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AL-SX (H1616) Container Support: Out-gassing of Polyethylene & Polycarbonate Resins

G. Cook Story, Leon Seibel and Linda Domeier

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

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G. Cook Story and Leon Seibel
GTS Engineering Department 8414

Linda Domeier
Materials Processing Department 8230
Sandia National Laboratories, Livermore, CA

Abstract

Out-gassing tests were carried out on samples of polyethylene and polycarbonate packaging components used within the AL-SX (H1616) shipping container and compared to known samples of high and low density polyethylene and polycarbonate. Polyethylene is used to fabricate the shipping container overpack for the MC3007A/MC4059 and 1X-Acorn; LEXAN^{®1} polycarbonate (General Electric) is used to fabricate the lid of the Protective Container utilized to package the MC4213/MC4240 and MC4524 for shipment in the AL-SX (H1616).

Pressure was monitored up to about 650°F and all the samples showed similar increases in pressure which were only slightly above those measured for control runs using no resin sample. None of the polymer samples showed out-gassing behavior that would lead to excessive pressure increases in the H1616 within that temperature range.

Acknowledgements

Eric Skidmore at Savannah River measured the density and melting point of MC3007A/MC4059 and 1X-Acorn overpack samples and also contributed other information regarding the use of different grades of polyethylene.

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Table of Contents

	<u>Page</u>
Introduction	7
<i>Polyethylene</i>	7
<i>Polycarbonate</i>	7
Out-gassing Experiment	8
Figure 1. Experiment Schematic	9
Experimental Procedure	10
Results and Discussion	11
<i>Polyethylene</i>	11
Table 1. Polyethylene Resins Tested	11
Figure 2. Sample Preparation Photograph	12
<i>Polycarbonate</i>	13
<i>Pressure/Temperature Discussion</i>	13
<i>Polyethylene</i>	14
<i>Polycarbonate</i>	15
Test Results	15
AL-SX (H1616)—Out-gassing Assessment	16
<i>Polyethylene</i>	16
Table 2. Out-gassing—Control	17
Table 3. Out-gassing—LDPE	17
Table 4. Out-gassing—HDPE	18
Table 5. Out-gassing—Overpack	18
<i>Polycarbonate</i>	19
Table 6. Out-gassing—LEXAN® 101 Polycarbonate	21
Table 7. Out-gassing—Protective Container Lid	21
Conclusions	22
Figure 3.: Out-gassing Pressure of Storage Container PE vs. LDPE and HDPE	23
Figure 4.: Out-gassing Pressure of Storage Container LEXAN® Lid vs. LEXAN® 101	24
Figure 5.: Out-gassing Pressure of Storage Container Resins	25
References	26

Appendix: Polyethylene & Polycarbonate Out-gassing Test Data Sheets	27
Control Run—Empty Vessel, Run # 1	28
Control Run—Empty Vessel, Run # 2	29
Aldrich Polyethylene—Low Density, Run # 1	30
Aldrich Polyethylene—Low Density, Run # 2	31
Aldrich Polyethylene—High Density, Run # 1	32
Aldrich Polyethylene—High Density, Run # 2	33
SRS Curly Shavings—MC3007A/MC4059 and 1X-Acorn Polyethylene overpack, Run # 1	34
SRS Curly Shavings—MC3007A/MC4059 and 1X-Acorn Polyethylene overpack, Run # 2	35
Polycarbonate—LEXAN® 101, Run # 1	36
Polycarbonate—LEXAN® 101, Run # 2	37
Polycarbonate—Protective Container Lid, Run # 1	38
Polycarbonate—Protective Container Lid, Run # 2	39

Introduction

The AL-SX (H1616) family of shipping containers is qualified for the transportation of gas reservoirs to the requirements set forth in SS393217.² This specification is based upon the requirements stated in the Code of Federal Regulations, 10CFR 71.³ SS393217 states that "Organic materials (e.g. port plugs or foam or plastic overpacks) that are part of the reservoir shipping configuration shall not generate high pressure gaseous products when exposed to an accident scenario. The AL-SX (H1616) may reach temperatures up to 450°F in an accident (per SAND91-2205⁴).” The upper temperature requirement was increased from 375°F when Issue D of SS393217 was released in May 1998. Because of material documentation inadequacy with the earlier tests and to assure compliance with the specification, the out-gassing of the polyethylene overpacks for the MC3007A/MC4059 and 1X-Acorn was reevaluated. The polycarbonate lid of the Protective Container utilized to package the MC4213/MC4240 and MC4524 for shipment in the AL-SX (H1616) shipping container also was tested to assure compliance at 450°F.

Polyethylene

Previous out-gassing tests on polyethylene resins such as those used in the AL-SX (H1616) were carried out in 1992⁵ and indicated no excess pressurization at temperatures up to about 600°F and only a slight increase in pressure buildup from 600-650°F. While the resin used in the test was apparently low-density polyethylene, there was no documentation of the actual resin source and density. Furthermore, the material specifications for the polyethylene overpack for the MC3007A/MC4059 and 1X-Acorn allows the use of any density grade from high to low. While no significant differences in out-gassing behavior were anticipated between different grades of polyethylene, it was desirable to verify the behavior of the range of polyethylene types that may have been used to fabricate the overpack. A sample of polyethylene from an actual overpack was also tested under the same conditions.

Polycarbonate

The polycarbonate (LEXAN[®]) lid of the Protective Container⁶ was previously assessed, from manufacturer's data, to comply with the 375°F limit. However, the increase in temperature requirement to 450°F resulted in the decision to also evaluate the out-gassing of this component,

again using a sample taken from an actual Protective Container. A sample of LEXAN® 101 obtained from General Electric was also tested.

Out-gassing Experiment

The test set-up (see Figure 1. Experiment Schematic) consists of a small test chamber made from a standard 2.75-inch flange size Conflat®⁷ style of vacuum nipple with a blank flange on one end and a flange modified to accept a pressure fitting on the other end. To this fitting is fastened a High Pressure (HP) cross, a thermocouple (used to monitor gas temperature), and two HP valves, a Teledyne Taber⁸ pressure transducer, a Heise⁹ Pressure Indicator and a pressure relief valve. The test chamber is wrapped with heating tape, aluminum foil and Fiberfrax®¹⁰. The HP valves are Autoclave¹¹ Model 60VM-4073, three way (two ports to pressure) valves. These valves are numbered V1 and V2 in Figure 1. Valve V1 connects to a vacuum source and HEISE Digital Pressure Indicator, Model 901B(0 to 100 psig range), Serial No. S9-17078 (SNL Instrument ID # R104775); calibration expires 3/12/99. Valve V2 connects to an Argon supply manifold and the pressure transducer—a Teledyne-Taber Model 2210 (0 – 100 psia pressure range), Serial No. 922249 (SNL Instrument ID# R109298); calibration certified until 10/15/99. The data acquisition system (DAQ) is a Nicolet¹² Odyssey.

The volume of the system, including vessel, valves, transducer and tubing is approximately 145 cm³ as determined by measuring the interior dimensions of the vessel and tubing and then calculating the volume.

Figure 1. Experiment Schematic

Experimental Procedure:

- 1) Measure out approximately five grams of the selected polyethylene or polycarbonate sample and place in a "boat" of aluminum foil.
Record weight of sample only.
Record weight of sample and boat.
- 2) Cool test vessel to less than 100°F (if still hot from previous test).
- 3) Place the boat w/sample inside the test vessel.
- 4) Install new copper gasket under blank flange, install bolts and nuts. Tighten the nuts until the flanges are drawn up face to face.
- 5) Record pressure transducer reading while at atmospheric pressure. Record temperature of the vessel at the start of the test.
- 6) Open Valve V1 to evacuate the vessel down to approximately 1.0 torr.
- 7) Close Valve V1.
- 8) Open Valve V2, fill the vessel with Argon to a pressure that is 5.0 ± 3.0 psi over atmospheric pressure, or approximately 19.4 psia)
- 9) Close Valve V2.
- 10) Record the Argon fill pressure.
- 11) Start the DAQ taking data (pressure vs. time & temperature vs. time).
- 12) Start the temperature controller (set point at 820°F) to heat the vessel.
- 13) Monitor the test until the temperature inside the vessel reaches 650°F.
- 14) Stop the data acquisition system. Shut off the power to the heat tape.
- 15) Save data, Copy data to files, Plot data.
- 16) Open the vessel, remove sample and record the combined weight of the sample and boat.

Results and Discussion

Polyethylene

The following values for density and melting point were obtained for the polyethylene samples taken from the MC3007A/MC4059 and 1X-Acorn overpacks at the Savannah River Site (SRS):

Density: 0.93 g/cc (per ASTM D792)

Melting Point: Softening began at 130°C (266°F), as evidenced by tackiness to the hot plate (no sharp crystalline melting point)

The low density (<0.94-0.95 g/cc) and high melting/softening point indicate that the material is probably LLDPE (linear low-density polyethylene). The higher melting range is due to higher crystallinity as the branching is shorter and more uniform than in standard low-density polyethylene (LDPE). High and low density polyethylene differ primarily in the amount and type of branching from the polymer backbone. Lower branching permits tighter packing of the polymer chains, higher crystallinity, and therefore a higher resin density.

For the packaging application, the specific variety may or may not be critical depending upon which parameters are most important. LLDPE is superior in some respects to LDPE and HDPE in terms of stress-cracking resistance, low-temperature impact resistance, and slightly higher melting range (although only by a few degrees). Out-gassing characteristics are unknown at specific temperatures, but have generally been assumed to be very similar for all polyethylene types. Molecular weight may also affect out-gassing and can overlap between varieties.

To evaluate the out-gassing behavior of the container polyethylene as well as known types of polyethylene resins, two 5 gram samples of each resin type were individually heated and the pressure monitored in the experimental apparatus. The control resins were obtained from Aldrich Chemical Co. while chips of the shipping overpack resin were obtained from Savannah River.

Table 1. Polyethylene Resins Tested

Polyethylene Resin Type	Density (grams/cc)	Melting Point (°C)	Resin Form	Molecular Weight	Lot Number	Aldrich Catalog No.
Low Density	0.906	90	powder	35,000	BQ-08417JN	42,779-9
High Density	0.950	130	beads	125,000	HS-15829AR	18,190-0
SRS sample	0.93	~130	shavings	--	--	--

Examples of samples as prepared for test are shown in the following photograph.

Figure 2. Sample Preparation Photograph

Pressure vs. temperature plots of the six polyethylene out-gassing tests and the control runs are shown in Figure 3. All of the samples showed only slightly greater pressure buildup than observed in the control runs. All showed good reproducibility and similar behavior with no significant difference between the high and low-density polyethylene samples or the Savannah River sample. All the samples had formed a solid melt by the end of the heating cycle. The overlap of all the polyethylene data suggests that the original sample form (powder, beads, or shavings) was not a determining factor. The control runs utilized an empty sample container; thus, the pressure vs. temperature curve provides the reference baseline (the thermal response of the argon gas in the test apparatus). The actual out-gassing is represented by the difference between the baseline and the sample curves. The "Polyethylene Out-gassing Test Data Sheet" for each experimental run is included in the Appendix.

Polycarbonate

The polycarbonate material specified (Reference 6) for the MC4213/MC4240 and MC4524 Protective Container lid is not a specific grade and would be consistent with numerous grades available from several manufacturers. A widely used standard grade of polycarbonate meeting this specification and available at the time of manufacture would be LEXAN® 101 from General Electric. Polycarbonate is an amorphous (non-crystalline) thermoplastic with the following properties.

Density:	1.20 g/cc (per ASTM D792)
Glass Transition Temperature, T _g :	softening begins at 155°C (310°F) (per ASTM D1525)
Melting Point, m.p.:	no sharp crystalline melting point

Because the actual grade of polycarbonate is not verifiable at this time, samples were removed from one of the available lids of the Protective Container. The out-gassing characteristics of this lid material as well as a known sample of LEXAN® 101 (lot LZ7434) were evaluated, again using duplicate runs. Samples were not dried in any manner. Pressure vs. temperature plots of the four polycarbonate out-gassing tests and the control runs are shown in Figure 4. The out-gassing behavior of all the resin samples, polyethylene and polycarbonate are shown in Figure 5. All the polycarbonate samples showed slightly greater out-gassing than observed in the polyethylene samples, probably due to higher levels of adsorbed moisture. All showed good reproducibility. The "Polycarbonate Out-gassing Test Data Sheet" for each experimental run is included in the Appendix.

Pressure/Temperature Discussion

All test samples showed a steady rate of pressure increase, after the initial ramp-up, typical of thermally driven pressurization of confined gas (compare to the "Control Runs" data), up to about 600°F. Above 600°F, most of the samples showed an increase in the rate of pressure buildup, presumably due to resin decomposition. None of the samples reached pressures above 40 psia up to 650°F. The thermally induced pressurization for the control runs, adjusted for the unheated volume of the diagnostic and support plumbing and the small volume increase due to

the coefficient of thermal expansion (α) of the stainless steel vessel, can be predicted using the perfect gas law.

The results, shown below, indicate that a doubling of the pressure would normally be expected over this temperature range.

The test apparatus consisted of:

A heated Sample Container— $V_1 \approx 120$ cc

Unheated Diagnostic Plumbing— $V_2 \approx 25$ cc

Initial Conditions: Temperature— T_a ; Argon Fill Pressure— P_a

Test Conditions: Temperature— T_x ; Heated Argon + Out-gassing Pressure (P_o)— P_x

The heated sample container expands during the heating due to its coefficient of thermal expansion (CTE). Thermal effects on the volume may be calculated ($\Delta T = T_x - T_a$):

$$(1) \quad V_{1x} = (1 + \alpha(\Delta T))^3 \times V_{1a}$$

The Perfect Gas Law may be utilized to show that:

$$(2) \quad P_x = P_a \times (1 + V_{1x}/V_2) / [1 + (T_a/T_x)(V_{1x}/V_2)] + P_o$$

The pressure increase observed in the test runs (see Figure 3) show that significant out-gassing of the polyethylene, or polycarbonate, does not occur at temperatures up to 650°F. In the case of the "Control Runs" or, no out-gassing:

$$\text{For: } \alpha = 9.6 \times 10^{-6} \text{ in/in}^\circ\text{F}, T_a = 70^\circ\text{F}, T_x = 650^\circ\text{F}; \underline{P_x \approx 1.76 \times P_a}$$

The "Control Runs" (see Figure 3) had the initial pressure: $P_a \approx 19.8$ psia. The Perfect Gas Law, Equation (2), predicts: $P_x \approx 35$ psia ($T_x = 650^\circ\text{F}$). This agreement with the data of the "Control Runs" provides a "positive check" on the validity of the test system and the data collected (see Table 2).

The out-gassing pressure increase for a sample run (at temperature T_x) can be expressed as:

$$(3) \quad P_o = P_x - P_a \times (1 + V_{1x}/V_2) / [1 + (T_a/T_x)(V_{1x}/V_2)]$$

Polyethylene

The data from the sample runs and the "Control Runs" shown in Figure 3 reveal that the increase in pressure due to the out-gassing of the polyethylene as a function of temperature is quite modest.

All of the resins had melted into a solid mass during the test with the low-density polyethylene resin showing greater flow than the other two resins. The two control resins showed no significant discoloration during the test while the Savannah River samples did show a slight yellowing after heating. This may result from differences in the resin additives and stabilizers.

Polycarbonate

The out-gassing of the polycarbonate samples (see Figure 4.) was only slightly greater than the polyethylene samples. The resins had again melted into a solid mass with some discoloration. All showed signs of bubbling that would be expected from the water typically present in polycarbonate resins.

Test Results

The data collected are summarized, along with the results calculated from the above equations, in the following Tables. The heat input to the test vessel was from heat tape and is proportional to the temperature difference between the tape and the vessel. Therefore, the rapid temperature rise for the start of each test results in the thermal non-equilibrium of the sample container being large until temperatures above approximately 400°F are reached. The data for lower temperatures in the control runs, when compared to the perfect gas law prediction, verify that the temperatures reported during this "ramp up" do not exactly represent the average gas temperature. Test runs required approximately thirty minutes to reach 650°F with the temperature rise rate decreasing with increasing temperature. In addition, there is some uncertainty regarding the volume of the sample container and the volume of the unheated diagnostic and gas supply plumbing. The control runs show that these effects are small.

AL-SX (H1616)—Out-gassing Assessment

Polyethylene

The sealed stainless steel vessel of the H1616-1 is the shipping containment vessel for the MC3007A/MC4059 and 1X-Acorn reservoirs. This vessel contains packing material in addition to the reservoir and its overpack. The free volume of the H1616-1 shipping containment vessel has been verified to be $0.65 \text{ ft}^3 (18,400 \text{ cm}^3)^{13}$ with the packing material in place. The reservoir and its stem protectors occupy an additional volume of approximately 1075 cm^3 . The polyethylene overpack for the MC3007A/MC4059 and 1X-Acorn weighs about 1700 grams and occupies an additional 1900 cm^3 . The free volume remaining in the H1616-1, ready for shipment of an MC3007A, MC4059 or 1X-Acorn is approximately $15,400 \text{ cm}^3$.

The pressure increase due to out-gassing of the polyethylene overpack in the H1616-1 can be calculated from the test data in the following manner.

$$\text{H1616-1 Free Volume: } V_{\text{free}} = 15,400 \text{ cm}^3$$

$$\text{Polyethylene Overpack weight: } M_{\text{OP}} = 1700 \text{ grams}$$

$$V_{\text{free}}/M_{\text{OP}} \approx 9 \text{ cm}^3/\text{gram}$$

The test apparatus free volume to polyethylene mass ratio may be similarly calculated.

$$V_{\text{test}}/M_{\text{sample}} \approx 23 \text{ cm}^3/\text{gram}$$

The ratio of these volume/mass ratios may be utilized to determine the increase in pressure from polyethylene out-gassing in the H1616-1.

$$(4) \quad \Delta P_{\text{H1616-1}} \approx [(V_{\text{test}}/M_{\text{sample}})/(V_{\text{free}}/M_{\text{OP}})] \times P_0$$

$$(5) \quad \Delta P_{\text{H1616-1}} \approx 2.5 \times P_0$$

The pressure increases due to the polyethylene out-gassing determined by equations (4) and (5) must be added to the thermally induced (Perfect Gas Law) pressure increase in the H1616-1 stainless steel containment chamber to obtain the rise in total pressure.

The pressure increase due to out-gassing of the polyethylene overpack in the H1616-1 is shown in Tables (3), (4) and (5). The polyethylene induced pressure increase in the H1616-1 is less than an additional 4 psi. The pressure limit in the H1616-1 is 177 psia at the 450°F limit.

Table 2. Out-gassing Data—Controls

Test System Validation (No Sample)	T (°F)	P _x Total (psia)
Control, Run #1	73	19.9
	308	26.9
	447	29.8
	551	32.1
	606	33.5
	651	35.1
Control, Run #2	76	19.8
	305	26.9
	442	29.7
	554	32.2
	598	33.3
	651	35.1

Table 3. Out-gassing Data—LDPE

Low Density Polyethylene (LDPE)	T (°F)	P _x Total (psia)	P _o (out-gas) (psi)	ΔP _{H1616-1} (psi)
Aldrich Polyethylene Lot # BQ08417JN Run # 1	69	19.5		
	305	27.5	1.3*	3.3*
	451	30.8	0.9	2.3
	551	33.2	0.9	2.3
	602	34.3	0.9	2.3
	650	36.0	1.5	3.8
Aldrich Polyethylene Lot # BQ08417JN Run # 2	71	19.4		
	302	27.5	1.5*	3.8*
	456	30.9	1.1	2.8
	549	33.0	1.0	2.5
	600	34.4	1.0	2.5
	651	35.8	1.5	3.8

* Reported temperature lags actual gas temperature during ramp-up

Table 4. Out-gassing Data—HDPE

High Density Polyethylene (HDPE)	T (°F)	P _x Total (psia)	P _o (out-gas) (psi)	ΔP _{H1616-1} (psi)
Aldrich Polyethylene Lot # HS15829AR Run # 1	89	19.6		
	294	26.8	1.5*	3.8*
	448	30.7	1.5	3.8
	551	32.8	1.3	3.3
	595	33.8	1.3	3.3
	653	35.5	1.7	4.3
Aldrich Polyethylene Lot # HS15829AR Run # 2	82	19.7		
	303	27.3	1.3*	3.3*
	441	30.7	1.3	3.3
	555	33.0	1.0	2.5
	608	34.4	1.1	2.8
	658	35.9	1.5	3.8

Table 5. Out-gassing Data—Polyethylene Overpack

MC3007A/MC4059 Overpack	T (°F)	P _x Total (psia)	P _o (out-gas) (psi)	ΔP _{H1616-1} (psi)
SRS 1-X Run # 1	70	19.8		
	299	27.6	1.3*	3.3*
	451	31.3	1.1	2.8
	543	33.4	1.0	2.5
	602	34.6	0.9	2.3
	651	36.2	1.4	3.5
SRS 1-X Run # 2	75	19.8		
	296	27.2	1.0*	2.5*
	459	31.4	1.1	2.8
	561	33.8	1.1	2.8
	599	34.6	1.0	2.5
	655	36.5	1.7	4.3

* Reported temperature lags actual gas temperature during ramp-up

Polycarbonate

The sealed stainless steel vessel of the H1616-1 is the shipping containment vessel for the MC4213/MC4240 and MC4524 reservoirs. This vessel contains packing material in addition to the reservoir and its overpack. The free volume of the H1616-1 shipping containment vessel has been verified to be 0.65 ft^3 ($18,400 \text{ cm}^3$)¹³ with the packing material in place. The reservoir and its stem protector occupy an additional volume of approximately 225 cm^3 . The Protective Container and Protective Bracket occupy an additional $1,375 \text{ cm}^3$. The free volume remaining in the H1616-1, ready for shipment of an MC4213/MC4240 or MC4524 reservoir is approximately $16,800 \text{ cm}^3$.

Pressure increases due to polycarbonate out-gassing may be determined as follows.

$$\text{H1616-1 Free Volume: } V_{\text{free}} = 16,800 \text{ cm}^3$$

The polycarbonate Lid's definition¹⁴ and density were used to calculate a conservative maximum quantity of polycarbonate (the cut out in the lid for handle stowage was ignored).

$$\text{Polycarbonate Lid weight: } M_{\text{PL}} < 570 \text{ grams}$$

$$V_{\text{free}}/M_{\text{PL}} \approx 29 \text{ cm}^3/\text{gram}$$

The test apparatus free volume to polyethylene mass ratio may be similarly calculated.

$$V_{\text{test}}/M_{\text{sample}} \approx 23 \text{ cm}^3/\text{gram}$$

The ratio of these volume/mass ratios may be utilized to determine the increase in pressure from polyethylene out-gassing in the H1616-1.

The pressure increases due to the polycarbonate out-gassing determined by equations (6) and (7) must be added to the thermally induced (Perfect Gas Law) pressure increase in the H1616-1 stainless steel containment chamber to obtain the rise in total pressure.

$$(6) \quad \Delta P_{\text{H1616-1}} \approx [(V_{\text{test}}/M_{\text{sample}})/(V_{\text{free}}/M_{\text{PL}})] \times P_0$$

$$(7) \quad \Delta P_{\text{H1616-1}} \approx 0.8 \times P$$

The pressure increases due to the polycarbonate out-gassing determined by equations (6) and (7) must be added to the thermally induced (Perfect Gas Law) pressure increase in the H1616-1 stainless steel containment chamber to obtain the rise in total pressure.

The pressure increase due to out-gassing of the polycarbonate Container Lid in the H1616-1 is shown in Tables (6) and (7). The polycarbonate induced pressure increase in the H1616-1 is less than an additional 2 psi. The pressure limit in the H1616-1 is 177 psia at the 450°F limit.

Table 6. Out-gassing Data—LEXAN® Polycarbonate

Polycarbonate LEXAN® 101	T (°F)	P _x Total (psia)	P _O (out-gas) (psi)	ΔP _{H1616-1} (psi)
L-1 Run # 1	72	19.9		
	301	28.1	1.7*	1.4*
	449	32.2	2.0	1.6
	552	34.7	2.0	1.6
	597	35.7	2.0	1.6
	658	38.0	3.0	2.4
L-1 Run # 2	75	19.8		
	282	27.5	1.8*	1.4*
	447	32.0	2.0	1.6
	553	34.6	2.1	1.7
	598	36.0	2.4	1.9
	655	38.12	3.4	2.7

Table 7. Out-gassing Data—Polycarbonate Lid

Protective Container Lid	T (°F)	P _x Total (psia)	P _O (out-gas) (psi)	ΔP _{H1616-1} (psi)
PC-1 Run # 1	78	19.8		
	290	27.3	1.5*	1.2*
	457	31.8	1.7	1.4
	545	34.1	1.9	1.5
	601	35.4	2.0	1.6
	653	37.4	2.8	2.2
PC-1 Run # 2	78	21.0		
	315	28.5	1.6*	1.3*
	452	32.3	1.9	1.5
	554	34.8	2.0	1.6
	600	36.0	2.2	1.8
	653	38.2	3.2	2.6

* Reported temperature lags actual gas temperature during ramp-up

Conclusions

No significant differences in the rate of pressurization and the total out-gassing pressure measured during out-gassing tests were observed between samples of high and low-density polyethylene and a sample of polyethylene obtained from a MC3007A/MC4059 and 1X-Acorn overpack. The tests validate that thermally induced out-gassing of the polyethylene overpack results in no excess pressures during heating of such polyethylene parts up to temperatures well above the required 450°F. The out-gassing of the polyethylene overpack at temperatures to 450°F, and above, does not result in a safety concern for the H1616-1 shipping container.

Similarly, the test results on samples taken from the polycarbonate lid of the Protective Container for the MC4213/MC4240 and MC4524 and known samples of LEXAN® 101 show that thermally induced polycarbonate out-gassing does not present an overpressure concern well above the required 450°F. The out-gassing of the polycarbonate Lid of the Protective Container at temperatures to 450°F, and above, does not result in a safety concern for the H1616-1 shipping container.

Figure 3. Outgassing Pressure of Storage Container PE vs. LDPE and HDPE

Figure 4. Outgassing Pressure of Lexan Lid vs. Lexan 101

Figure 5. Outgassing Pressure of Storage Container Resins

References

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- ¹ LEXAN[®] is a registered trademark of General Electric Company, Pittsfield, Massachusetts
 - ² Reservoir Qualification for AL-SX (H1616)
 - ³ Code of Federal Regulations, Title 10, Part 71.
 - ⁴ Safety Analysis Report for the Type B AL-SX (H1616) Reservoir Packages
 - ⁵ A. R. York and S. M. Thornberg, "Summary of Out-gassing Tests Performed in Support of the AL-SX (H1616) Program," SAND91-2780, Feb. 1992.
 - ⁶ Polycarbonate Sheet, Clear (U), 2290080
 - ⁷ Conflat[®] is a registered trademark of Varian Vacuum Products, Lexington, Massachusetts
 - ⁸ Teledyne Taber Industries, N. Tanawanda, NY
 - ⁹ Heise Precision Instruments, A Division of Dresser Industries
 - ¹⁰ Fiberfrax[®] is a registered trademark of The Carborundum Company, Fibers Division, Niagra Falls, NY
 - ¹¹ Autoclave Engineers, Erie, PA
 - ¹² Nicolet Instrument Technologies, Inc., Madison, Wisconsin
 - ¹³ Conversation with Greg Tipton, AL-SX (H1616) Engineer, SNL/NM
 - ¹⁴ COVER, CONTAINER; Drawing #1468890

Appendix

Polyethylene & Polycarbonate Out-gassing Test Data Sheets

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/10/99

Sample ID: Control - No Sample - Run#1

Sample density: n/a

Pre-Test Weights;

Boat only: n/a grams

Sample only: n/a grams

Sample & boat: _____ grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 72.68 °F

Argon Backfill Pressure: 19.88 PSIA

5.17 PSIG

Temp. Controller Setpoint: 820

Start Time: 2:54 pm

Post Test Conditions:

Temperature: 657.8 °F

Pressure: 35.43 PSIA

20.66 PSIG

Stop time: 3:14 pm

Post-Test Weight;

Sample & boat: n/a grams

Odyssey file name: cntrl_6

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/10/99

Sample ID: Control - No Sample - Run#2

Sample density: n/a

Pre-Test Weights;

Boat only: n/a grams

Sample only: n/a grams

Sample & boat: _____ grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 76.14 °F

Argon Backfill Pressure: 19.81 PSIA

5.19 PSIG

Temp. Controller Setpoint: 820

Start Time: 4:46 pm

Post Test Conditions:

Temperature: 653.8 °F

Pressure: 35.22 PSIA

20.53 PSIG

Stop time: 5:05 pm

Post-Test Weight;

Sample & boat: n/a grams

Odyssey file name: cntrl_7

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/8/99

Sample ID: Aldrich Polyethylene - Run #1

Sample density: 0.906 Lot No. 08417 JN

Pre-Test Weights;

Boat only: 3.55 grams

Sample only: 5.06 grams

Sample & boat: 8.60 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.41 PSIA

0.0 PSIG

Temperature: 68.94 °F

Argon Backfill Pressure: 19.53 PSIA

5.15 PSIG

Temp. Controller Setpoint: 820

Start Time: 11:58 am

Post Test Conditions:

Temperature: 690.6 °F

Pressure: 37.99 PSIA

23.6 PSIG

Stop time: 12:37 pm

Post-Test Weight;

Sample & boat: 8.484 grams

Odyssey file name: d906_4Ald

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/9/99

Sample ID: Aldrich Polyethylene - Run #2

Sample density: 0.906 Lot No. 08417 JN

Pre-Test Weights;

Boat only: 4.025 grams

Sample only: 5.009 grams

Sample & boat: 9.031 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.36 PSIA

0.0 PSIG

Temperature: 71.10 °F

Argon Backfill Pressure: 19.44 PSIA

5.14 PSIG

Temp. Controller Setpoint: 820

Start Time: 11:08 am

Post Test Conditions:

Temperature: 659.0 °F

Pressure: 36.06 PSIA

21.71 PSIG

Stop time: 11:32

Post-Test Weight;

Sample & boat: 9.027 grams

Odyssey file name: d906_5Ald

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 02/09/99

Sample ID: Aldrich Polyethylene - Run #1

Sample density: 0.950 Lot No. HS 15829 AR

Pre-Test Weights;

Boat only: 4.335 grams

Sample only: 5.025 grams

Sample & boat: 9.359 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.38 PSIA

0.0 PSIG

Temperature: 89.17 °F

Argon Backfill Pressure: 19.61 PSIA

5.22 PSIG

Temp. Controller Setpoint: 820

Start Time: 2:04 pm

Post Test Conditions:

Temperature: 655.5 °F

Pressure: 35.52 PSIA

21.12 PSIG

Stop time: 2:33 pm

Post-Test Weight;

Sample & boat: 9.362 grams

Odyssey file name: d950_3A1d

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 02/09/99

Sample ID: Aldrich Polyethylene - Run#2

Sample density: 0.950 Lot No. HS 15829 AR

Pre-Test Weights;

Boat only: 4.263 grams

Sample only: 5.338 grams

Sample & boat: 9.600 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.44 PSIA

0.0 PSIG

Temperature: 81.54 °F

Argon Backfill Pressure: 19.72 PSIA

5.24 PSIG

Temp. Controller Setpoint: 820

Start Time: 4:38 pm

Post Test Conditions:

Temperature: 659.8 °F

Pressure: 35.98 PSIA

21.50 PSIG

Stop time: 5:10

Post-Test Weight;

Sample & boat: 9.604 grams

Odyssey file name: d950 - 4A1d

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/10/99

Sample ID: Savannah River 1-X Run# 1

Sample density: unknown

Pre-Test Weights;

Boat only: 4.100 grams

Sample only: 5.315 grams

Sample & boat: 9.412 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 70.09 °F

Argon Backfill Pressure: 19.78 PSIA

5.17 PSIG

Temp. Controller Setpoint: 820

Start Time: 8:58 am

Post Test Conditions:

Temperature: 666.6 °F

Pressure: 36.87 PSIA

22.30 PSIG

Stop time: 9:24 am

Post-Test Weight;

Sample & boat: 9.409 grams

Odyssey file name: 1X_3SRS

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/10/99

Sample ID: Savannah River 1-X Run#2

Sample density: unknown

Pre-Test Weights;

Boat only: 4.006 grams

Sample only: 5.213 grams

Sample & boat: 9.216 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 74.62 °F

Argon Backfill Pressure: 19.83 PSIA

5.18 PSIG

Temp. Controller Setpoint: 820

Start Time: 12:13 pm

Post Test Conditions:

Temperature: 683.2 °F

Pressure: 37.81 PSIA

23.10 PSIG

Stop time: 12:49 pm

Post-Test Weight;

Sample & boat: 9.208 grams

Odyssey file name: 1X_4SRS

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/11/99

Sample ID: GE LEXAN Grade 101, Lot# LZ 7434 - Run#1

Sample density: ~ 1.2 g/cc

Pre-Test Weights;

Boat only: 3.876 grams

Sample only: 5.474 grams

Sample & boat: 9.350 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 72.25 °F

Argon Backfill Pressure: 19.85 PSIA

5.22 PSIG

Temp. Controller Setpoint: 820

Start Time: 9:52 am

Post Test Conditions:

Temperature: 669.2 °F

Pressure: 38.51 PSIA

23.88 PSIG

Stop time: 10:19 am

Post-Test Weight;

Sample & boat: 9.340 grams

Odyssey file name: LEX 101-1

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/11/99

Sample ID: GE LEXAN Grade 101, Lot# LZ 7434 - Run#2

Sample density: ~ 1.2 g/cc

Pre-Test Weights;

Boat only: 4.305 grams

Sample only: 5.572 grams

Sample & boat: 9.879 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 74.77 °F

Argon Backfill Pressure: 19.83 PSIA

5.20 PSIG

Temp. Controller Setpoint: 820

Start Time: 1:20 pm

Post Test Conditions:

Temperature: 657.2 °F

Pressure: 38.25 PSIA

23.56 PSIG

Stop time: 1:51 pm

Post-Test Weight;

Sample & boat: 9.870 grams

Odyssey file name: LEX101_2

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/11/99

Sample ID: Polycarbonate cover from shipping container - Run#1

Sample density: ~ 1.2 g/cc

Pre-Test Weights;

Boat only: 4.487 grams

Sample only: 5.358 grams

Sample & boat: 9.844 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.60 PSIA

0.0 PSIG

Temperature: 78.30 °F

Argon Backfill Pressure: 19.81 PSIA

5.17 PSIG

Temp. Controller Setpoint: 820

Start Time: 3:15 pm

Post Test Conditions:

Temperature: 673.7 °F

Pressure: 38.26 PSIA

23.61 PSIG

Stop time: 3:48 pm

Post-Test Weight;

Sample & boat: 9.828 grams

Odyssey file name: lid_1

Polyethylene & Polycarbonate Out-gassing Test Data Sheet

Date: 2/15/99

Sample ID: Polycarbonate cover from shipping container - Run#2

Sample density: ~ 1.2 g/cc

Pre-Test Weights;

Boat only: 4,246 grams

Sample only: 5,016 grams

Sample & boat: 9,262 grams

Pre Test Conditions:

ODYSSEY

HEISE Pressure Indicator

Atmospheric Pressure: 14.52 PSIA

0.0 PSIG

Temperature: 69.80 °F

Argon Backfill Pressure: 19.85 PSIA

5.17 PSIG

Temp. Controller Setpoint: 820

Start Time: 9:29 am

Post Test Conditions:

Temperature: 654.8 °F

Pressure: 38.28 PSIA

23.69 PSIG

Stop time: 9:57 am

Post-Test Weight;

Sample & boat: 9,253 grams

Odyssey file name: lid_2

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LOS ALAMOS SCIENTIFIC LABORATORY

G780 John Straw, LANL/ESA-WE

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235-H Geoff Netzley, SRS/TO/WSRC

773-A T. Eric Skidmore, SRS/WSRC

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