Contract No:

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

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3013 Inner Can Lid Leak Test System Development

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July 2019

SRNL-STI-2019-00392

SRNL.DOE.GOV

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Printed in the United States of America

Prepared for
U.S. Department of Energy

Keywords: *3013, Leak Inner, Can*

Retention: *Permanent*

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EXECUTIVE SUMMARY

Contained in this report is a description of the 3013 inner container lid leak detection system, a listing of the data collected to validate the system and a statistical analysis of collected data.

The 3013 Container Surveillance Program provides assessment criteria and evaluates 3013 containers selected from the storage inventory for potential degradation mechanisms. The 3013 outer container is the boundary credited to prevent release of material to the environment. The integrity of the outer container is only at risk if the inner container loses its seal and allows corrosive gases to diffuse into the outer container. To date, the determination of potential outer container exposure to corrosive gases has been through comparison of the gas analysis of the annular space and the inner container. If the two volumes have the same gas composition and pressure, then the inner container may have leaked. The leak detection system described in this report will provide a direct measurement of the integrity of the inner container, and if approved, will provide for the elimination of gas analysis.

The inner container lid leak testing system consists of two basic parts: the Agilent leak testing instrument and the leak test fixture. The test fixture base provides the connection between the leak test instrument and the test sample. This connection allows helium to flow into the leak detector when a leak path exists in the test sample allowing leak measurement to be performed.

The tests reported here were conducted in a cold lab using a configuration very similar, but not identical to, the configuration anticipated when installed in a glove box. A total of sixty-five leak rate measurements were made on 10 containers and the data is included in the report. The data analysis shows that the leak detection system can identify leaks in the lid, including the weld and heat affected zone of 3013 inner containers, during destructive examination. The measurements taken support that a 3013 IC lid with a leak rate value greater than 2.0×10^{-7} atm cc/sec will be identified using the leak test system prior to introduction into a glove box. These results from the baseline for future tests of the leak test system after it is installed in the glove box for use as part of surveillance DE.

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LIST OF ABBREVIATIONS

DE	Destructive Evaluation
IC	Inner Container
ICCWR	Inner Container Closure Weld Region
LANL	Los Alamos National Laboratory
LR	Leak Rate
OC	Outer Container
OI	Outer Inner
SRNL	Savannah River National Laboratory

1.0 Introduction

The objective of the 3013 Container Surveillance Program is to ensure structural integrity of the 3013 outer containers (OC) for at least 50 years. The integrity of the OC is only at risk if the inner container (IC) loses its seal, allowing corrosive gases and particles access to the OC. Therefore, the current central goal of the 3013 Surveillance Program is to determine the likelihood of breaching an inner container in any manner during its design life that would result in corrosion within the outer container [1].

The 3013 Container Surveillance Program provides assessment criteria and evaluates 3013 containers selected from the storage inventory for potential degradation mechanisms. Pitting corrosion and microscopic cracking have been observed in some inner containers during destructive evaluation (DE). It is possible for similar pit locations to develop into stress corrosion cracks over time [1]. The potential issue being the stress corrosion crack penetrating the thickness of the IC resulting in a leak path between the IC and annulus/head space of the OC. The term for this volume has been defined as the Outer Inner space (OI) in 3013 documents. Over time, corrosive gas can migrate across a through-wall flaw into the OI from the IC and expose the OC to corrosive gas species.

Part of the DE process for the 3013 nested containers utilizes a can puncture device and gas sample collection manifold to collect two gas samples, one from the OI volume and one from the IC volume. The current method for evaluating whether a leak has already occurred into the OI is through comparative analysis of these gas samples.

An evaluation of the effectiveness of the gas analysis approach was completed in FY2014 by SRNL [2]. The results of this evaluation showed that it is unlikely that a leak in the IC occurred prior to DE for any of the containers examined during fiscal years 2007 through 2012. Reference 2 recommends that gas sampling and analysis for both the OI and IC atmospheres be continued as part of DE to evaluate the entire inner container for evidence of a through wall leak.

A helium leak testing system was evaluated as a replacement to comparative gas analysis to determine the integrity of the 3013 IC lid, including the weld and the heat affected zone adjacent to the weld. The leak testing system has the potential to provide a more effective means than gas analysis to detect any through-wall crack in the IC lid. A report completed by LANL [3] evaluates the leak measurement sensitivity requirements for a helium leak testing system to meet or exceed the capability of the current comparative gas analysis methodology. The capability of the leak testing system has been evaluated in a cold lab in a configuration very similar, but not identical to, the configuration anticipated when installed in a glove box. This report provides a description of the 3013 IC lid helium leak testing system, the data collection performed on IC lids, and the data analysis performed to provide validation of the system. Performance tests will be conducted after the system is installed in a glove box and compared to the results presented here. Final determination of leak testing criteria will be developed after the results from the instrument installed in a glove box are available.

2.0 Leak Test System

The IC lid leak testing system consists of two basic parts: the Agilent leak testing instrument shown in Figure 1, and the leak test fixture shown in Figure 2. The leak testing instrument is connected to the test fixture using flexible metallic stainless-steel braided hose.

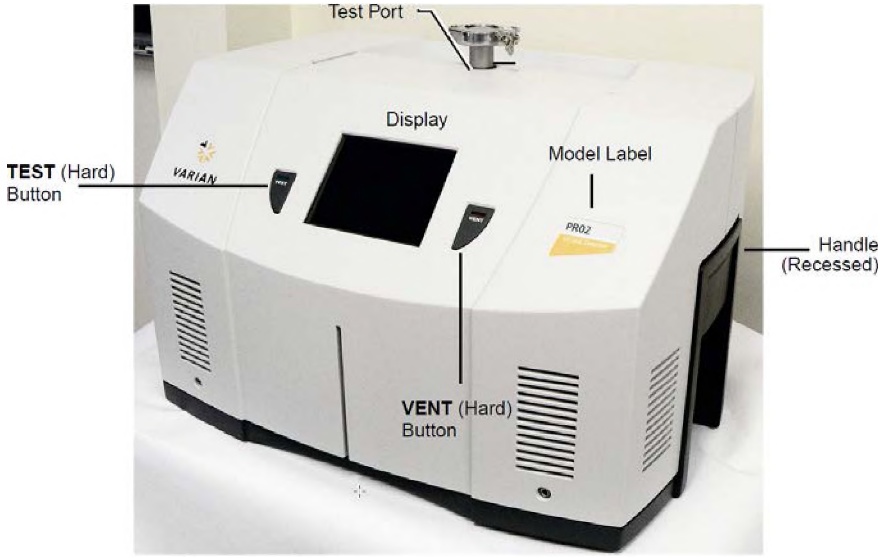

Figure 1. Agilent Leak Test Instrument

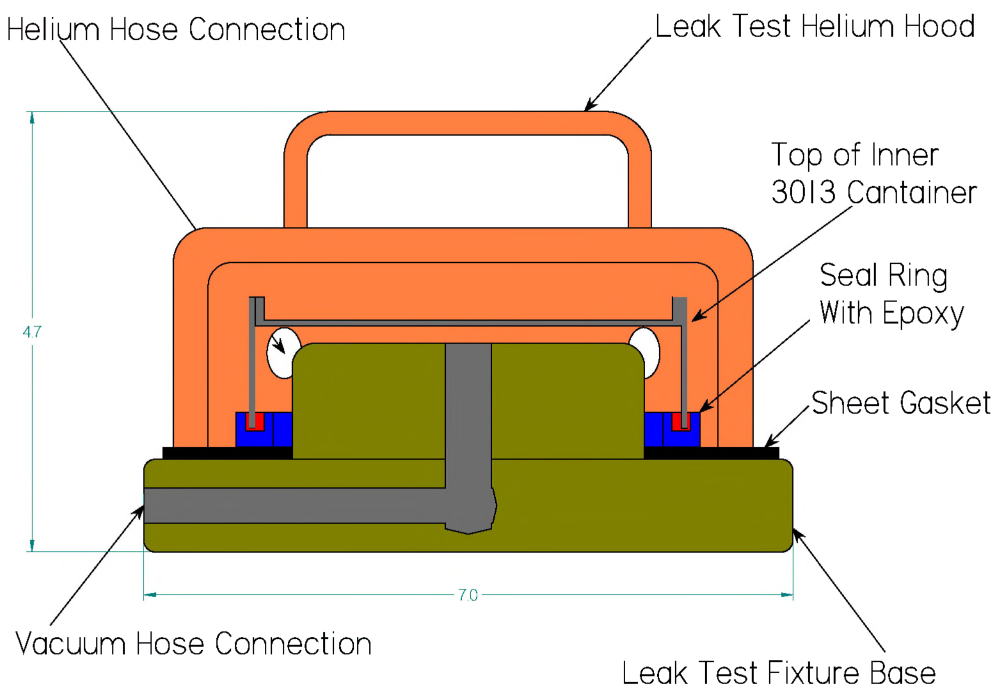

Figure 2. Leak Test Fixture

The leak test instrument is an Agilent VS PD03 Dry (Oil Free) Helium Mass Spectrometer Leak Detector. The minimum detectable leak for the instrument is 5 x 10^{-12} atm cc/sec helium @1000 ppm ambient helium. The differential pressure provided by the instrument's vacuum system provides a mode of force for the helium to pass through any crack that may be present in the IC weld. If helium is detected by the Agilent leak testing instrument, a defect is assumed present in the IC weld or heat affected zone, and appropriate metallurgical testing and analysis is performed on the IC lid. The weld and heat affected zones are the regions of interest for possible gas-phase corrosion in the 3013 container since the stresses in this area are high enough to allow for stress corrosion cracking. The design of the system ensures that leakage past any of the seals in the system biases the system toward an increased leak rate and metallurgical testing of the IC lid.

The instrument was selected because of its small size and because the instrument envelope contained all the components required to perform a complete leak test. The small footprint was evaluated because the initial plan was to install the leak testing instrument inside the 3013 DE glovebox at SRNL. Evaluations since the initial installation plan have resulted in the instrument being located in the DE laboratory, and only the test fixture base being located in the DE glovebox. Filters are being used to control any possible contamination from the DE glovebox. The filters being used are Swagelok SCF series ceramic filters with a particle removal rating greater than 99.9999999% at 0.003 µm. The filters are connected into the system with Swagelok VCR face seal fittings.

The IC test fixture consists of four basic parts as shown in Figure 2. The basic parts include the test fixture base, the IC seal ring, the sealing gasket, and the leak test hood.

The test fixture base provides a vacuum connection to the leak test instrument. This connection allows helium to flow into the leak test instrument when measurements are being performed. The test fixture base is fabricated with a polished upper surface allowing the base to be sealed to the test fixture gasket.

The connection between the test fixture base and the instrument is through a Swagelok flexible metallic stainless-steel braided hose with VCR face seal fittings. A VCR fitting is welded into the test fixture base to provide a robust leak-tight seal. The connection to the test instrument is made with a KF O-ring clamp to VCR fitting. There is a valve installed directly above the test port to isolate the leak test instrument for calibration and to reduce contamination into the instrument when the system is not in use.

Only the upper section of the IC including the lid with the closure weld and approximately 2 inches of the cylindrical wall is available for leak testing (See Figure 3). When the upper section of the can is cut from the bottom section, a coarse cut edge is formed. The IC seal ring provides a means to seal the cut edge of the IC lid to the test fixture. The groove in the seal ring is filled with 3M Scotch Weld DP-190 epoxy. This epoxy was chosen because of its low off gassing characteristic. The IC lid is pressed into the epoxy and allowed to cure for 24 hours before leak testing. The seal ring is fabricated with a polished bottom surface allowing the ring to be sealed to the test fixture gasket. The test fixture gasket is used to form the seal between the seal ring and the test fixture base. A Buna-N gasket was chosen because the material has a low helium permeation coefficient.

Figure 3. Sample Lid with Attached Seal Ring

The purpose of the leak test hood is to concentrate helium around the IC test sample. The leak test hood is connected to a helium source to provide the gas for the test measurement. The helium pressure source for this test is a standard industrial gas cylinder. The pressure is regulated to approximately 10 psig. The leak test hood is placed over the IC lid seal ring epoxy assembly after vacuum is achieved. Helium flow to the hood is then established. The test measurement is then allowed to stabilize and is recorded.

3.0 Data Collection

Thirteen lids were available for testing and labeled consecutively as A-L and another lid as K-Can 6. Ten sample lids were obtained from SRNS (A-I and K-can) and three sample lids were sent for testing from LANL (J-L). Testing was completed on lids A-E and J-L. These data were adequate for the statistical analysis, so no additional testing was required with lids F-I.

Lids were epoxied to the seal rings. A ¼ inch thick Buna-N gasket was placed on the leak test fixture base, with the fully cured lid and seal ring assembly placed on the gasket.

Samples were put into test mode on the leak detector instrument and a vacuum established to less than 4.5×10^{-2} torr. A leak rate was recorded with no helium flow with vacuum established. The helium hood was placed over the lid sample and helium flowed over the sample for a minimum of three minutes. The leak rate measurement was recorded when a stable value was established. Helium flow was then terminated, and the hood was removed. For the first six iterations of data collection, the sample was pumped down on the instrument for 10 and 20 minutes without helium and the leak rate was recorded after each time. For the final nine iterations, the leak rate after 10 and 20 minutes was not recorded.

4.0 Data Analysis

Appendix A contains the leak detector test data collected from February 28th through April 12th, 2019. During this time multiple leak rate (*Test LR*) measurements (seven to eight) were made on nine containers without leaks (A, B, C, D, E, J, K, L). The multiple measurements were generally reported on groups of four or five containers at different times. There are 15 of these groupings. Initially, there were only cans A-D and K-Can 6 available for testing. The groupings were created to accommodate the number of samples available for testing. When more samples were available for testing, they were added to the data stream without changing the format of the data spreadsheet. There are no changes between the different measurement groupings. The exception is that on April 1st container E was measured five times in the same iteration, in order to gain understanding of repeatability of multiple measurements during a glove box test cycle

In the spreadsheet shown in Appendix A, the first column is the order of the measurement within the group (*Order*), the second column gives the container ID (*Sample*), the third column provides the date, the fourth column is the start value with no He flow (*Leak Rate @ Start No He Flow*), the fifth column contains the vacuum at test (*Vacuum@Test*), and the final column is the measured leak rate (*Leak Rate@Test*).

One observation, Sample B on 3/21/19, was identified as a statistical outlier. One possible explanation for the outlier was determined to be allowable warmup time for the instrument. It was determined that the startup time for this observation was not long enough and the measurement was deleted from the analysis. The minimum startup time for the leak test instrument is set in the software to be 20 minutes. However, it was determined through discussions with Agilent that to achieve reliable measurements in the 10^{-8} range a minimum startup time of one hour was needed. All additional measurements were taken with a minimum one hour startup time. The required startup time has been incorporated in the leak testing procedure.

In addition, the extra measurements on container E (April 1st) were not included in the analysis, so that they did not weight container E unduly. Measurements below 0.1×10^{-08} are identified as 0, but in the analysis 0.99×10^{-09} was used.

As previously discussed, there is a small positive bias in the leak rate measurement due to leakage sources such as the gasket. The main goal of the data analysis was to determine the minimum leak rate that the measurement system could reliably detect given this bias.

Figure 4 shows plots of leak rate versus container ID. This plot shows that the container measurement variability is larger than the variability across containers.

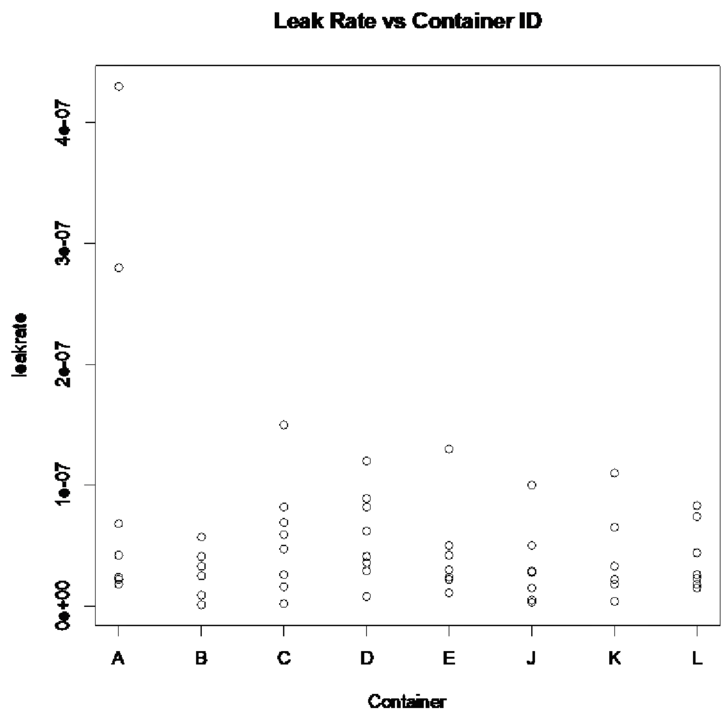

Figure 4. Leak Rate Plotted Against Container ID

Figure 5 shows the leak rate measurements (*Test LR*) from one day (4/12/2019) versus the leak rate at start (*LR@start no He flow*). On 4/12/2019 there were four groupings of four containers. Containers J, K, and L were in each grouping so had four measurements each. These measurements include a separate lid measurement in each grouping, also plotted on the figure below (See Appendix A for lid sample detail). This figure shows that the leak rate depends linearly on *LR@start no He flow* and that there is very little variability between measurements if this dependency is removed.

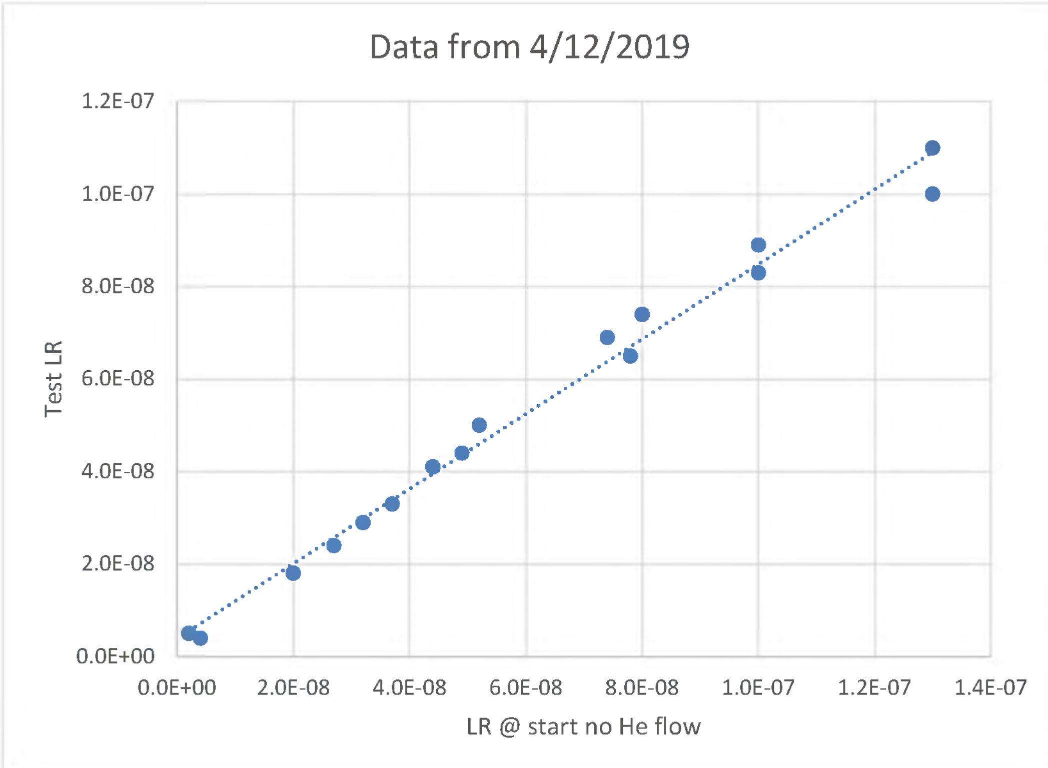

Figure 5. Leak rate (*Test LR*) plotted against *LR@start no He flow* for April 12

There are several possible mechanisms for this effect, including He from permeation though the gasket, and an increase in the helium background. The leak rate at start will increase as concentration increases in the gasket. Concentration in the gasket increases with exposure to He on the outside, diffuses through the gasket and is released on the inside. The diffusion takes longer than a measurement but is apparent at subsequent measurements. This effect is mitigated by manually zeroing the instrument prior to each measurement.

Figure 6 contains the plot of all the leak rate data (*LR Test*) versus *LR@start no He flow*. The orange circles are for container A and the gray circles are for container D. It is likely that the three high measurements for container A and one for container D are due to actual leaks at the seal, since the remaining measurements for these containers lie on the same line as the rest of the data. If any measurement on a container lies on the line with the rest of the measurements, then the container does not have a leak. Having multiple measurements allows identifying measurements that could be problematic.

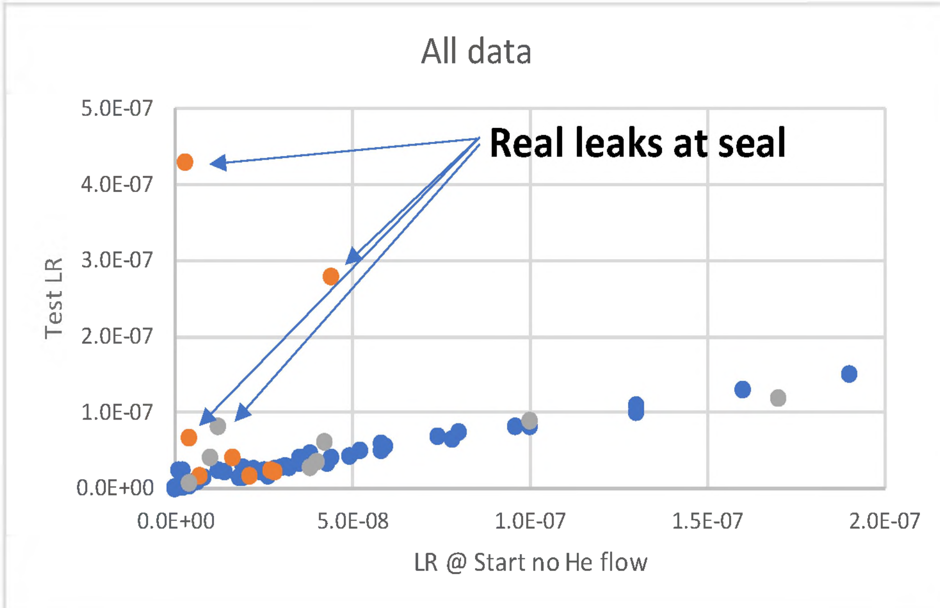

Figure 6. Leak rate (*Test LR*) plotted against *LR@start no He flow* for all data. The orange circles are for container A and the gray circles are for container D.

Figure 7 shows the regression plot of *leak rate* versus *LR@start no He flow* when the four high measurements resulting from possible seal leakage are removed. The red dashed lines are 99.9% prediction limits. These are the bounds for a future measurement. It is extremely unlikely that a future observation from a no-leak population measured in the same way and in the same environment would be outside of these bounds.

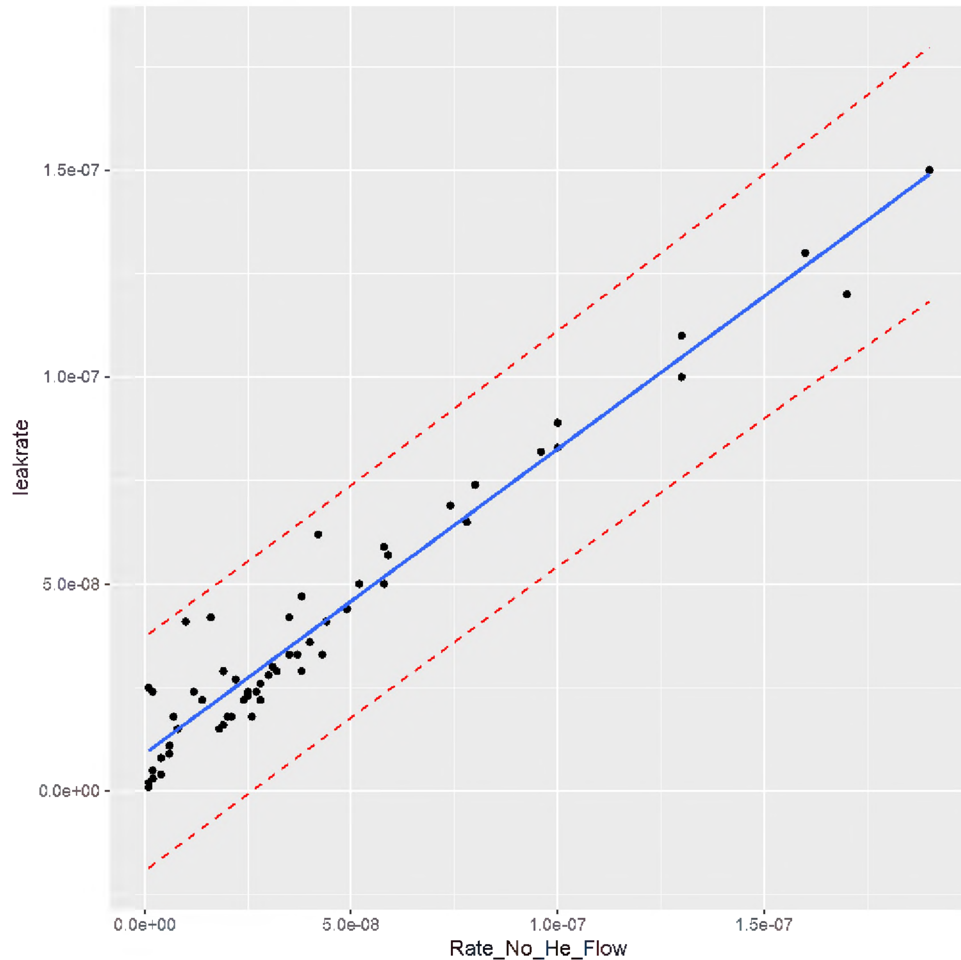

Figure 7. Regression for *leak rate* as a function of *LR@start no He flow*

5.0 Developing Containers with Leaks

To evaluate the size of leak in a weld that can be detected, leaks have been machined into sample lids B, C, and D. To determine the location to machine the leak a digital x-ray was taken of each of the weld regions in the containers. An example processed image of the weld region is shown in Figure 8. The image was used to identify a location in the weld with minimum weld penetration. Preceding the start of machining, each container was leak tested to ensure no leaks were present. Leak rates for the three cans were less than 5×10^{-8} atm cc/sec prior to machining. A V-shaped end mill was used to remove the bulk of the material. The final material was removed with a small V-shaped file. Several iterations were required between machining and testing until a leak developed. A photo of the machined leak is shown in Figure 9. The leak data for the 3 samples is provided in Table 1.

Figure 8. Digital X-Ray of IC Weld

Figure 9. Photo of Machined Leak Location

Table 1. Leak Data for Machined Leaks

Sample	Test Date	Leak Rate at Start No Helium Flow	Leak Rate (atm cc/sec helium)
B	5/15/19	0.0	2.1×10^{-4}
C	5/15/19	0.0 [1]	9.3×10^{-7}
D	5/15/19	0.0 [1]	2.7×10^{-6}
B	5/16/19	0.0	2.5×10^{-4}
C	5/16/19	0.0 [1]	9.6×10^{-7}
D	5/16/19	0.0 [1]	2.8×10^{-6}
B	5/17/19	0.0	2.5×10^{-4}
C	5/17/19	0.0 [1]	9.6×10^{-7}
D	5/17/19	0.0 [1]	2.9×10^{-6}

[1] Leak detector manually zeroed.

6.0 Locating Leaks Using Helium Spray Probe

A helium spray probe was evaluated to determine its effectiveness in locating leak sites in a sample lid. The spray probe purchased from LACO technologies is shown in Figure 10. The probe is attached to a regulated industrial helium bottle. A pressure regulator with a 10 psig set point relief valve is required to protect the probe and personnel from overpressure events.

Figure 10. Photo of Helium Spray Probe Gun

The spray probe gun was tested on sample lids B, C, and D with known leaks to determine the best technique to locate a leak site. The most suitable application for the spay probe is to define a sector of the container lid that most probably contains the leak site. Testing of the existing leaking lids indicates that determining the leak location is difficult. However, the lid sector containing the leak was readily determined.

The following directions were determined to provide the best results and is illustrated in Figure 11:

- Optimal results will be obtained by keeping the background helium level to a minimum. To achieve this while scanning for leaks the trigger on the spray probe should be pulsed, not held down continuously.
- Locate the tip of the spray probe at the outer circumference of the lid and scan in a circumferential direction until helium is detected. Mark the location where helium is detected.
- Return the probe tip to the starting location and scan in the opposite direction until helium is detected. Mark the second location where helium is detected.
- Repeat the scanning several times using multiple starting locations until the sector or sectors containing the leak is well defined.

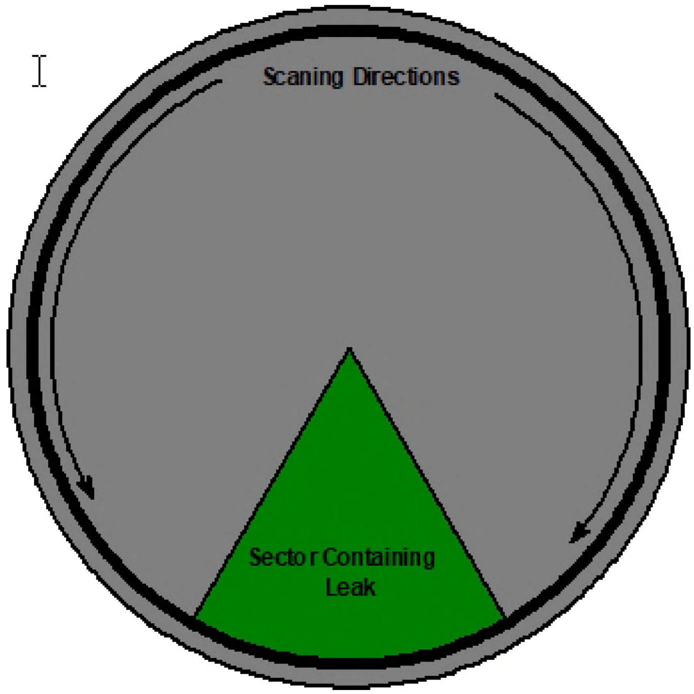

**Figure 11. Illustration of scanning 3013 sample lid for leak site.
Sample lid is viewed from the top.**

7.0 Discussion

The leak test system has been tested in a cold lab and the results presented in the body of this report. The results, which are discussed below, should be considered as a baseline and the leak test system installed in a glove box may perform differently. Performance tests using the glove box installed system will form the basis for informing a decision by the MIS Working Group on leak test criteria. Nevertheless, it is important to identify the capabilities of the system as tested in the cold lab and how results might be applied during 3013 DE analysis.

The measurements made on containers without leaks shown in Figure 4 are all below 2.0 x10-7 atm cc/sec except for two measurements inferred to indicate a seal leak. These results indicate that any measured leak rate of 2.0 x10-7 atm cc/sec or higher would indicate a likely true leak and not be due to positive bias in the system. The prediction bounds for the regression of leak rate versus the no flow leak rate shown in Figure 7 support this result. The prediction bounds are less than 2.0 x 10-7 atm cc/sec for all of the no flow leak rates.

The leak rate measurements in Table 1 show that known leaks produce reproducible measurement values at all leak sizes that were tested, down to the lowest tested leak of just over 9.0 x 10^{-7} atm cc/sec. The no-flow leak rate will be controlled in measurements during 3013 DE and the engineers are confident that a leak rate of 2.0 x 10-7 can be detected as distinct from measurement error.

These cold lab results (i.e., testing is outside the glovebox) provide confidence that the leak detection system can identify leaks of concern in the 3013 inner container lids. The cold lab testing will be followed with testing inside the glove box. A possible approach based on the cold lab results is to use the leak rate measurements to make a decision on detailed metallurgical examination as follows:

1. Determine leak rate of the 3013 lid using the specified SRNL procedure.

2. If the leak rate is below 2.0 x 10^{-7} atm cc/sec, partial metallurgical examination shall be performed.

3. In any test where a leak is indicated in a 3013 inner container by a leak rate above 2.0 x 10^{-7} atm cc/sec, an additional leak measurement should be performed following inspection of the seals and replacement of the gasket. If a leak is still indicated, location of the leak using the He spray probe will be performed, and a full metallurgical examination shall be completed.

8.0 Conclusion

A leak detection system has been developed to provide a measurement of the leak integrity of the 3013 inner container. The evaluation of the leak rate data in the report supports that measurements greater than 2.0 x 10^{-7} atm cc/sec indicate that a leak could be present in the weld or heat affected zone of the inner container.

9.0 References

1. AMNMS-15-0014, “Integrated Surveillance and Monitoring Program for Materials Packaged to Meet DOE-STD-3013”, May 2015
2. Duffey J. M.,"A Comparison of Gas Composition and Pressure of Inner and Outer 3013 DE Containers." SRNL-STI-2014-00439, 2014
3. Berg, John M., “Technical Basis for Inner Container Leak Detection Sensitivity Goals in 3013 DE Surveillance”, LA-UR-17-25093, August 2017

Appendix A. Leak Test Data

Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode off.					
Order	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	A	2/28/2019	7.0E-09	2.6E-02	1.8E-08	0.0E+00	
4	B	2/28/2019	0.0E+00	2.2E-02	0.0E+00	0.0E+00	
2	C	2/28/2019	0.0E+00	2.4E-02	0.2E-8	0.0E+00	
3	D	2/28/2019	1.7E-07	2.4E-02	1.2E-07	1.1E-08	0.0E+00
	K- Can 6						

Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode off.					
Order	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
3	A	3/4/2019	2.1E-08	1.9E-02	1.8E-08	0.9E-9	0.0E+00
1	B	3/4/2019	0.1E-8	2.7E-02	2.5E-08	1.1E-08	0.0E+00
4	C	3/4/2019	2.8E-08	1.7E-02	2.6E-08	1.9E-08	0.0E+00
2	D	3/4/2019	1.0E-08	1.9E-02	4.1E-08	1.4E-08	1.2E-08
5	K- Can 6	3/4/2019	1.1E-06	5.0E-02	> 9.9E-4	NA	7.6E-07

Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	A	3/11/2019	0.3E-8	4.0E-03	4.3E-07	2.8E-08	2.6E-08
4	B	3/12/2019	4.3E-08	1.0E-03	3.3E-08	3.5E-08	4.0E-08
3	C	3/12/2019	9.6E-08	2.0E-03	8.2E-08	3.8E-08	3.2E-08
2	D	3/11/2019	4.2E-08	2.0E-03	6.2E-08	3.5E-08	3.0E-08
	K- Can 6						

Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	A	3/14/2019	0.4E-8	3.0E-03	6.8E-08	4.8E-08	4.6E-08
3	B	3/14/2019	3.5E-08	1.0E-03	3.3E-08	3.8E-08	3.9E-08
2	C	3/14/2019	3.8E-08	1.0E-03	4.7E-08	4.1E-08	4.1E-08
4	D	3/14/2019	1.2E-08	1.0E-03	8.2E-08	7.3E-08	5.6E-08
5	E	3/14/2019	5.8E-08	1.0E-03	5.0E-08	4.2E-08	4.0E-08
Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	A	3/20/2019	4.4E-08	1.5E-02	2.8E-07	1.8E-07	1.3E-07
3	B	3/21/2019	0.5E-8	1.5E-02	9.3E-06	2.1E-07	1.6E-07
2	C	3/20/2019	1.9E-07	2.0E-03	1.5E-7	1.2E-07	1.0E-07
5	D	3/21/2019	4.0E-08	1.0E-03	3.6E-08	5.2E-08	4.6E-08
4	E	3/21/2019	3.1E-08	1.0E-03	3.0E-08	2.9E-08	2.9E-08
Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
3	A	3/22/2019	2.8E-08	1.0E-03	2.2E-08	2.3E-8	2.4E-08
1	B	3/22/2019	0.6E-8	2.0E-03	0.9E-8	1.1E-08	1.2E-08
2	C	3/22/2019	1.9E-08	1.0E-03	1.6E-08	1.9E-08	2.0E-08
4	D	3/22/2019	3.8E-08	1.0E-03	2.9E-08	3.6E-08	3.8E-08
Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Sample	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
2	A	3/28/2019	1.6E-8	1.0E-03	4.2E-08		
4	B	3/28/2019	5.9E-08	1.0E-03	5.7E-08		
3	C	3/28/2019	5.8E-08	1.0E-03	5.9E-08		
1	D	3/28/2019	0.4E-8	1.0E-03	0.8E-8		
5	E	3/28/2019	1.6E-07	1.0E-03	1.3E-07		

Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on. All zeroes indicate 0e-8.					
Sample	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	E	4/1/2019	0.6E-8	2.0E-03	1.1E-08		
2	E	4/1/2019	1.2E-08	2.0E-03	2.4E-08		
3	E	4/1/2019	1.9E-08	2.0E-03	2.9E-08		
4	E	4/1/2019	2.2E-08	2.0E-03	2.7E-08		
5	E	4/1/2019	2.5E-08	1.0E-03	2.4E-08		
Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Sample	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	E	4/1/2019	3.5E-08	2.0E-03	4.2E-08		
2	J	4/1/2019	1.8E-8	1.0E-03	1.5E-08		
3	K	4/1/2019	2.4E-08	1.0E-03	2.2E-8		
4	L	4/1/2019	2.5E-08	1.0E-03	2.3E-08		
Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Sample	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	E	4/4/2019	0.2E-8	1.0E-03	2.4E-08		
2	J	4/4/2019	0.2E-8	1.0E-03	0.3E-8		
4	K	4/4/2019	1.4E-08	1.0E-03	2.2E-08		
3	L	4/4/2109	0.8E-8	1.0E-03	1.5E-08		
Order Run	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Sample	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	E	4/4/2019	2.8E-8	2.0E-03	2.2E-08		
3	J	4/4/2019	3.0E-08	1.0E-03	2.8E-08		
2	K	4/4/2019	2.6E-08	1.0E-03	1.8E-08		
4	L	4/4/2019	2.8E-08	1.0E-03	2.6E-08		

	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on. All zeroes indicate 0e-8.					
Order Run	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
1	J	4/12/2019	0.2E-8	2.0E-03	0.5E-8		
2	K	4/12/2019	0.4E-8	2.0E-03	0.4e-8		
4	L	4/12/2019	2.0E-08	2.0E-03	1.8E-08		
3	A	4/12/2019	2.7E-08	2.0E-03	2.4E-08		
	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order Run	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
2	J	4/12/2019	3.2E-08	2.0E-03	2.9E-08		
1	K	4/12/2019	3.7E-8	2.0E-03	3.3E-08		
3	L	4/12/2019	4.9E-08	2.0E-03	4.4E-8		
4	B	4/12/2019	4.4E-08	2.0E-03	4.1E-08		
	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order Run	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
2	J	4/12/2019	5.2E-8	2.0E-03	5.0E-08		
1	K	4/12/2019	7.8E-8	2.0E-03	6.5E-8		
4	L	4/12/2019	1.0E-07	2.0E-03	8.3E-08		
3	C	4/12/2019	7.4E-8	2.0E-03	6.9E-08		
	Gasket	Buna-N 1/4in. Set point ≥ 0.0e-8. Fine Test Mode on.					
Order Run	Sample	Date	Leak Rate @ Start No He Flow	Vacuum @ Test	Leak Rate @ Test	Leak Rate @ 10 min No He Flow	Leak Rate @ 20 min No He Flow
2	J	4/12/2019	1.3E-7	1.0E-03	1.0E-07		
4	K	4/12/2019	1.3E-07	2.0E-03	1.1E-07		
1	L	4/12/2019	8.0E-08	1.0E-03	7.4E-08		
3	D	4/12/2019	1.0E-07	1.0E-03	8.9E-08		

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