time.

The purging method requires a package operator to remove both bung plugs from the 30-gallon drum lid and insert a wand in the smaller ¾ inch diameter lid opening to force nitrogen into the drum. The larger lid opening is 2 inches in diameter and allows the gas in the drum to escape to the environment.

Purge Testing

The applicant performed three experimental tests [7] to determine the parameters required to perform the drum purge operations safely in order to prevent pressurization of the drum or radiological contamination by the process of displacing the gas in the drum with nitrogen. PCP staff reviewed the tests and concurred with the methods, results, and configurations that established the flow rate parameters.

A 30-gallon drum assembly (CoC Drawing R-R1-G-00028) was used for each test. The contents are typically loaded in the insulation bag, covered with the insulation cover, and then the insulation bag is cinched closed. The applicant used a cylindrical cardboard spacer as non-radioactive substitute for the package contents and as a form to hold the insulation bag in place. In addition, the applicant applied fluorescent powder on the surface of cardboard cylinder as a non-radioactive substitute for detecting any contamination externally released by the purging process.

The applicant evaluated three purging test configurations:

- Test 1 was performed to determine the effects of gas flow over particulate that may be present within the 30-gallon drum. The fluorescent powder was only applied to cardboard spacer, so for this test scenario contamination would initially be on the underside of the insulation cover. The insulation bag was folded and cinched closed. This test configuration represents the normal loading configuration.
- Test 2 was performed to determine the effects of gas flow over particulate that may be present within the 30-gallon drum. The insulation cover was reversed so that contamination was on the outside of the insulation cover. The insulation bag was folded, but not cinched closed. This test configuration represents a package whose contents were not properly loaded and as a result may have internally contaminated the 30-gallon drum.
- Test 3 was performed to evaluate the effects of using a 100μm filter over the 2 inch lid opening to prevent gross contamination while purging the drum, and to ensure that the filter did not restrict gas flow or over pressurize the drum. The loading configuration for Test 3 was the same as Test 2.

The applicant's acceptance criterion for Tests 1 and 2 was no detectable external contamination at the maximum flow rate. The acceptance criteria for Test 3 was no detectable external contamination at the maximum flow rate or internal pressurization in the drum due to the filter.

No external contamination was detected for the flow rates up to 5 scfm for Test 1. The tester simulated a sudden pressure release by covering the 2 inch lid opening with their gloved hand while the gas was flowing at 3 scfm, and then suddenly removing their hand. There was no external contamination detected by this sudden pressure release. The tester subsequently checked for contamination during the drum unloading process and only found contamination on the underside of the insulation cover and on the cardboard cylinder where the contaminant was initially applied.

No external contamination was detected for a flow rate at 2 scfm for Test 2; however, increasing external contamination was detected for flow rates from 3 to 5 scfm.

The results for Test 3 were based the 30-gallon drum lid configured with a 100μm sintered metal filter of 0.092" thickness covering the larger lid opening during the purging operation. Nitrogen gas passed through the filter at input flow rates of 2 to 5 scfm (i.e., did not pressurize the drum) and the filter prevented external contamination. Internal contamination was detected on the underside of the filter.

The applicant added Section 7.4.3 to the SARP to implement the operation procedure for the purging method. The package user must know the drum void volume to calculate the purge time, based on the formula Section 7.4.3. The purge flow rate must not exceed 2 scfm.

PCP staff confirmed by review of the applicant's calculation and test report that the applicant's operation procedure in Section 7.4.3 of the SARP is sufficient to reset the shipping period for Tables 2 and 4 contents based on purging with nitrogen gas.

Based on the statements and technical references in the SARP Rev 5 Chapter 7 page changes that implement the diffusion and purging procedure to reset the shipping period, and PCP staff's confirmatory evaluation, staff finds the operating procedures described in page changes acceptable, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

Condition of Approval

The 9979 certificate revision was changed from Revision 13 to Revision 14, with the following changes:

- 5.(d) Condition 9 was revised to add "… The shipping period may be reset by the diffusion or purging methods described in the operations procedures in Section 7.4.3 of the SARP, as supplemented. For the purging method, use of the 100μm sintered metal filter of 0.092" thickness is required for contamination control.
- 5.(d) Condition 14, was revised to "… Revisions 12 and 13 of this certificate may be used until July 31, 2020."
- Supplement 5.(e)(18) was added to "*Safety Analysis Report for Packaging – Model 9979 Type AF-96*, S-SARP-G-00006, Revision 5, Pages-changes: 7-ii, 7-10, and 7-12, January 11, 2019."
- Supplement 5.(e)(19) was added to "*Safety Analysis Report for Packaging – Model 9979 Type AF-96*, S-SARP-G-00006, Revision 5, Page-change: 7-11, July 9, 2019."

Conclusion

Based on the statements and representations in the application, as supplemented, and PCP staff's confirmatory evaluation, staff finds the operating procedures for reducing the hydrogen concentration in the 30-gallon drum by either natural diffusion or nitrogen purging acceptable, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

References

[1] *Application for 9979 Package CoC Amendment: 30-Gallon Drum Purging to Reduce Hydrogen Concentration*, SRNL-L4500-2019-00002, Rev. 0, Letter from Robert Watkins to James Shuler, January 11, 2019, with enclosures (M-TRT-G-00020_Rev0.pdf, M-CLC-A-00654_Rev0.pdf, and 9979_C7_Rev5_pagechanges.pdf).

[2] *Applicant Response to PCP Q1 s Regarding 9979 Docket No. 19-29-9979*, SRNL-L4500-2019-00019, Letter from Robert Watkins to James Shuler, May 2, 2019, with enclosures (S-SARQ-G-00053 R0.pdf, Prep Methods & Characteristics of UO2.pdf, and UV206 Safety Datasheet.pdf).

[3] *Revised 9979 SARP Page Change for Docket 19-29-9979*, SRNL-L4500-2019-00028, Rev. 0, Letter from Robert Watkins to James Shuler, July 9, 2019, with enclosure (Docket 19-29-9979 p7-11.pdf).

[4] *Safety Analysis Report – 9979 Type AF Packaging*, S-SARP-G-00006, Revision 5, Page-changes: 7-ii, 7-10, and 7-12, January 11, 2019, and Page-change 7-11, July 9, 2019.

[5] *Safety Analysis Report – 9979 Type AF Packaging*, S-SARP-G-00006, S-SARP-G-00006, Revision 4, March 2015, as supplemented.

[6] *Hydrogen Concentration Reduction in a 30 Gallon Drum*, M-CLC-A-00654, Revision 0, December 12, 2018.

[7] *Model 9979 Type AF Shipping Packaging 30-Gallon Drum Purging Test Report*, M-TRT-G-00020, Revision 0, December 14, 2018