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Test Report
Performance Evaluation Test Series Of
Century Industries' Model VP-55 & VP-110
Versa-Pac Shipping Container

US NRC Docket Number 71-9342

Test Conducted in Accordance with Test Plan TP-001 Revision 0
And
Test Specification TS-001 Revision 0
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1.0 INTRODUCTION

This Report describes the methods and guidelines Century Industries followed for the preparation and testing of the Versa-Pac Shipping Container in accordance with the requirements specified in Century Industries Test Plan TP-001 Revision 0 and Century Industries Test Specification TS-001 Revision 0 (Attachment A and B). The test program was conducted by Century Industries located in Bristol, Virginia between February 25 and March 5, 2009. This report includes the program objective, test procedure, item description, test results, test records (Attachment C) and other applicable documents including photographs of the testing.

2.0 OBJECTIVE

The objective of this test program was to conduct the physical performance evaluation tests for Century Industries VP-55 and VP-110 Versa-Pac Shipping Container designer and manufacturer of the package, in accordance with the normal conditions and hypothetical accident conditions specified in Title 10 Part 71.73 [1], Test Plan TP-001 Revision 0 and Test Specification TS-001 Revision 0.

The test items were identified as Versa-Pac shipping container prototypes and subjected to the following performance tests:

1. Initial visual inspection of the outer and inner container surfaces.

2. Low Temperature Conditioning

3. Drop testing in accordance with 10 CFR 71.71(c)(7), 71.73 (c)(1),(2) & (3), along with NUREG6818, Shallow Angle Drop in a variety of orientations described in Regulatory Guide 7.9

4. Post Test Visual Inspection of the outer and interior container surfaces.

Following each test the physical condition of the shipping container was inspected and the results recorded.

3.0 RESPONSIBILITIES

Century Industries personnel conducted the test program and were responsible for the base analysis of the test articles, the test plan and oversight of the test series. All test personnel completed the Pre-test Readiness Review and associated procedures.

The test series was performed in accordance with the applicable requirements and guidance of Century Industries QA Program QA-1 Revision 1, 10 CFR 71 and this test plan.

The program manager was William M. Arnold, President of Century Industries.
Quality Assurance Coordinator was Heather Little.

4.0 TEST ITEM IDENTIFICATION

Century Industries was responsible for the design, fabrication, inspection, recording the preliminary measurements and the loading of payload and payload containers with multiple size gravels and loose sand.

5.0 TEST ITEM DESCRIPTION

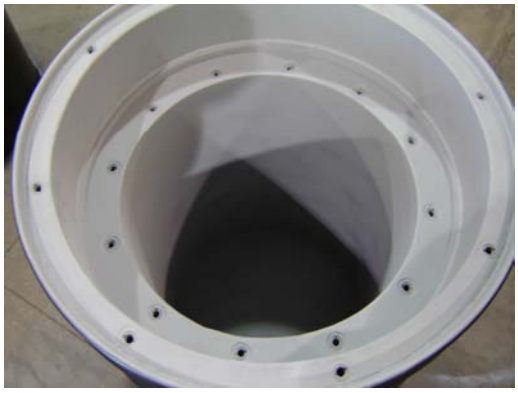
The Versa-Pac Shipping Container is designed for the shipment of Type A radioactive and fissile materials in the form U-metal, oxides, fluorides and nitrate for both product and scrap materials. The fissile payload was design for 350 grams at 100% enrichment and a criticality safety index of 1.5.

The Versa-Pac Shipping Container was designed in two basic versions, a UN1A2 -55 gallon and 110 gallon outer drum with a 16 gauge body, bottom and cover, in addition to the standard 12 gauge closure ring with a 5/8" ASTM A307 bolt, the cover is reinforced and secured using the addition of bolts attached to the internal structure of the package as detailed in the design drawings. The internal structure consists of vertical and horizontal stiffeners at specific points around the package. Outer and inner 16 gauge liners, with an insulating ceramic fiber blanket between the liners complete the primary inner structural components. A secondary barrier of insulation consisting of ceramic fiber blanket; surround the inner containment body. The payload gasket is a woven fiberglass yarn in a flexible substrate, coated with high grade silicone rubber. The gasketed payload containment cavity is made of 10 gauge body and bottom with a ¼" thick top flange to which in the initial series of testing, a 3/16" thick top flange was secure using 12 -1/2" bolts. In the second round of testing the 3/16" thick flange was replaced by a ½ " thick flange and secured by the same number of bolts. The payload cavity is attached to the internal structural components by use of a bolted connection through a fiberglass thermal break between the payload cavity and the structure. Closed cell polyurethane foam is utilized to provide insulation and added impact protection, to both the top and bottom of the Versa-Pac. The top insulation plug is encapsulated in sheet metal welded to the outer drum closure lid. Plastic plugs enclosed within the body of the structure provide a path for venting to the external acetate plug on the exterior of the drum. The cavity is designed to be loaded directly or with the use of an insert to reduce the diameter or with up to a 30 gallon standard drum.

The Versa-Pac was designed in accordance with the requirements of 10 CRF 71 [1] and Century Industries – QA-8, Plan for Manufacture of Versa-Pac Shipping Containers [2].

Pre-Test Photographs 110 and 55 Gallon Versions

110 Gallon - Side View



110 Gallon - Inside View

55 Gallon - Outer Side Top View

55 Gallon - Internal Loaded View

55 Gallon – Blind Flange Bolted

55 Gallon - Top Closure Side View

55 Gallon Version - Side View

6.0 TEST FACILITES & EQUIPMENT

6.1 Environmental Conditioning

Low temperature conditioning of the test articles was conducted before the drop testing was performed in a pre-existing refrigeration chamber. The chamber was cooled by multiple refrigeration units and forced air in the top of the chamber with capability to cool below the required temperatures. Twin door allowed for the packages to be placed into the conditioning chamber by forklift. Temperatures were monitored by the use of calibrated surface thermometers. The packages were transported directly to the drop site in a manner to minimize the time between removal of the shipping container and the drop site.

6.2 Drop Test Pad Facilities

The drop test pad consists of a 70 ton concrete pad made in accordance with IAEA Safety Series No. 37. The pad is 10 feet wide by 10 feet long by 10 feet deep, reinforced with a grid of ¾ inch re-bar spaced on 12 inch centers and capped with a 1 inch thick by 8 feet wide by 10 feet long carbon steel plate, which is embedded into the surface of the concrete and secured by fourteen 1-1/2 inch diameter bolts by 16 inches long.

6.3 Release Device

The release device utilized was capable of releasing the package in a manner that provided a smooth clean drop without imparting any twisting or turning of the package. The device has a safe working load limit of 18,000 pounds. The test articles were lifted into place by use of a crane.

6.4 Orientation and Angles

The orientation if each drop was controlled by the use of nylon fixed straps and adjustable straps used to set the angles required. The orientation of the container was verified using a magnetic protractor attached to the test article surface.

6.5 Measurements and Weights

Drop heights were determined by use of a pre-measured plumb line set by a 100 foot steel tape measure Serial Number 08461846, calibrated by Starett Company and traceable to NIST. The test items tare weights and payload weights were made using a set of floor scales calibrated by Carlton Scales, Kingsport, Tennessee and traceable to NIST.

6.6 Temperature and Wind Speed

Surface and air temperatures were obtained using calibrated surface gauge Serial Number 05548 with a range of -100°F to +160°F and Dickson Temperature Recorder Model SM320 and traceable to NIST. Wind speed was obtained thru the local metro airport service**.**

6.7 Puncture Device

The puncture device consist of a 6 inch diameter by 22 inches long carbon steel round bar welded to a ¾ inch thick plate, which was then secured to the drop test pad by means of tack welding to the center of the pad.

6.8 Photographic Equipment

Color photographs were taken with a Sony 4.1 Mega pixel digital camera by Century Industries. Video was taken using Sony Digital Handy Cam Mini0DVD DCR-TR-17 and Sony Handy Cam Mini DV DCR-HC20 equipment.

6.9 Crush Plate

The crush test plate is made of A36 carbon steel with measurements of 2-5/8 inches thick by 40-1/4 inches wide by 40-1/4 inches long. The weight of the crush test plate is 1205 pounds. The plate is lifted by up to four ½ thick flat bars welded to each corner of the plate.

7.0 EQUIPMENT AND INSTRUMENT CALIBRATION

All applicable test and measurement equipment were calibrated in accordance with Century Industries Quality Assurance Program. Test and measurement calibration certificates are found in Attachment E. The instrumentation used during testing is listed in Table 1 below.

ITEM	MODEL	S/N	CALIBRATION DUE DATE	COMENTS
Starett 100' Tape Measure	N/A	08461846	November 17, 2009	Used to measure length of plumb bob drop heights
Dickson Temperature Recorder	SM320	09057179	February 01, 2009	Used to calibrate surface thermometer and record air temperature
PTC Instruments Surface Thermometer	330F	05548	April 09, 2009	Used to measure the temperature of the test articles during the conditioning
Floor Scale	0-300 Pound	98530806V1812	February 15, 2009	Used to measure the weight of the payload
Elizabethton Airport	N/A	N/A	N/A	Used to check wind speed
Protractor	N/A	N/A	N/A	Used to measure angles, Calibration not required
4 ' Level	N/A	N/A	N/A	Used as straight edge for measurements
Plumb Bob 30', 4' & 1 Meter Drop height	N/A	N/A	N/A	Used during drop series length determined by calibrated tape

Table 1 – Test Instruments

8.0 ACCEPTANCE CRITERIA

The acceptance criteria for this series of testing was retention of the outer closure, no openings, tears or failure that would lead to loss of materials, no open pathway to the insulation materials and no loss of the inner containment payload.

9.0 TEST PREPARATION AND RESULTS

9.1 Initial Inspection

On February 25, 2009, the visual inspection of the test item was conducted prior to performing any of the physical evaluation tests. During the inspection no damage was found to the exterior or interior surface of the shipping containers. Measurements were taken and recorded on all test articles.

Test Article Serial Number 10550

Location	Pre-Test Measurement	Description
A-C	20-15/16" ID	Inner Container
A-C	31" Ø	Outer Container
A	41-7/8"	Drum Height
A	5-1/16"	Wall – In/Our
A	29-11/16"	Inside Height
A	7-5/16"	Top Rim – Inside Flange
B	41-15/16"	Drum Height
B	7-1/4"	Top Rim – Inside Flange
B	5-1/8"	Wall – In/Out
B-D	20-13/16" ID	Inner Container
B-D	31"Ø	Outer Container
C	29-11/16"	Inside Height
C	5-1/16"	Wall – In/Out
C	42"	Drum Height
C	7-1/4"	Top Rim – Inside Flange
D	29-11/16"	Inside Height
D	42"	Outer Container
D	7-5/16"	Top Rim – Inside Flange
D	5-1/8"	Wall – In/Out

Test Article Serial Number 10551

Location	Pre-Test Measurement	Description
A-C	20-7/8" ID	Inner Container
A-C	31-1/16" Ø	Outer Container
A	41-7/8"	Drum Height
A	5-1/8"	Wall – In/Our
A	29-3/4"	Inside Height
A	7-1/4"	Top Rim – Inside Flange
B	41-7/8"	Drum Height
B	7-3/16"	Top Rim – Inside Flange
B	5-1/8"	Wall – In/Out
B-D	20-7/8" ID	Inner Container
B-D	31"Ø	Outer Container
C	29-3/4"	Inside Height
C	5-1/8"	Wall – In/Out
C	41-7/8"	Drum Height
C	7-3/16"	Top Rim – Inside Flange
D	29-3/4"	Inside Height
D	42"	Outer Container
D	7-3/16"	Top Rim – Inside Flange
D	5-3/16"	Wall – In/Out

Test Article Serial Number 10552

Location	Pre-Test Measurement	Description
A-C	20-7/8" ID	Inner Container
A-C	31-1/16" Ø	Outer Container
A	41-7/8"	Drum Height
A	5-1/8"	Wall – In/Our
A	29-5/8"	Inside Height
A	7-3/16"	Top Rim – Inside Flange
B	41-7/8"	Drum Height
B	7-1/8"	Top Rim – Inside Flange
B	5-3/16"	Wall – In/Out
B-D	20-15/16" ID	Inner Container
B-D	31"Ø	Outer Container
C	29-11/16"	Inside Height
C	5-1/8"	Wall – In/Out
C	41-13/16"	Drum Height
C	7-1/8"	Top Rim – Inside Flange
D	29-5/8"	Inside Height
D	41-15/16"	Outer Container
D	7-3/16"	Top Rim – Inside Flange
D	5"	Wall – In/Out

9.2 Weights and Payload

The package tare weights were recorded on the individual test records. In order to provide the test articles with the most aggressive challenge to the inner payload containment of the Versa-Pac it was decided to use 30 gallon drums to contain the payload contents of multiple size gravel and sand. The materials once place into the drum partially filled the drum container. The payload would provide a secondary piston action within the drum, with an additional piston action occurring from the drum to containment flange impact. 1-1/2 pounds of loose sand was place upon the top of each 30 gallon drum within the containment area in order to provide content material capable of breaching the containment flange seal.

Item/Serial Number	10550	10551	10552
Package Tare Weight	660	662	661
Payload Drum/Gravel and Sand	259.5	260	260.5
Loose Sand Weight	1.5	1.5	1.5
Total	921 lbs.	923.5 lbs.	923 lbs.

9.3 Loading of the Test Item

The 30 gallon drums were closed and the bolt closure ring of each container was torqued to 60 ft/lbs. and lowered into the containment cavity and the loose sand placed onto the top of the drum within the containment cavity. The 1/8" thick silicone coated fiberglass gasket and 3/16" thick containment flange were placed into position and the bolts inserted and hand tightened. The flange bolts were then tightened using an alternating method and torqued to 40 ft/lbs. The top gasket and outer closure, which includes the attached encased polyurethane foam insulation top plug, was installed on each of the test articles and the top outer bolts installed and torqued using the same alternating method to a tension of 40 ft/lbs. The outer drum closure rings were then installed and tightened to a torque of 60 ft/lbs.

30 Gallon Drum Loaded With 260 Pounds of Loose Gravel

1-1/2 Pounds of Sand on Top of Containment Payload

Bolted Inner Blind Flange and Top Gasket

Side View – 110 Gallon Acetate Plug

9.4 Test Article Conditioning

The test articles were placed into the conditioning chamber to achieve the targeted test temperature of -40°F, on the exterior skin of the shipping container test articles. To measure the temperature a calibrated surface thermometer was placed on the surface of the test articles and the side walls of the conditioning chamber and temperatures recorded upon removal of the packages from the chamber for transport to the drop test site. Conditioning was conducted for a period of 16 hours, starting on February 24 at 4:00 PM. At time of transport to the test site test article temperatures were -28°F.

Test Articles in Cooling Chamber

110 Gallon upon Removal from Cooling Chamber

10.0 DROP TEST SEQUENCES

The drop test sequences were chosen based upon engineering calculations, historical drop testing and prototype testing conducted on both the 55 gallon and 110 gallon versions. The original prototype testing results are included in Attachment D. All three test articles were produced in accordance with the fabrication drawings and QA-8, plan for the Manufacture of Versa-Pac Shipping Containers. The test articles were tested in accordance with Century Industries Test Plan TP-001 Revision 0. The original series of drops describe below were conducted on February 25, 2009 and recorded on Century Industries NCT and HAC Test Records for each package.

11.0 TEST PACAKGE SERIAL NUMBER 10552 – TEST RECORD TS-001-1

11.1 Test Number 1A – NCT - 4' Top End Drop

The drop test performance evaluation describe in the Test Plan TP-0001 Revision 0 was performed with the undamaged Versa-Pac Shipping Container. Test Configuration 1A was a 4' free drop vertically onto the top end of the test article at an angle of 0 degrees. The air temperature at the start of this series was 45°F and wind speed was 4 mph. The test article was suspended from a crane by use of a sling connected to the clip that was welded to the center of the bottom of the package and attached to a release mechanism. It was lifted above the test pad in a vertical orientation so that the lowest point of the package was at 4 feet above the top surface of the test pad. The test article was released so that it did not impart rotational motion into the package free fall to the test pad. The container impact on to the test pad surface and produced no noticeable damage to the top of the test article. Both height and diameter were unaffected by the drop. Measurements and photographs were taken showing the extent of the damage.

Top End Drop – 4' Height

Damage from NCT 4' Drop

There were no tears or openings to the drum surface. All bolts remained in tact.

11.2 Test Number 1B – HAC 30' Top End Drop

Configuration 1B was a free drop onto the top end of the previously used test article from test number 1A from a height of 30 feet-1 inch. It was positioned vertically onto the top end of the test article at an angle of 0 degrees. The air temperature at the start of this series was 45°F and wind speed was 4 mph. The test article was suspended from a crane by use of a sling connected to the clip that was welded to the center of the bottom of the package and attached to a release mechanism. It was lifted above the test pad in a vertical orientation so that the lowest point of the package was at 30 feet-2 inch above the top surface of the test pad. The test article was released so that it did not impart rotational motion into the package free fall to the test pad. Measurements and photographs were taken showing the extent of damage.

Top End 30' HAC Drop in Position

Free Fall of HAC 30' Top End Drop

Upon impact to the top end of the package the overall height was reduced by 1/4" inch and the diameter was increased by 1/16 inch. The closure ring and all bolts remained in tact and secure.

Side View – Top End Drop Damage

Close-up – Damage to Closure End

11.3 Test Number 1C – HAC 1 Meter Puncture Drop – Horizontal

Configuration 1C was a puncture drop from a height of 41 inches form the lowest point of the package side to the top of the puncture ram, on the side of the test article at a location directly between two of the vertical stiffeners. The package was positioned level and horizontal (1 degree). This location was chosen to validate that upon impact with the puncture ram that the side wall material of the outer surfaces would not tear and create an opening to the internal components of the package.

Horizontal Side – Puncture Drop

Positioned over the Puncture Ram

Horizontal Puncture Impact onto Ram

Upon impact a deformation in the side of the test article was measured at a depth of 3/8 inch. There were no tears as a result of the puncture drop. The results were recorded and photographed.

Close-up Damage from Puncture Between the Vertical Stiffeners

Side View – Horizontal Puncture Damage

11.4 Results and Conclusions

As a result of this test series the outer closure bolts recorded a post test torque of 30 ft/lbs. The outer lid was removed exposing a bulge in the inner containment flange. The bulge allowed sand which was placed on the top of the inner containment payload 30 gallon drum to be forced under the containment gasket. The bulge was caused by the impact of the inner payload and the secondary piston impact of the internal payload within the drum itself. Containment flange bolts were torqued prior to removal and recorded at 20 ft/lbs. The gaskets and the internal cavity of the containment were found to be in good condition with no damage. The conclusion of this test series is that corrections were needed to the blind flange seal and closure and that additional testing would be required.

Internal Blind Flange Bulge

Post Test View - Payload

12.0 TEST PACKAGE SERIAL NUMBER 10551 – TEST RECORD TS-001-2

12.1 Test Number 2A – NCT Horizontal Side Drop

After cooling, test configuration 2A was positioned in a level and horizontal orientation of 0 degrees over the test pad at a height of 48 inches from the lowest point of the test article to the surface of the pad. The package was positioned with the use of nylon straps and attached to the release mechanism. The air temperature was 47.5°F with a wind speed of 4 mph. All measurements were previously recorded. The package was released so as not to impart any rotational motion to the test article free fall to the test pad.

Pre-Test Side View 110 Gallon Version

NCT- Horizontal Side Drop – 4' Height

The resultant impact to the exterior surface allowed the bolted closure ring to push into the side wall approximately 5/8 inch deep. There was no reduction in the diameter or height of the package. No bolts were broken and there were no tears or broken welds. Damage was documented and photographed.

Post-Test – End View of Damage

12.2 Test Number 2B – HAC 30' Horizontal Side Drop

The same package was positioned for test configuration 2B for the HAC 30 foot horizontal side drop onto the same surface as the normal conditions drop. This was done in an effort to accumulated damage in this drop orientation. The air temperature was 48°F with a wind speed of 4 mph. The package was lifted to a height of 30 feet–1 inch with the angle of orientation at 0 degrees. The package was release so as not to impart any rotation motion to the test article freefall to the test pad.

The damage from this drop produced a buckle around the closure bolt area and on the lid, along with a decrease in the diameter of 1 inch in the direction of impact through the bolt. There was no loss of bolts or closure and all welds remained in tact. The damage was recorded and photographed.

Post-Test HAC 30' Drop
End View of Damage

Close-Up HAC 30' Horizontal Side Drop
Damage

Side View – Top End Closure Ring Bolt
30' HAC Horizontal Drop Damage

12.3 Test Number 2C – HAC 30’ Crush Plate Side Drop

Test configuration 2C was conducted using the same test article used in test number 2B above. The air temperature was recorded at 49°F and the wind speed was 4 mph. The test package was placed in the horizontal position on the test pad with the crush test plate suspended at an angle of 0 degrees from horizontal directly over the package so as to impact the test article directly on both the closure and top flange areas and also the bottom edge of the package. The package was lifted to a height of 30 feet-1 inch from the lowest point of the crush plate to the top of the horizontally placed test package. It was suspended and attached to the release mechanism by nylon straps. The crush plate was released so as not to impart any rotational motion to the crush plate free fall to the impact point with the test article.

HAC 30’ Crush Plate Positioning

Crush Plate at 30’ Height

Crush Plate Impact

Upon impact the overall diameter of the package in the direction of the impact was reduced by a total of 2-1/2" from the original diameter at its maximum point. A gap of ¼ inch by 1-1/4 inch long was documented at the drum to lid interface. However due to the design of the Versa-Pac closure lid the metal to metal interface between the top flange and the encased insulation was visible with no direct opening to the internal structure or seals of the package. The results were recorded and photographed.

Post Test – Top Closure Lid Intact

End View – Sheared Drum Ring Top Closure In Place and Secure

Bottom End Impact Damage

Bottom End View – 30' Crush Plate Damage

End View Bottom End Damage

Close-up Top End Damage ¼" x 1-1/14" Gap – Metal to Metal Seal No Opening

Top End Damage - Post Test View

Post Test – Side View Damage

12.4 Results and Conclusions

As result of this series of testing the outer closure bolts were torqued prior to removal and found to be at a reading of 25 ft/lbs. Upon removal of the outer closure lid a slight deformation of the inner wall was noted. There was no loss of containment contents found within the inner well area. The inner containment blind flange remained in good condition and sealed. The interior bolts were torqued with readings at 25 ft/lbs. The gaskets were intact with minimal damage. The payload drum did exhibit some crumpling at the lid but all of the payload materials remained within the drum and payload cavity as required. The inner cavity upon inspection showed no visible damage. The results of this series proved to be acceptable.

Post Test – No Loss of Payload Contents

Top Closure Lid – Post Test

Side Wall Deformation View

Post Test View of Containment Cavity

13.0 TEST PACKAGE SERIAL NUMBER 10550 – TEST RECORD TS-001-3

13.1 Test Number 3A – NCT Center of Gravity Drop

In test configuration 3A the test article was cooled and positioned with the center of gravity impact to be through the package bolted closure ring over the test pad at angle of 57 degrees from horizontal. The height of the drop was 4 feet from the lowest point of the package to the test pad surface. The air temperature at the time of the drop was 53°F and the wind speed was 5 mph. The package was attached to the release device and lifted by use of nylon straps to the proper orientation. The package was release so as not to impart any rotational motion to the free fall to the test pad.

Center of gravity 57° - NCT 4' Drop

Pre-Drop NCT 4' Height

The impact resulted in a deformation on the drum side at the closure bolt measuring 1-1/16 inch deep by 2 inches long. The diameter of the test article was decreased by 1/8 inch. All welds, bolts and closures remained in tact with no tearing of the outer structural components.

Post Drop Damage to Top Closure

Side View Center of Gravity NCT Damage

13.2 Test Number 3B – HAC 30' Center of Gravity Top Closure Drop

The test article used in test configuration 3B was previously used in 3A above and was positioned with the center of gravity through the bolted connection at an angle of 56 degrees from horizontal. The package was raised to the drop height of 30 feet-1 inch above the test pad surface from the lowest point of the package. The air temperature was 54.5°F with a wind speed of 5 mph.

HAC 30' Center of Gravity 57° Position

HAC 30' Impact

The impact resulted in a depression 11/16 inch deep into the lid and caused additional side deformation totaling 2-1/2 inches deep by 20 inches long. All welds, bolts and closures remained intact.

Accumulated Damage – Top Closure

Close-up Post Test Photograph

Close-up Damage from Center of Gravity Drop onto Top Closure Ring

Side View – Top End

13.3 Test Number 3C – HAC Shallow Angle Accelerated Drop (Slap Test)

Using the same test article that was utilized in 3B an oblique (Shallow Angle) drop from a height of 30 feet-1 inch and an angle of 17 degrees from horizontal was positioned over the test pad using nylon strap attached to the release mechanism. The height was measured from the lowest point of the package to the test pad surface.

Shallow Angle Accelerated Drop Set-up

17° Angle of HAC Shallow Angle Drop

Shallow Angle Drop Impact

The damage to the exterior package surface produced a tear at the exterior drum side to bottom rim connection point measuring 3/16 inch at its widest point by 7 inches in length. Although this slit to the outer drum sheet meet metal occurred, no internal breach of the inner liner occurred and the package remained completely sealed from the exterior atmosphere due to the design of the Vera-Pac with its inner liner directly in contact with the outer drum surface. Additional deformation at the bolted closure ring affected an area measuring 2-15/16 inches deep with a 1 inch crumple in the lid closure. The diameter of the package was reduced in the direction of the impact through the bolt by approximately 3 inches. The test article bolts and seals remained in place. Measurements of the damage were recorded and photographed.

Top End Damage from Shallow Angle Drop

Close-up View Impact Damage

Impact Side – Initial Impact Point View

Long Side View of Damage

Bolted top Closure & Ring Post Test Damage View

Bottom Slit at Drum Rim Showing Inner Metal Re-enforcing Sheet In Place with No Openings

13.4 Test Number 3D – HAC 1 Meter Puncture Drop – Center of Gravity Over Bolted Closure

The test article chosen for test configuration 3D was previously used in the test series above due to the accumulated damage to the exterior surface of the package. Based upon this damage the most detrimental orientation was chosen to be through the center of gravity at the bolted closure ring connection. The package was suspended by use of nylon straps which were attached to the release mechanism at a height of 41 inches measured from the lowest point of the package to the top of the puncture ram. The angle of orientation was 56 degrees from the horizontal position. The air temperature was 56°F and the wind speed was 5 mph. The test package was released so as not to impart rotation motion to the test article free fall to the impact point of the puncture ram.

56° Angle for Center of Gravity HAC Puncture Drop

HAC 1 Meter Center of Gravity Puncture Drop Height Position

Free Fall of Center of Gravity Puncture Drop

The impact upon the puncture ram produced additional damage to the side of the drum at the closure bolt with a small opening of ¼ inch by 3 inches long at the drum closure lid and drum rim interface. The opening was again sealed by a metal to metal contact between the flange and the drum lid insulation sheet metal cover and the top flange gasket which remained in tact. All welds, bolts and closures remained in place.

Impact Damage from Puncture Drop

Close-up View of ¼" Wide x 3" Long Gap – Sealed by Metal to Metal Contact and Top Flange Gasket

13.5 Results and Conclusions

As a result of this series of testing the outer closure bolts recorded a torque at less than 20 ft/lbs. Upon removal of the outer closure lid a bulge in the containment blind flange was discovered with some sand from within the containment cavity found. A deformation at the impact point to the inner wall was also recorded. The bolts of the inner containment flange were torqued with a reading of less than 20 ft/lbs recorded. Once the flange and payload had been removed inspection of the inner containment cavity found no visible damage. The inner gaskets were in good condition with only minimal damage to the outer closure gasket.

Damage from Series Testing Drop Total

Bulge in Containment Blind Flange Showing Loose Sand from Containment Cavity

Side Wall Damage and Bulge of Containment Flange

Post Test View of Top Closure Lid

Top View Containment Payload – Post-Test

The conclusion of this test series is that again corrections were needed to the blind flange seal and closure and that additional testing would be required.

14.0 CORRECTIONS AND ADDITIONAL TESTING

Based upon the information obtained from the series of drops conducted it was determined that due to the unsatisfactory results upon post test inspection that corrections to the internal blind flange closure were required prior to an additional testing. It is believed that the piston action from within the inner payload cavity was the primary cause of the damage to the containment closure. The damage to the flange led to the conclusion that the blind flange thickness of 3/16 inch was insufficient for the force that occurred during the test series and that an increase to ½ inch thick and the reinstallation of the inside flange pad would provide an acceptable condition after the follow up testing was complete. In addition it was decided that the bolt torque for all bolts on the Versa-Pac Shipping Container would 60 ft/lbs to provide a better sealing of the silicone coated fiberglass inner gasket and provide a much higher strength to support the impact of the piston action within the payload area.

After evaluation, two of the previously utilized test articles were found to be in good condition and were able to be resealed for use in the follow up test series. The payloads were identical to the original test series with 1-1/2 pounds of loose sand being placed on top of and around the inner payload as before. The test articles were fitted with new ½ inch thick inner blind flanges with 3/8 inch thick neoprene sponge rubber pads affixed to the inside of the inner flange prior to installation. The torque of inner containment blind flange was increased to 60 ft/lbs. The outer closure lid bolts were also torqued at 60 ft/lbs.

On review of the previous testing which produced unsatisfactory results it was determined that the testing should duplicate those tests. The test articles were then placed into the cooling chamber for a period of 18 hours prior to the new drop tests.

These tests were intended to validate that the corrections made to the design of the inner containment flange would prove to correct the loss of materials and damage to the flange previously found during the original drop testing.

15.0 RE-TEST PACKAGE SERIAL NUMBER 10551 – TEST RECORD TS-001-4

Containment Cavity with Payload With Loose Sand on top of Payload

Inner Containment Blind Flange

Pre-Test – Top Closure of Sealed Test Article

15.1 Re-Test Number 1A – NCT - 4' Top End Drop

On March 05, 2009 the package was removed from the cooling chamber and was transported to the test area. It was positioned with the top end of the package over the test target at an angle of 0 degrees so that the impact of the container would be directly onto the top surface of the package. The height of the test article from the lowest point to the surface of the test target was 4 feet. The air temperature was 58.5 degrees and wind speed of 5 mph. The package was release so that no rotational motion was imparted during the free fall to test pad surface. New package tare weight was increased by 43 ponds with the additional thickness of the inner flange.

Pre-Drop Top End Side View

NCT 4' Top End Drop Position

As a result of the impact no visible damage was found on the exterior surface of the package. All welds, closures and bolts remained intact. The results were recorded and photographed.

Post-Test Top End Drop Damage

15.2 Re-Test Number 1B – HAC 30' Top End Drop

After the NCT test above the package was positioned for test configuration 1B the HAC 30' drop onto the same surface and orientation of 0 degrees. The air temperature was 58.5°F and the wind speed was 5 mph.

Pre-Drop HAC 30' Top End Drop **30' Height Position Top End Drop**

Post test inspection of the outer surface found that the overall height had been reduced by 7/16 inch and that three of the top bolts had been impacted, but all bolts remained in place and sealed. There was no damage to any welds and no tears were found during the inspection.

Post Test View of Damage
Total Package Drops – 2 NCT,
3-HAC 30' Drop, 1-wCrush Plate Drop

15.3 Results and Conclusions

Prior to opening of the test package the outer bolts were torqued and readings were found to be between 20 and 80 ft/lbs. with all bolts intact. After opening the test article photographs were taken and the interior well surfaces inspected with no damage found. The new thicker blind flange remained flat, sealed and no loss of the payload contents were found outside the containment cavity. The bolts of the inner blind flange were torqued and found to have readings of between 30 to 50 ft/lbs. The gaskets and payload cavity were in good condition. All post test damage was recorded and photographed.

The conclusion of this series is that the design changes of increasing the flange thickness, increasing the torque requirement and the reinstallation of the flange inside pad were found to be successful.

½" Thick Inner Blind Flange Post Test Flat & No Loss of Payload Contents

Payload and Lose Sand Remained within the Containment Cavity

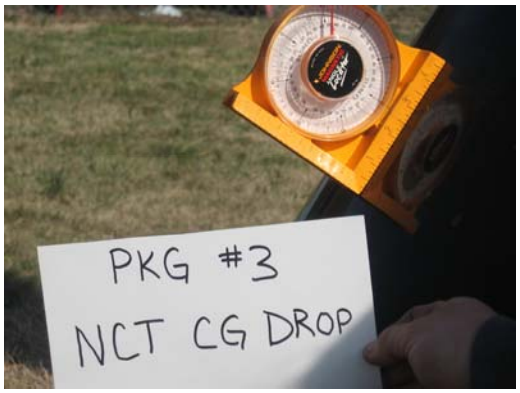
16.0 RE-TEST PACKAGE SERIAL NUMBER 10551 – TEST RECORD TS-001-5

16.1 Re-Test Number 3A – NCT Center of Gravity Drop

Top View of ½" Thick Blind Flange

Pre-Test Top View of Sealed Test Article

After cooling, the test article was positioned with the orientation at 57 degrees from horizontal over the test surface target so that the impact would be through the bolted closure of the package and through the center of gravity. The normal conditions drop was made from a height of 4 feet from the lowest point of the package to the test pad surface. The package was positioned using nylon straps attached to the release mechanism. The package was release so as not to impart any rotational motion during the free fall to the test pad. The temperature was 67.5°F with wind speed of 5 mph.



57° Angle NCT Center of Gravity

Positioned NCT 4' Height Center of Gravity Drop – Pre-Test View

NCT 4' Center of Gravity Impact

The impact resulted in a deformation on the closure bolt area with measurements of 1-3/16 inch deep by 2-1/4 inches long. All welds, bolts and closures remained intact. Damage was recorded and photographed.

NCT Post Test Damage View

16.2 Re-Test Number 3B – HAC 30' Center of Gravity Drop

Test configuration 3B was repositioned in the same attitude of 57 degrees so as to impact the identical area previously tested in test number 3A. The test article was raised to a height of 30 feet from the lowest point of the package to the surface of the test pad using nylon straps attached to the release mechanism.

HAC Center of Gravity Drop Positioned at 57° Angle

30’ Height Drop Position

HAC 30’ Impact Thru the Center of Gravity

As a result of the impact a deformation on the closure bolt area totaling 2-9/16 inches deep by 20-1/2 inches long was recorded. The diameter of the package was reduced by 5/16 inch. All welds, bolts and closures remain in place. There were no tears or openings found on the package.

Side View – Impact Damage from 30' Center of Gravity Drop

Top View of Damage

16.3 Re-Test Number 3C – HAC Shallow Angle Accelerated Drop (Slap Test)

Using the same test package, an oblique (Shallow angle) drop was positioned over the test pad at an angle of 17 degrees from horizontal with the height of the lowest point of the package 30 feet from the top surface of the test pad target. It was positioned using nylon straps attached to the release device. The package was released so as not to impart any rotational motion during the free fall to the test pad target.

HAC 30' Shallow Angle 17° Drop Position

30' Shallow Angle Drop Position

The damage to the exterior surface produced deformation on the initial top closure, measuring 2-5/16 inches deep with a 1 inch crumple of the outer closure lid. The secondary impact produced damage measuring – on the bottom rim of the test article. The diameter of the package in the direction of the impact was reduced by approximately 1 inch. There was no damage to any bolts, welds or closures and there were no tears found on inspection of the package.

End View of Top Damage from Initial Impact of Shallow Angle Drop

Close-Up of Damage to Impact Point

16.4 Results and Conclusions

Before opening the outer closure the torque was measure and found to be less than 20 ft/lbs. Photographs were taken and an inspection of the inner well area found only minor deformation to the sidewalls no other damage was found. The inner flange was flat and sealed with no loss of materials form within the inner containment cavity. Bolt torque of the inner flange recorded arrange of torque from 20 to 40 ft/lbs.

The conclusion of this series is that again, the design changes of increasing the flange thickness, increasing the torque requirement and the reinstallation of the flange inside pad were found to provide acceptable results.

Post Series Side View–Package Drop Total 2- NCT Drops, 3-HAC 30' Drops & 1-Puncture Drop

½" Thick Inner Blind Flange Post Test Flat & No Loss of Payload Contents

Payload and Lose Sand Remained within the Containment Cavity

17.0 POST TEST MEASEUREMENTS

On March 05, 2009, the post test inspection and measurements were taken and recorded on all test articles.

Test Article Serial Number 10550

Location	Post-Test Measurement	Description
A-C	21-1/16” ID	Inner Container
A-C	31-1/6” Ø	Outer Container
A	42”	Drum Height
A	5”	Wall – In/Our
A	29-11/16”	Inside Height
A	7-7/16”	Top Rim – Inside Flange
B	42”	Drum Height
B	7-5/16”	Top Rim – Inside Flange
B	5”	Wall – In/Out
B-D	20-7/8” ID	Inner Container
B-D	30-15/16”Ø	Outer Container
C	29-11/16”	Inside Height
C	5-1/4”	Wall – In/Out
C	42”	Drum Height
C	7-3/16”	Top Rim – Inside Flange
D	29-11/16”	Inside Height
D	42”	Outer Container
D	7-1/4”	Top Rim – Inside Flange
D	5-9/16”	Wall – In/Out

Final Tare Weight – 660 Pounds
Final Gross Weight – 920 Pounds

Test Article Serial Number 10551

Location	Post-Test Measurement	Description
A-C	20-7/8" ID	Inner Container
A-C	31-1/16" Ø	Outer Container
A	41-15/16"	Drum Height
A	5-1/16"	Wall – In/Our
A	29-3/4"	Inside Height
A	7-3/8"	Top Rim – Inside Flange
B	41-7/8"	Drum Height
B	7-3/16"	Top Rim – Inside Flange
B	5-1/8"	Wall – In/Out
B-D	20-7/8" ID	Inner Container
B-D	31-1/8"Ø	Outer Container
C	29-3/4"	Inside Height
C	5-3/16"	Wall – In/Out
C	42-3/16"	Drum Height
C	7-3/16"	Top Rim – Inside Flange
D	29-3/4"	Inside Height
D	42-1/16"	Outer Container
D	7-1/4"	Top Rim – Inside Flange
D	5-1/16"	Wall – In/Out

Final Tare Weight – 704 Pounds Final Gross Weight 964 Pounds

Test Article Serial Number 10552

Location	Post-Test Measurement	Description
A-C	20-15/16" ID	Inner Container
A-C	29-7/8" Ø	Outer Container
A	41-11/16"	Drum Height
A	5-1/4"	Wall – In/Our
A	29-5/8"	Inside Height
A	6-13/16"	Top Rim – Inside Flange
B	41-5/8"	Drum Height
B	6-7/8"	Top Rim – Inside Flange
B	5-5/16"	Wall – In/Out
B-D	20-15/16" ID	Inner Container
B-D	30-11/16"Ø	Outer Container
C	29-11/16"	Inside Height
C	5-1/16"	Wall – In/Out
C	41-11/16"	Drum Height
C	6-7/8"	Top Rim – Inside Flange
D	29-5/8"	Inside Height
D	41-7/8"	Outer Container
D	6-3/4"	Top Rim – Inside Flange
D	5"	Wall – In/Out

Final Tare Weight - 705 Pounds Final Gross Weight – 965 Pounds

18.0 FINAL CONCLUSION OF ALL TEST RESULTS

The objective of this test program was to conduct the physical evaluation test of Century Industries Versa-Pac Shipping Container design in accordance with the Normal Conditions of Transport (NCT) and the Hypothetical Accident Conditions (HAC) specified in 10 CFR 71 and Century Industries Test Plan TP-001 Revision 0 to verify the performance capabilities under specified conditions. The Versa-Pac was subjected to performance test simulating hypothetical accident condition for free drop, crush, shallow angle and puncture described in 10 CFR 71.71 and 73. Following each test, the physical condition of the test package was inspected and the results were recorded and photographed.

The acceptance criteria for the all test series was retention of the outer closure, no openings, tears or failure that would lead to loss of material, no open pathways to the insulation materials and no loss of the inner containment payload.

The test series results provided information that the internal blind flange of the containment cavity allowed payload contents to escape into the outer well of the package during two of the initial three test series.

To correct this condition it was determined that a increase in the thickness of the blind flange, addition of a neoprene sponge rubber pad affixed to the inside of the flange and an increase in the torque requirement would be needed. With completion of these changes two previously utilized test articles were refitted with the changes and subjected to the identical test series which caused the unacceptable results.

Following the re-test of these packages, when subjected to the original test series requirements, the post test inspection found that the acceptance criteria had been successfully met.

There was no shift in the payload cavity, no contents outside the containment cavity and no unacceptable damage to the inner or outer surfaces of the Versa-Pac Shipping Container. Additionally, the results of these physical performance evaluation tests demonstrate that the package system is capable of meeting the requirements of 10 CFR 71 and Century Industries Test Plan TP-0001 Revision 0.

19.0 TEST DROP TOTALS

Three Versa-Pac Shipping Containers were subjected to a total of 5 test series during the test program described above, along with the preliminary testing as follows in the table below:

Item	55 Gallon – Preliminary Prototype	110 Gallon Preliminary Prototype	110 Gallon Test Article
4’ NCT Drops	1	1	5
30’ HAC Drops	1	1	5
30’ Shallow Angle	N/A	N/A	2
30’ Crush Plate	1	1	1
1 Meter Puncture	3	4	2

20.0 ATTACHMENTS, REFENECES & CALIBRATION RECORDS

Attachment A – Test Plan TP-001 Revision 0
Attachment B – Test Specification TS-001-1 Revision 0
Attachment C – Century Industries NCT and HAC Test Record
Attachment D – Preliminary Drop Test Results & Conclusions
Attachment E – Training & Calibration Records
Reference 1 – 10 CFR Part 71
Reference 2 – NUREG 6818

Attachment A

Test Plan TP-001 Revision 0

(Consisting of 28 pages)

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

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Figure Withheld Under 10 CFR 2.390

Attachment B

Test Specification TS-001 Revision 0

(Consisting of 12 Pages)

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

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Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Attachment C

NCT & HAC Test Series Records

(25 Pages)

Century Industries **NCT and HAC Test Record No.** TS-001-1 **Page 1 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Test Package Serial No. 10552 (#3) Package Description: Versa-Pac (110-Gallon Version)

Test Program Manager: William M. Ald Date: 2-25-09
Test Engineer: William M. Ald Date: 2-25-09
Quality Assurance Coordinator: Heather Yuill Date: 2/26/09

Photographic Equipment

Sony Cyber-Shot (4.1 Mega Pixel) Digital Camera DSC-P73
Sony Digital Handycam Mini-DV DCR-TRV17
Sony Handycam Mini-DV DCR-HC20

Calibrated Equipment Utilized

Surface Thermometer s/N: 05548
Starrett Steel Tape Measure s/N: 08461846
Cummins Industrial Tools Tape Measure (25'x1") No. 3286

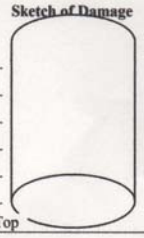
Package Preparation Checklist and Measurements

Procedure Step No.	Description	Date	Initials
6.1.2	Measure and record package temperature upon removal from conditioning room AT TRANSPORT. -28°F Package temperature (°F)	2-26-09	WMA
	Photograph interior and exterior of the package prior to loading	2-25-09	WMA
	Measure centerline and near side distance to edge of cavity and mark on package	2-25-09	WMA
	Weigh empty test package 661 Package tare weight (lbs)	2-25-09	WMA
	Load pre-loaded 30-gal drum into the test package, closed and torque drum to required torque of 60 ft./lbs.	2-25-09	WMA
	Spread one (1) pound of residual sand/dirt into the inner containment cavity	2-25-09	WMA
	Inspect the inner containment components for good condition and in accordance with drawings	2-25-09	WMA
	Install cavity gasket and blind flange, snug all bolts, then torque to 40 ft-lbs	2-25-09	WMA
	Install outer gasket and reinforced drum lid with proper bolts per drawing and torque to 40 ft-lbs.	2-25-09	WMA
↓	Install outer drum ring and torque to 60 ft-lbs	2-25-09	WMA

Century Industries **NCT and HAC Test Record No.** TS-001-1 **Page 2 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Procedure Step No.	Description	Date	Initials
6.1.2	Weigh loaded test package 923 Package test weight (lbs)	2-25-09	WMA
↓	Measure height from bottom rim to top of closure ring and diameter of outer package at center rolling hoop of drum and mark measurements on the test package 41 7/8 Package height (in.) 31 3/8 Package diameter (in.)	2/26/09	HL
	Verify the external acetate vent plug is in place	2/26/09	HL
↓	Photograph exterior of test package for evidence of pre-test condition	2/26/09	HL

Test Number (Description): 1A (NCT Top End Drop)

Procedure Step No.	Description	Date	Initials
6.1.2	Measure and record air temperature at drop pad 45 Air Temperature(°F) 4 Wind speed (mph)	2/26/09	HL
↓	Measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	2/26/09	HL
	Lift test article to required drop height	2/26/09	HL
↓	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 48 Drop test height (in.)	2/26/09	HL
6.1.3	Photograph exterior surfaces of test article for visual evidence of damage	2/26/09	HL
↓	Document visual damage to package (e.g. deformation or bolt failure) No visible damage. Sketch of Damage  	2/26/09	HL
↓	Measure height and diameter of test package 41 7/8 Package height (in.) 31 3/16 Package diameter (in.)	2/26/09	HL

Century Industries **NCT and HAC Test Record No.** TS-001-1 **Page 3 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Test Number (Description): 1B (HAC Top End Drop)

Procedure Step No.	Description	Date	Initials
6.2.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HL
	Measure and record the air temperature at the drop pad 45 Air temperature(°F) 4 Wind speed (mph)	2/26/09	HL
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	2/26/09	HL
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 360 Drop test height (in.)	2/26/09	HL
6.2.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HL
	Document visual damage to package (e.g. deformation or bolt failure) Crumple zone under lid rim is 2 3/8". Reduced height of package by 1/4" and increased diameter by 1/16". Sketch of Damage Top	2/26/09	HL
	Measure and record height and diameter of test article 41 5/8 Package height (in.) 31 3/8 Package diameter (in.)	2/26/09	HL

Test Number (Description): 1C (HAC 1-M Puncture Drop-Horizontal)

Procedure Step No.	Description	Date	Initials
6.3.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HL
	Measure and record the air temperature at the drop pad HL 2/26/09 45 56 Air temperature (°F) HL 2/26/09 4 5 Wind speed (mph)	2/26/09	HL
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 1° Angle of orientation	2/26/09	HL

Century Industries
Bristol, Virginia

NCT and HAC Test Record No. TS-001-1
in accordance with
Versa- Pac Test Specification, TS-001, Rev. 0

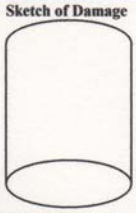
Page 4 of 5

Procedure Step No.	Description	Date	Initials
6.3.2	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 41 Drop test height (in.)	2/26/09	HR
6.3.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HR
↓	Document visual damage to package (e.g. deformation or bolt failure) 3/8" maximum deformation from puncture pin. Sketch of Damage Top	2/26/09	HR
↓	Measure and record height and diameter of test article 41 11/16 Package height (in.) 31 3/8 Package diameter (in.)	2/26/09	HR

Test Number (Description): N/A

Procedure Step No.	Description	Date	Initials
	Photograph exterior surfaces of test article for visual evidence of pre-test condition		
	Measure and record the air temperature at the drop pad _____ Air temperature(°F) _____ Wind speed (mph)		
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) _____ Angle of orientation		
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) _____ Drop test height (in.)		
	Photograph exterior surfaces of test article for visual evidence of additional damage		

Century Industries **NCT and HAC Test Record No.** TS-001-1 **Page 5 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Procedure Step No.	Description	Date	Initials
	Document visual damage to package (e.g. deformation or bolt failure) _____ _____ _____ _____ _____ Top 		
	Measure and record height and diameter of test article _____ Package height (in.) _____ Package diameter (in.)		

Final Test Record Measurements

Procedure Step No.	Description	Date	Initials
6.3.3	Measure and record torque of outer closure bolts 30 Torque (ft-lbs)	2/24/09	HR
	Open outer package and remove outer lid	2/24/09	HR
	Photograph interior surface of test article and examine for any apparent indications of containment boundary loss, e.g. payload materials Bulge in containment lid with a little sand around outside edge of lid.	2/24/09	HR
	Measure and record torque of interior bolts 20 Torque (ft-lbs)	2/24/09	HR
	Remove inner containment cavity blind flange	2/24/09	HR
	Examine and document condition of the gasket and payload contents Bulge in inner drum lid. No damage to gasket.	2/24/09	HR
	Measure and record the pre-test and post-test centerline and near side distance to edge of cavity for comparison (See attached Measurement Data Sheet)	2/24/09	HR
	Remove (if possible) and document any apparent damage or movement to the inner containment cavity No apparent damage.	2/24/09	HR
↓	Photograph inner cavity to provide visual evidence of any apparent damage	2/24/09	HR

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Versa- Pac Test Specification, TS-001, Rev. 0

Test Package Serial No. 10551 (#2) Package Description: Versa-Pac (110-Gallon Version)

Test Program Manager: William D. Arnold Date: 2-25-09
Test Engineer: William D. Arnold Date: 2-25-09
Quality Assurance Coordinator: Heather Little Date: 2/26/09

Photographic Equipment

Sony Cyber-Shot (4.1 Mega Pixel) Digital Camera DSC-P73
Sony Digital Handy-cam Mini-DV DCR-TRV17
Sony Handycam Mini-DV DCR-HC20

Calibrated Equipment Utilized

Surface Thermometer S/N: 05548
Starrett Steel Tape Measure S/N: 08461846
Cummins Industrial Tools Tape Measure (25'x1") No. 3286

Package Preparation Checklist and Measurements

Procedure Step No.	Description	Date	Initials
7.1.2	Measure and record package temperature upon removal from conditioning room AT TRANSPORT. -28°F Package temperature (°F)	2-26-09	WMA
	Photograph interior and exterior of the package prior to loading	2-25-09	WMA
	Measure centerline and near side distance to edge of cavity and mark on package	2-25-09	WMA
	Weigh empty test package 662 Package tare weight (lbs)	2-25-09	WMA
	Load pre-loaded 30-gal drum into the test package, closed and torque drum to required torque of 60 ft./lbs.	2-25-09	WMA
	Spread one (1) pound of residual sand/dirt into the inner containment cavity	2-25-09	WMA
	Inspect the inner containment components for good condition and in accordance with drawings	2-25-09	WMA
	Install cavity gasket and blind flange, snug all bolts, then torque to 40 ft-lbs	2-25-09	WMA
	Install outer gasket and reinforced drum lid with proper bolts per drawing and torque to 40 ft-lbs.	2-25-09	WMA
✓	Install outer drum ring and torque to 60 ft-lbs	2-25-09	WMA

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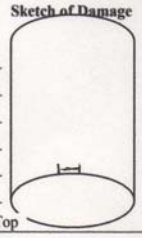
Procedure Step No.	Description	Date	Initials
7.1.2	Weigh loaded test package 923 1/2 Package test weight (lbs)	2/26/09	HR
↓	Measure height from bottom rim to top of closure ring and diameter of outer package at center rolling hoop of drum and mark measurements on the test package 42 1/4 Package height (in.) 31 1/8 Package diameter (in.)	2/26/09	HR
	Verify the external acetate vent plug is in place	2/26/09	HR
↓	Photograph exterior of test package for evidence of pre-test condition	2/26/09	HR

Test Number (Description): 2A (NCT Horizontal Side Drop)

Procedure Step No.	Description	Date	Initials
7.1.2	Measure and record air temperature at drop pad 47.5 Air Temperature(°F) 4 Wind speed (mph)	2/26/09	HR
↓	Measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	2/26/09	HR
	Lift test article to required drop height	2/26/09	HR
↓	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 48 Drop test height (in.)	2/26/09	HR
7.1.3	Photograph exterior surfaces of test article for visual evidence of damage	2/26/09	HR
↓	Document visual damage to package (e.g. deformation or bolt failure) Closure bolt pushed into package about 5/8". Sketch of Damage  Top	2/26/09	HR
↓	Measure height and diameter of test package 42 1/4 Package height (in.) 31 1/8 Package diameter (in.)	2/26/09	HR

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Test Number (Description): 2B (HAC - 30' Horizontal Drop)

Procedure Step No.	Description	Date	Initials
7.2.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HR
	Measure and record the air temperature at the drop pad 48 Air temperature(°F) 4 Wind speed (mph)	2/26/09	HR
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	2/26/09	HR
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 361 Drop test height (in.)	2/26/09	HR
7.2.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HR
	Document visual damage to package (e.g. deformation or bolt failure) Buckling around closure bolt area and on lid. Decreased diameter by 1". Sketch of Damage:	2/26/09	HR
	Measure and record height and diameter of test article 42 1/4 Package height (in.) 31 3/8 Package diameter (in.) 30" at bolt	2/26/09	HR

Test Number (Description): 2C (HAC - 30' Crush Plate Side Drop)

Procedure Step No.	Description	Date	Initials
7.3.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HR
	Measure and record the air temperature at the drop pad 49 Air temperature (°F) 4 Wind speed (mph)	2/26/09	HR
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	2/26/09	HR

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Procedure Step No.	Description	Date	Initials
7.3.2	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 361 Drop test height (in.)	2/26/09	HR
7.3.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HR
↓	Document visual damage to package (e.g. deformation or bolt failure) 1" decrease in diameter. Additional ¼" deformation from bolt to opposite seam. ¼" x 1¼" gap at bolt btw. drum lid and rim with visible metal-metal contact. Lost drum ring. Sketch of Damage Top	2/26/09	HR
↓	Measure and record height and diameter of test article 42 1/4 Package height (in.) 31 3/8 Package diameter (in.) 28 3/4" at bolt 29" at crush point	2/26/09	HR

Test Number (Description): N/A

Procedure Step No.	Description	Date	Initials
	Photograph exterior surfaces of test article for visual evidence of pre-test condition		
	Measure and record the air temperature at the drop pad _____ Air temperature(°F) _____ Wind speed (mph)		
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) _____ Angle of orientation		
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) _____ Drop test height (in.)		
	Photograph exterior surfaces of test article for visual evidence of additional damage		

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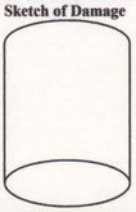
Procedure Step No.	Description	Date	Initials
	Document visual damage to package (e.g. deformation or bolt failure) _____ _____ _____ _____ _____ Top 		
	Measure and record height and diameter of test article _____ Package height (in.) _____ Package diameter (in.)		

Final Test Record Measurements

Procedure Step No.	Description	Date	Initials
7.3.3	Measure and record torque of outer closure bolts 25 Torque (ft-lbs)	2/26/09	HR
	Open outer package and remove outer lid	2/26/09	HR
	Photograph interior surface of test article and examine for any apparent indications of containment boundary loss, e.g. payload materials Slight inner wall deformation. No apparent loss of contents.	2/26/09	HR
	Measure and record torque of interior bolts 25 Torque (ft-lbs)	2/26/09	HR
	Remove inner containment cavity blind flange	2/26/09	HR
	Examine and document condition of the gasket and payload contents Gasket intact with minimal damage. Payload still inside drum. Some crumpling of drum lid.	2/26/09	HR
	Measure and record the pre-test and post-test centerline and near side distance to edge of cavity for comparison (See attached Measurement Data Sheet)	2/26/09	HR
	Remove (if possible) and document any apparent damage or movement to the inner containment cavity No apparent damage	2/26/09	HR
	Photograph inner cavity to provide visual evidence of any apparent damage	2/26/09	HR

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Versa- Pac Test Specification, TS-001, Rev. 0

Test Package Serial No. 10550(#1) Package Description: Versa-Pac (110-Gallon Version)

Test Program Manager: William D. Arld Date: 2-25-09
Test Engineer: William D. Arld Date: 2-25-09
Quality Assurance Coordinator: Heather Little Date: 2/26/09

Photographic Equipment

Sony Cyber-Shot (4.1 Mega Pixel) Digital Camera DSC-P73
Sony Digital Handycam Mini-DV DCR-TR17
Sony Handycam Mini-DV DCR-HC20

Calibrated Equipment Utilized

Surface Thermometer S/N: 05548
Starrett Steel Tape Measure S/N: 08461846
Cummins Industrial Tools Tape Measure (25'x1") No. 3286

Package Preparation Checklist and Measurements

Procedure Step No.	Description	Date	Initials
8.1.2	Measure and record package temperature upon removal from conditioning room AT TRANSPORT. -28°F Package temperature (°F)	2-26-09	WMA
	Photograph interior and exterior of the package prior to loading	2-25-09	WMA
	Measure centerline and near side distance to edge of cavity and mark on package	2-25-09	WMA
	Weigh empty test package 1660 Package tare weight (lbs)	2-25-09	WMA
	Load pre-loaded 30-gal drum into the test package, closed and torque drum to required torque of 60 ft./lbs.	2-25-09	WMA
	Spread one (1) pound of residual sand/dirt into the inner containment cavity	2-25-09	WMA
	Inspect the inner containment components for good condition and in accordance with drawings	2-25-09	WMA
	Install cavity gasket and blind flange, snug all bolts, then torque to 40 ft-lbs	2-25-09	WMA
	Install outer gasket and reinforced drum lid with proper bolts per drawing and torque to 40 ft-lbs.	2-25-09	WMA
	Install outer drum ring and torque to 60 ft-lbs	2-25-09	WMA

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Procedure Step No.	Description	Date	Initials
8.1.2	Weigh loaded test package 920 Package test weight (lbs)	2-25-09	WMR
	Measure height from bottom rim to top of closure ring and diameter of outer package at center rolling hoop of drum and mark measurements on the test package 41 13/16 Package height (in.) 31 1/8 Package diameter (in.)	2/26/09	HR
	Verify the external acetate vent plug is in place	2/26/09	HR
↓	Photograph exterior of test package for evidence of pre-test condition	2/26/09	HR

Test Number (Description): 3A (NCT Center of Gravity Drop)

Procedure Step No.	Description	Date	Initials
8.1.2	Measure and record air temperature at drop pad 53 Air Temperature(°F) 5 Wind speed (mph)	2/26/09	HR
	Measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 57° Angle of orientation	2/26/09	HR
	Lift test article to required drop height	2/26/09	HR
↓	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 48 Drop test height (in.)	2/26/09	HR
8.1.3	Photograph exterior surfaces of test article for visual evidence of damage	2/26/09	HR
↓	Document visual damage to package (e.g. deformation or bolt failure) 1 1/16" x 2" deformation at bolt area. Sketch of Damage Top	2/26/09	HR
↓	Measure height and diameter of test package 42 3/16" Package height (in.) 31" Package diameter (in.)	2/24/09	HR

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Test Number (Description): 3B (HAC - 30' Center of Gravity Top Closure Drop)

Procedure Step No.	Description	Date	Initials
8.2.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HK
	Measure and record the air temperature at the drop pad 54.5 Air temperature(°F) 5 Wind speed (mph)	2/26/09	HK
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 56° Angle of orientation	2/26/09	HK
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 361 Drop test height (in.)	2/26/09	HK
8.2.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HK
	Document visual damage to package (e.g. deformation or bolt failure) 11/16" ht. in crumpling on lid. 2 1/2" x 20" deformation at bolt area Sketch of Damage Top	2/26/09	HK
	Measure and record height and diameter of test article 42 3/16 Package height (in.) → 40 3/4" at bolt 31 1/2 Package diameter (in.) → 30 1/4" at bolt	2/26/09	HK

Test Number (Description): 3C (HAC 30' Shallow Angle Accelerated Drop)

Procedure Step No.	Description	Date	Initials
8.3.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HK
	Measure and record the air temperature at the drop pad 54.5 Air temperature (°F) 5 Wind speed (mph)	2/26/09	HK
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 17° Angle of orientation	2/26/09	HK

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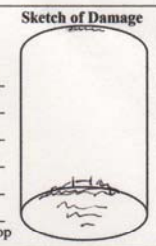
Procedure Step No.	Description	Date	Initials
8.3.2	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 361 Drop test height (in.)	2/26/09	HR
8.3.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HR
	Document visual damage to package (e.g. deformation or bolt failure) 3/16" x 7" weld tear on drum bottom with no breach of inner liner. 2 15/16" deformation at bolt. 1" crumpling ht. in lid. Sketch of Damage  Top	2/26/09	HR
	Measure and record height and diameter of test article 42 3/16 Package height (in.) → 40 15/16" at bolt 31 5/8 Package diameter (in.) → 28 1/2" at bolt	2/26/09	HR

Test Number (Description): ~~4~~ 3D (HAC 1-M Puncture Drop - CG over bolt area) WMA 2-26-09

Procedure Step No.	Description	Date	Initials
9.1.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	2/26/09	HR
	Measure and record the air temperature at the drop pad 56 Air temperature(°F) 5 Wind speed (mph)	2/26/09	HR
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 56° Angle of orientation	2/26/09	HR
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 41" Drop test height (in.)	2/26/09	HR
9.1.3	Photograph exterior surfaces of test article for visual evidence of additional damage	2/26/09	HR

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Procedure Step No.	Description	Date	Initials
9.1.3	Document visual damage to package (e.g. deformation or bolt failure) 1/4" maximum deformation from puncture pin. 1/4" x 3" gap in already damaged area btw. drum lid + rim. ~~No~~ Visible metal-metal contact and apparent intact gasket seal inside this gap.	2/26/09	HH
9.1.3	Measure and record height and diameter of test article 42 3/16 Package height (in.) 31 5/8 Package diameter (in.) → 28 9/16 at bolt	2/26/09	HH

Final Test Record Measurements

Procedure Step No.	Description	Date	Initials
8.3.3	Measure and record torque of outer closure bolts < 20 Torque (ft-lbs)	2/26/09	HH
	Open outer package and remove outer lid	2/26/09	HH
	Photograph interior surface of test article and examine for any apparent indications of containment boundary loss, e.g. payload materials Bulge in containment lid with some sand on top of lid. Deformation of inner wall at impact area.	2/26/09	HH
	Measure and record torque of interior bolts < 20 Torque (ft-lbs)	2/26/09	HH
	Remove inner containment cavity blind flange	2/26/09	HH
	Examine and document condition of the gasket and payload contents Inner and outer gaskets in good condition with minimal damage of outer gasket.	2/26/09	HH
	Measure and record the pre-test and post-test centerline and near side distance to edge of cavity for comparison (See attached Measurement Data Sheet)	2/26/09	HH
	Remove (if possible) and document any apparent damage or movement to the inner containment cavity No apparent damage.	2/26/09	HH
	Photograph inner cavity to provide visual evidence of any apparent damage	2/26/09	HH

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Versa- Pac Test Specification, TS-001, Rev. 0

Test Package Serial No. 10551 (#2) Package Description: Versa-Pac (110-Gallon Version)

Test Program Manager: William M. Arnold Date: 3-4-09
Test Engineer: William M. Arnold Date: 3-4-09
Quality Assurance Coordinator: Heather Little Date: 3/5/09

Photographic Equipment

Sony Cyber-Shot (4.1 Mega Pixel) Digital Camera DSC-P73
Sony Digital Handycam Mini-DV DCR-TR17
Sony Handycam Mini-DV DCR-HC20

Calibrated Equipment Utilized

Surface Thermometer S/N: 05548
Starrett Steel Tape Measure S/N: 09461846
Cummins Industrial Tools Tape Measure (25'x1") No. 3286

Package Preparation Checklist and Measurements

Procedure Step No.	Description	Date	Initials
6.1.2	Measure and record package temperature upon removal from conditioning room AT TRANSPORT. -29°F Package temperature (°F)	3-5-09	WMA
	Photograph interior and exterior of the package prior to loading	3-4-09	WMA
	Measure centerline and near side distance to edge of cavity and mark on package	3-4-09	WMA
	Weigh empty test package 105 Package tare weight (lbs)	3-4-09	WMA
	Load pre-loaded 30-gal drum into the test package, closed and torque drum to required torque of 60 ft./lbs.	3-4-09 WMA	WMA
	Spread one (1) pound of residual sand/dirt into the inner containment cavity	WMA 3-4-09	WMA
	Inspect the inner containment components for good condition and in accordance with drawings	3-4-09	WMA
	Install cavity gasket and blind flange, snug all bolts, then torque to ~~40~~ ft-lbs WMA 3-4-09 60 FT/Lbs.	3-4-09	WMA
	Install outer gasket and reinforced drum lid with proper bolts per drawing and torque to ~~40 ft-lbs.~~ WMA 3-04-09 60 Ft-Lbs.	3-4-09	WMA
	Install outer drum ring and torque to 60 ft-lbs	3-4-09	WMA

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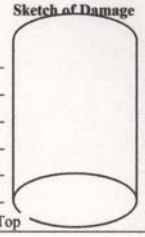
Procedure Step No.	Description	Date	Initials
6.1.2	Weigh loaded test package 965 Package test weight (lbs)	3-4-09	WMA
	Measure height from bottom rim to top of closure ring and diameter of outer package at center rolling hoop of drum and mark measurements on the test package 42 1/4 Package height (in.) 31 3/8 Package diameter (in.)	3/5/09	HK
	Verify the external acetate vent plug is in place	3/5/09	HK
↓	Photograph exterior of test package for evidence of pre-test condition	3/5/09	HK

Test Number (Description): 1A (NCT Top End Drop)

Procedure Step No.	Description	Date	Initials
6.1.2	Measure and record air temperature at drop pad 58.5 Air Temperature(°F) 5 Wind speed (mph)	3/5/09	HK
	Measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	3/5/09	HK
	Lift test article to required drop height	3/5/09	HK
↓	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 48 Drop test height (in.)	3/5/09	HK
6.1.3	Photograph exterior surfaces of test article for visual evidence of damage	3/5/09	HK
	Document visual damage to package (e.g. deformation or bolt failure) No visible additional damage. Sketch of Damage  Top	3/5/09	HK
↓	Measure height and diameter of test package 42 1/4 Package height (in.) 31 3/8 Package diameter (in.)	3/5/09	HK

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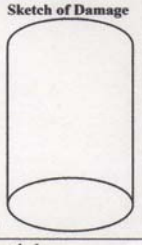
Test Number (Description): 1B (HAC Top End Drop)

Procedure Step No.	Description	Date	Initials
6.2.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	3/5/09	HR
	Measure and record the air temperature at the drop pad 58.5 Air temperature(°F) 5 Wind speed (mph)	3/5/09	HR
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 0° Angle of orientation	3/5/09	HR
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 360 Drop test height (in.)	3/5/09	HR
6.2.3	Photograph exterior surfaces of test article for visual evidence of additional damage	3/5/09	HR
	Document visual damage to package (e.g. deformation or bolt failure) 3 bolts flattened and 2 bolts partially flattened. 7/16" decrease in height. Sketch of Damage:  Top	3/5/09	HR
	Measure and record height and diameter of test article 41 13/16 Package height (in.) 31 3/8 Package diameter (in.)	3/5/09	HR

Test Number (Description): N/A

Procedure Step No.	Description	Date	Initials
	Photograph exterior surfaces of test article for visual evidence of pre-test condition		
	Measure and record the air temperature at the drop pad _____ Air temperature (°F) _____ Wind speed (mph)		
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) _____ Angle of orientation		

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Procedure Step No.	Description	Date	Initials
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) _____ Drop test height (in.)		
	Photograph exterior surfaces of test article for visual evidence of additional damage		
	Document visual damage to package (e.g. deformation or bolt failure) _____ _____ _____ _____ _____ _____ Top **Sketch of Damage**		
	Measure and record height and diameter of test article _____ Package height (in.) _____ Package diameter (in.)		

Test Number (Description): N/A

Procedure Step No.	Description	Date	Initials
	Photograph exterior surfaces of test article for visual evidence of pre-test condition		
	Measure and record the air temperature at the drop pad _____ Air temperature(°F) _____ Wind speed (mph)		
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) _____ Angle of orientation		
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) _____ Drop test height (in.)		
	Photograph exterior surfaces of test article for visual evidence of additional damage		

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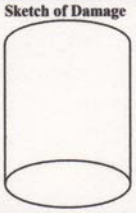
Procedure Step No.	Description	Date	Initials
	Document visual damage to package (e.g. deformation or bolt failure) _____ _____ _____ _____ _____ Top 		
	Measure and record height and diameter of test article _____ Package height (in.) _____ Package diameter (in.)		

Final Test Record Measurements

Procedure Step No.	Description	Date	Initials
6.3.3	Measure and record torque of outer closure bolts 20-80 Torque (ft-lbs)	3/5/09	HK
	Open outer package and remove outer lid	3/5/09	HK
	Photograph interior surface of test article and examine for any apparent indications of containment boundary loss, e.g. payload materials No apparent damage and no loss of contents.	3/5/09	HK
	Measure and record torque of interior bolts 30-50 Torque (ft-lbs)	3/5/09	HK
	Remove inner containment cavity blind flange	3/5/09	HK
	Examine and document condition of the gasket and payload contents Gasket and payload in good condition	3/5/09	HK
	Measure and record the pre-test and post-test centerline and near side distance to edge of cavity for comparison (See attached Measurement Data Sheet) N/A	3-5-09	WMA
	Remove (if possible) and document any apparent damage or movement to the inner containment cavity INNER Blind Flange Remains Sealed & Flat No Loss of MATL OUTSIDE INNER CONTAINMENT.	3-5-09	WMA
↓	Photograph inner cavity to provide visual evidence of any apparent damage	3-5-09	WMA

Century Industries **NCT and HAC Test Record No.** TS-001-5 **Page 1 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Test Package Serial No. 10552 (#3) Package Description: Versa-Pac (110-Gallon Version)

Test Program Manager: Willm. A U Date: 3-4-09
Test Engineer: Willm. A U Date: 3-4-09
Quality Assurance Coordinator: Heather Little Date: 3/5/09

Photographic Equipment

Sony Cyber-Shot (4.1 MegaPixel) Digital Camera DSC-P73
Sony Digital Handycam Mini-DV DCR-TR17
Sony Handycam Mini-DV DCR-HC20

Calibrated Equipment Utilized

Surface Thermometer S/N: 05548
Starrett Steel Tape Measure S/N: 084618446
Cummins Industrial Tools Tape Measure (25'x1") No. 3286

Package Preparation Checklist and Measurements

Procedure Step No.	Description	Date	Initials
8.1.2	Measure and record package temperature upon removal from conditioning room AT TRANSPORT -29°F Package temperature (°F)	3-5-09	WMA
	Photograph interior and exterior of the package prior to loading	3-4-09	WMA
	Measure centerline and near side distance to edge of cavity and mark on package	3-4-09	WMA
	Weigh empty test package 704 ~~705~~ WMA 3-4-09 Package tare weight (lbs)	3-4-09	WMA
	Load pre-loaded 30-gal drum into the test package, closed and torque drum to required torque of 60 ft./lbs.	3-4-09	WMA
	Spread one (1) pound of residual sand/dirt into the inner containment cavity	3-4-09	WMA
	Inspect the inner containment components for good condition and in accordance with drawings	3-4-09	WMA
	Install cavity gasket and blind flange, snug all bolts, then torque to ~~40 ft-lbs~~ WMA 3-4-09 60 FT-Lbs.	3-4-09	WMA
	Install outer gasket and reinforced drum lid with proper bolts per drawing and torque to ~~40 ft-lbs.~~ WMA 3-4-09 60 FT-Lbs.	3-4-09	WMA
	Install outer drum ring and torque to 60 ft-lbs	3-4-09	WMA

Century Industries **NCT and HAC Test Record No.** TS-001-5 **Page 2 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Procedure Step No.	Description	Date	Initials
8.1.2	Weigh loaded test package 965 Package test weight (lbs)	3-4-09	WMA
	Measure height from bottom rim to top of closure ring and diameter of outer package at center rolling hoop of drum and mark measurements on the test package 42 Package height (in.) 31 3/8 Package diameter (in.)	3/5/09	HR
	Verify the external acetate vent plug is in place	3/5/09	HR
	Photograph exterior of test package for evidence of pre-test condition	3/5/09	HR

Test Number (Description): 3A (NCT Center of Gravity Drop)

Procedure Step No.	Description	Date	Initials
8.1.2	Measure and record air temperature at drop pad 67.5 Air Temperature(°F) 5 Wind speed (mph)	3/5/09	HR
	Measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 57° Angle of orientation	3/5/09	HR
	Lift test article to required drop height	3/5/09	HR
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 48 Drop test height (in.)	3/5/09	HR
8.1.3	Photograph exterior surfaces of test article for visual evidence of damage	3/5/09	HR
	Document visual damage to package (e.g. deformation or bolt failure) ~~2 9/16" crumpling ht. in lid~~ ~~7 1/2" x 20 1/2" deformation at bolt area.~~ HR 3/5/09 1 3/16 x 2 1/4" deformation at bolt area. Sketch of Damage: Top	3/5/09	HR
	Measure height and diameter of test package 41 3/4 Package height (in.) 31 3/16 Package diameter (in.)	3/5/09	HR

Century Industries **NCT and HAC Test Record No.** TS-001-5 **Page 3 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Test Number (Description): 3B (HAC - 30' Center of Gravity Drop

Procedure Step No.	Description	Date	Initials
8.2.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	3/5/09	HK
	Measure and record the air temperature at the drop pad 67.5 Air temperature(°F) 5 Wind speed (mph)	3/5/09	HK
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 57° Angle of orientation	3/5/09	HK
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 360 Drop test height (in.)	3/5/09	HK
8.2.3	Photograph exterior surfaces of test article for visual evidence of additional damage	3/5/09	HK
	Document visual damage to package (e.g. deformation or bolt failure) 2 9/16" crumpling ht. in lid, 7 1/2" x 20 1/2" deformation at bolt area. Sketch of Damage Top	3/5/09	HK
	Measure and record height and diameter of test article 41 9/16 Package height (in.) 30 7/8 Package diameter (in.)	3/5/09	HK

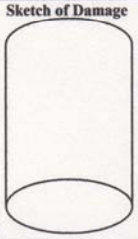
Test Number (Description): 3C (HAC-30' Shallow Angle Accelerated Drop)

Procedure Step No.	Description	Date	Initials
8.3.2	Photograph exterior surfaces of test article for visual evidence of pre-test condition	3/5/09	HK
	Measure and record the air temperature at the drop pad 67.5 Air temperature (°F) 5 Wind speed (mph)	3/5/09	HK
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) 17° Angle of orientation	3/5/09	HK

Century Industries
Bristol, Virginia

NCT and HAC Test Record No. TS-001-5
in accordance with
Versa- Pac Test Specification, TS-001, Rev. 0

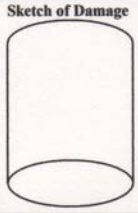
Page 4 of 5

Procedure Step No.	Description	Date	Initials
8.3.2	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) 360 Drop test height (in.)	3/5/09	HL
8.3.3	Photograph exterior surfaces of test article for visual evidence of additional damage	3/5/09	HL
↓	Document visual damage to package (e.g. deformation or bolt failure) 4 3/4" x 14 1/2" deformation on bottom of drum. Sketch of Damage  Top	3/5/09	HL
↓	Measure and record height and diameter of test article 42 3/8 Package height (in.) 29 3/4 Package diameter (in.) at bolt	3/5/09	HL

Test Number (Description): N/A

Procedure Step No.	Description	Date	Initials
	Photograph exterior surfaces of test article for visual evidence of pre-test condition		
	Measure and record the air temperature at the drop pad _____ Air temperature(°F) _____ Wind speed (mph)		
	Once suspended, measure and record the angle at which the test article is oriented to the nearest degree (within ±1 degree of specified drop orientation) _____ Angle of orientation		
	Measure and record height from test pad surface to lowest point on test package (at least the specified drop height and not more than +2 inches) _____ Drop test height (in.)		
	Photograph exterior surfaces of test article for visual evidence of additional damage		

Century Industries **NCT and HAC Test Record No.** TS-001-5 **Page 5 of 5**
Bristol, Virginia **in accordance with**
Versa- Pac Test Specification, TS-001, Rev. 0

Procedure Step No.	Description	Date	Initials
	Document visual damage to package (e.g. deformation or bolt failure) _____ _____ _____ _____ _____ Top 		
	Measure and record height and diameter of test article _____ Package height (in.) _____ Package diameter (in.)		

Final Test Record Measurements

Procedure Step No.	Description	Date	Initials
8.3.3	Measure and record torque of outer closure bolts ≤20 Torque (ft-lbs)	3/5/09	HK
	Open outer package and remove outer lid	3/5/09	HK
	Photograph interior surface of test article and examine for any apparent indications of containment boundary loss, e.g. payload materials No apparent damage to containment lid and no loss of contents. Some inner wall deformation.	3/5/09	HK
	Measure and record torque of interior bolts ≤20 Torque (ft-lbs) 3 bolts with 25, 30+ 40 ft.-lbs.	3/5/09	HK
	Remove inner containment cavity blind flange	3/5/09	HK
	Examine and document condition of the gasket and payload contents Gasket and payload in good condition.	3/5/09	HK
	Measure and record the pre-test and post-test centerline and near side distance to edge of cavity for comparison (See attached Measurement Data Sheet) N/A	3-5-09	WMA
	Remove (if possible) and document any apparent damage or movement to the inner containment cavity Blind Flange on inner containment flat, sealed with no matl. escaping from inner containment area.	3-5-09	WMA
	Photograph inner cavity to provide visual evidence of any apparent damage	3-5-09	WMA

Attachment D

Preliminary Drop Test Results & Conclusions

(9 Pages)

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

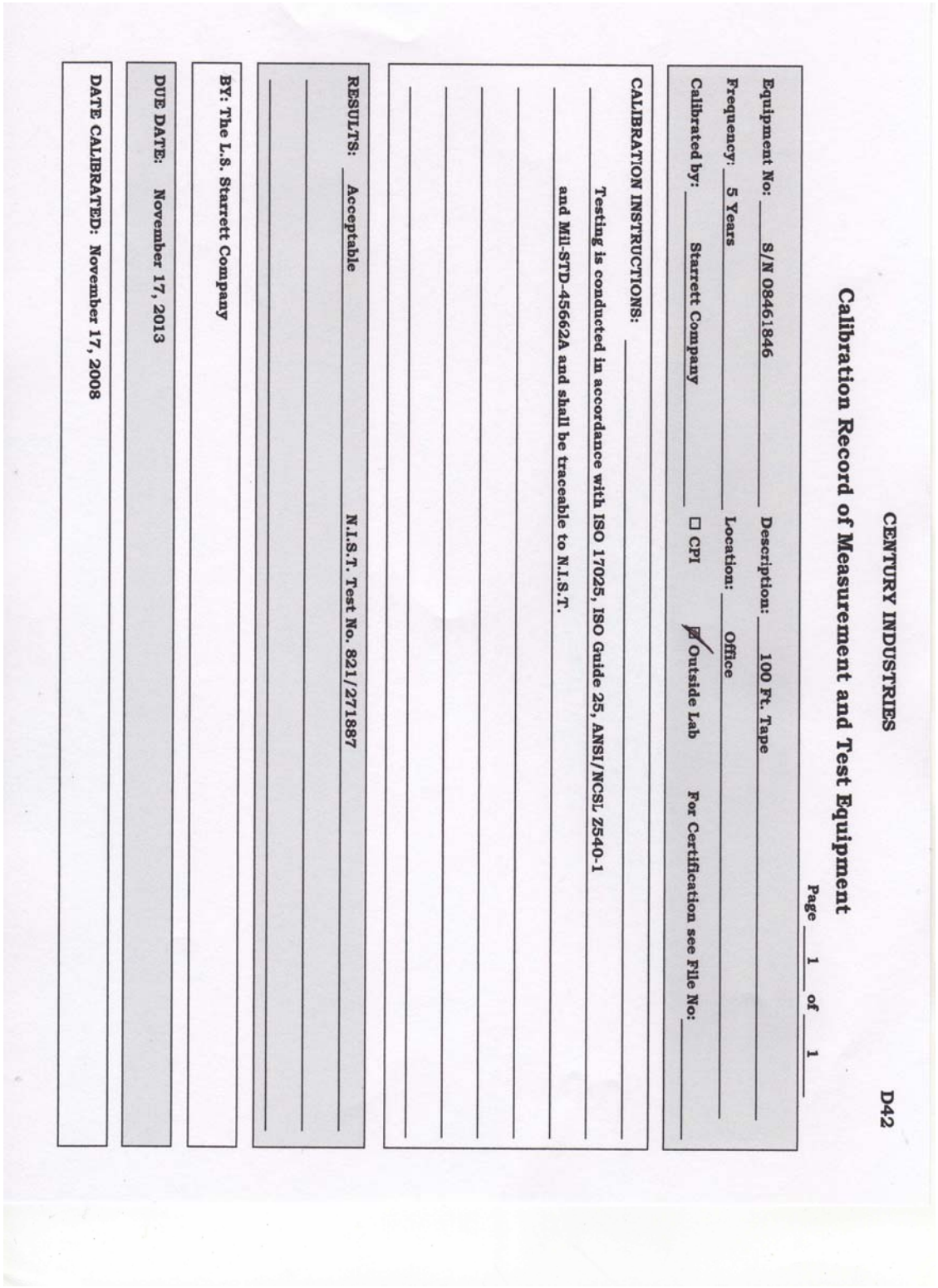
Proprietary Related Information
Figure Withheld Under 10 CFR 2.390

Attachment E

Training & Equipment Calibration Records

(8 Pages)

Starett 100' Tape Measure Calibration Record



CENTURY INDUSTRIES D42

Calibration Record of Measurement and Test Equipment

Page 1 of 1

Equipment No: S/N 08461846 Description: 100 Ft. Tape

Frequency: 5 Years Location: Office

Calibrated by: Starrett Company ☐ CPI ☑ Outside Lab For Certification see File No:

CALIBRATION INSTRUCTIONS:

Testing is conducted in accordance with ISO 17025, ISO Guide 25, ANSI/NCSL Z540-1 and Mil-STD-45662A and shall be traceable to N.I.S.T.

RESULTS: Acceptable N.I.S.T. Test No. 821/271887

BY: The L.S. Starrett Company

DUE DATE: November 17, 2013

DATE CALIBRATED: November 17, 2008

E-1

Starrett®

The L.S. Starrett Company
121 Crescent Street
Athol, MA 01331-1915 USA
Tel.: 978 249-3551
Fax.: 978 249-8495
www.starrett.com

ATTN: QUALITY ASSURANCE
MCMASTER-CARR SUP CO
6100 FULTON IND BLVD
ATLANTA GA 30336-2853

NOVEMBER 17, 2008

STANDARD LETTER of CERTIFICATION

THIS IS TO CERTIFY THAT THE ITEM LISTED BELOW MEETS THE REQUIREMENTS OF ACCURACY OF THE APPLICABLE SPECIFICATION ON DATE OF SHIPMENT.

STANDARDS AND EQUIPMENT USED FOR INSPECTION ARE CERTIFIED ACCURATE WITH REFERENCE TO 68 DEGREES F, TRACEABLE TO MASTER STANDARDS AT THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, WASHINGTON, D.C. CALIBRATION IS PERFORMED WITH TRANSFER STANDARDS WHICH ARE PROGRESSIVELY MORE ACCURATE IN THE ORDER OF 4: 1.

WE ATTEST THAT OUR MEASURING AND TEST EQUIPMENT, AND CALIBRATIONS PERFORMED ON THE ITEM (S) LISTED BELOW, ARE IN ACCORDANCE WITH ISO 17025, ISO GUIDE 25, ANSI/NCSL Z540-1 AND MIL-STD-45662A.

YOURS VERY TRULY,
THE L. S. STARRETT COMPANY

Candace Sheffield

DEXTER J. CARLSON,
CHIEF INSPECTOR

YOUR ORDER NO.	OUR ORDER NO.	TOOL	SPECIFICATION
QA-87917960	1335247	530-100 TAPE S/N 08461846	GGG-T-106F NIST HANDBOOK #44

N.I. S.T. TEST NO.
821/271887

ACCURACY-WHEN THE TAPE IS SUPPORTED ON A HORIZONTAL SURFACE, AND PULLED WITH A TENSION OF 10 POUNDS AT A TEMPERATURE OF 68 DEGREES FAHRENHEIT, THE OVERALL LENGTH WILL NOT BE IN ERROR BY MORE THAN .100" IN 100' OR LESS.

The estimated uncertainties reflect a Confidence Probability of approximately 95%.
This Certificate or Report shall not be reproduced except in full, without the written approval of the Chief Inspector of The L.S. Starrett Company.

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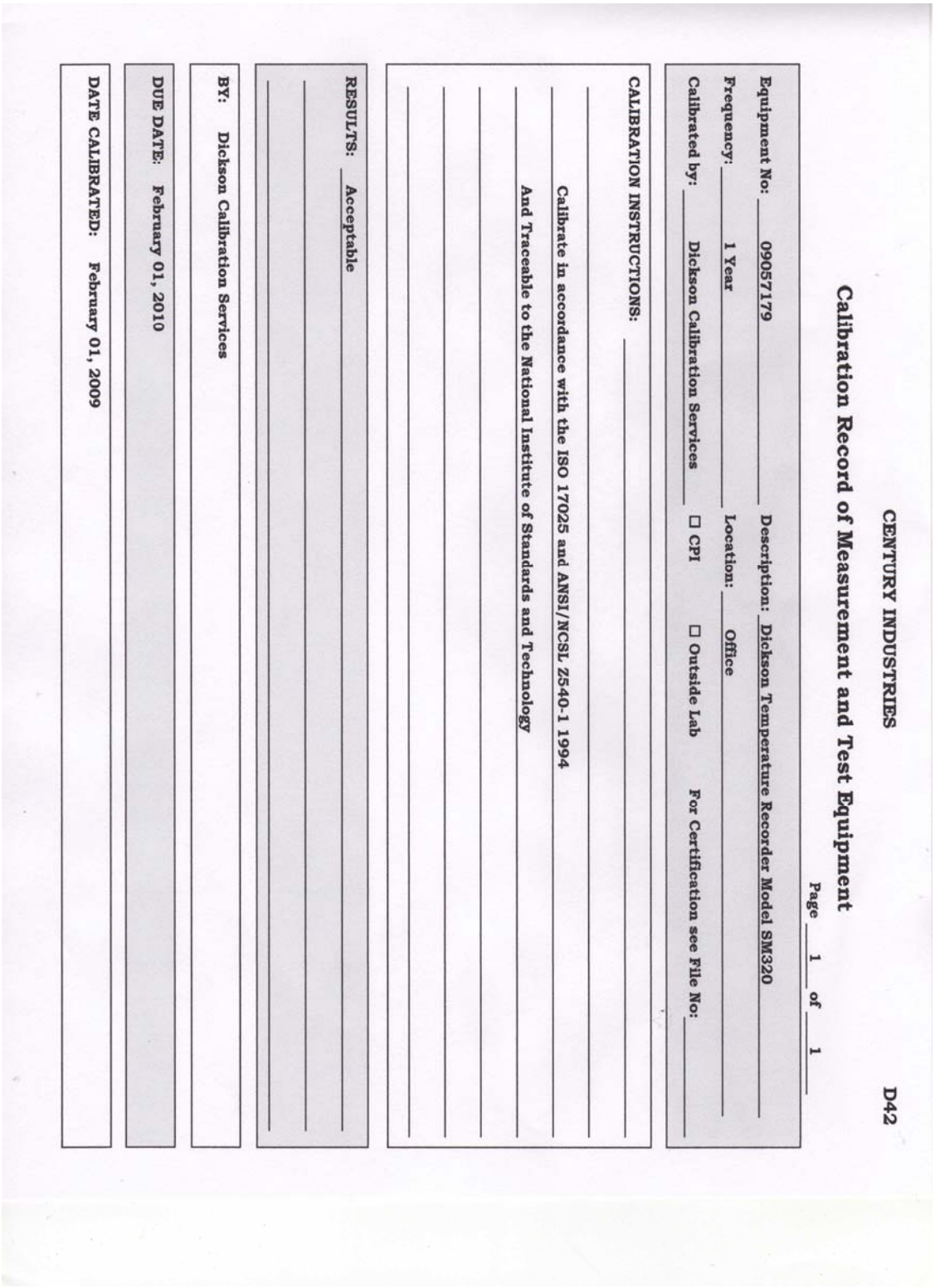
E-2

Calibration Record for Dickson Data Thermometer



CENTURY INDUSTRIES D42

Calibration Record of Measurement and Test Equipment

Page 1 of 1

Equipment No: 09057179 Description: Dickson Temperature Recorder Model SM320

Frequency: 1 Year Location: Office

Calibrated by: Dickson Calibration Services ☐ CPI ☐ Outside Lab For Certification see File No:

CALIBRATION INSTRUCTIONS:

Calibrate in accordance with the ISO 17025 and ANSI/NCSL Z540-1 1994

And Traceable to the National Institute of Standards and Technology

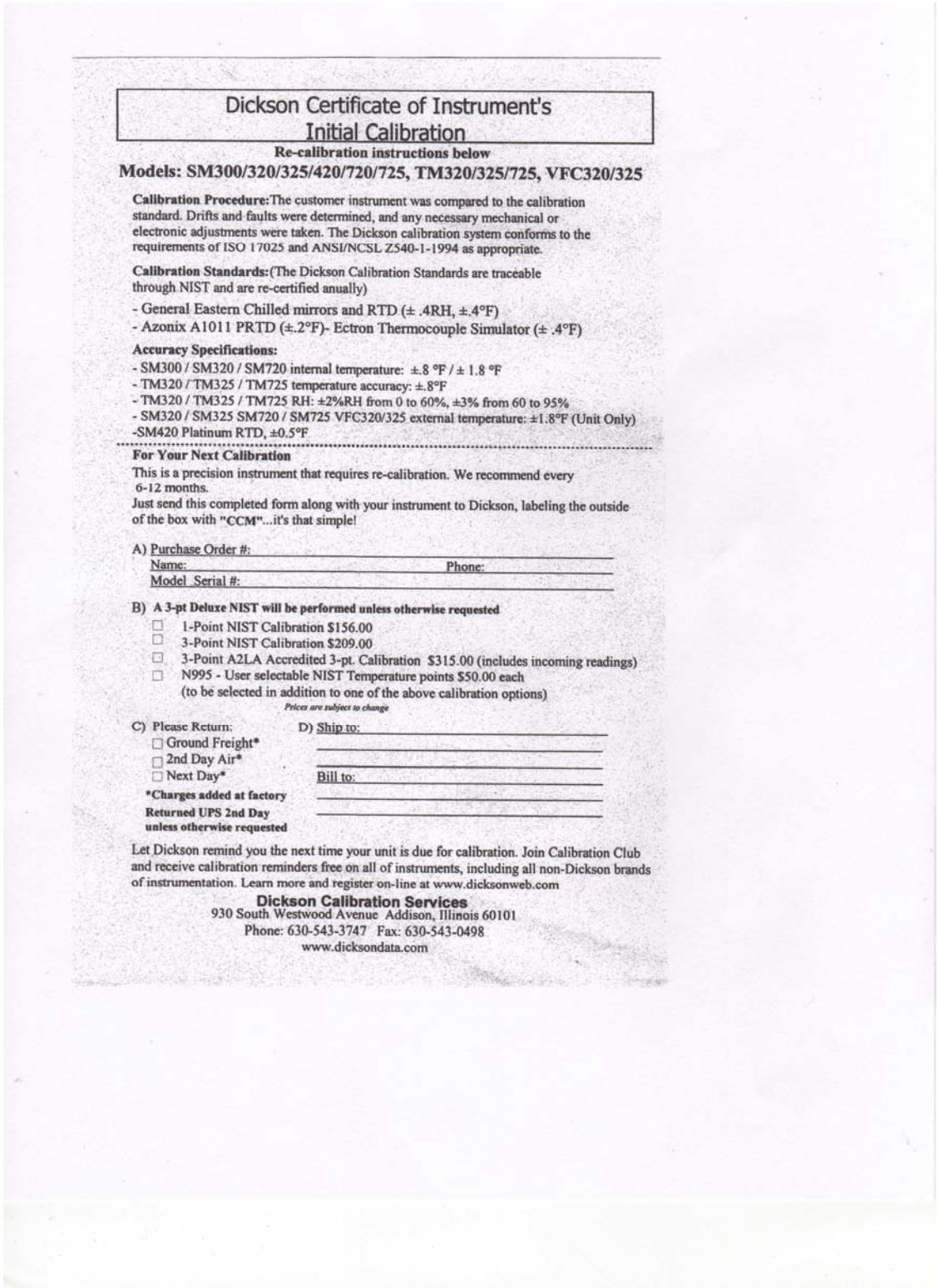
RESULTS: Acceptable

BY: Dickson Calibration Services

DUE DATE: February 01, 2010

DATE CALIBRATED: February 01, 2009

E-3



Dickson Certificate of Instrument's Initial Calibration

Re-calibration instructions below

Models: SM300/320/325/420/720/725, TM320/325/725, VFC320/325

Calibration Procedure: The customer instrument was compared to the calibration standard. Drifts and faults were determined, and any necessary mechanical or electronic adjustments were taken. The Dickson calibration system conforms to the requirements of ISO 17025 and ANSI/NCSL Z540-1-1994 as appropriate.

Calibration Standards: (The Dickson Calibration Standards are traceable through NIST and are re-certified anually)

- General Eastern Chilled mirrors and RTD (± .4RH, ±.4°F)
- Azonix A1011 PRTD (±.2°F)- Ectron Thermocouple Simulator (± .4°F)

Accuracy Specifications:

- SM300 / SM320 / SM720 internal temperature: ±.8 °F / ± 1.8 °F
- TM320 / TM325 / TM725 temperature accuracy: ±.8°F
- TM320 / TM325 / TM725 RH: ±2%RH from 0 to 60%, ±3% from 60 to 95%
- SM320 / SM325 SM720 / SM725 VFC320/325 external temperature: ±1.8°F (Unit Only)
- SM420 Platinum RTD, ±0.5°F

For Your Next Calibration

This is a precision instrument that requires re-calibration. We recommend every 6-12 months.

Just send this completed form along with your instrument to Dickson, labeling the outside of the box with **"CCM"**...it's that simple!

A) Purchase Order #: _____

Name: _____ Phone: _____

Model Serial #: _____

B) **A 3-pt Deluxe NIST will be performed unless otherwise requested**

- ☐ 1-Point NIST Calibration $156.00
- ☐ 3-Point NIST Calibration $209.00
- ☐ 3-Point A2LA Accredited 3-pt. Calibration $315.00 (includes incoming readings)
- ☐ N995 - User selectable NIST Temperature points $50.00 each (to be selected in addition to one of the above calibration options)

Prices are subject to change

C) Please Return:

- ☐ Ground Freight*
- ☐ 2nd Day Air*
- ☐ Next Day*

***Charges added at factory**

Returned UPS 2nd Day unless otherwise requested

D) Ship to: _____

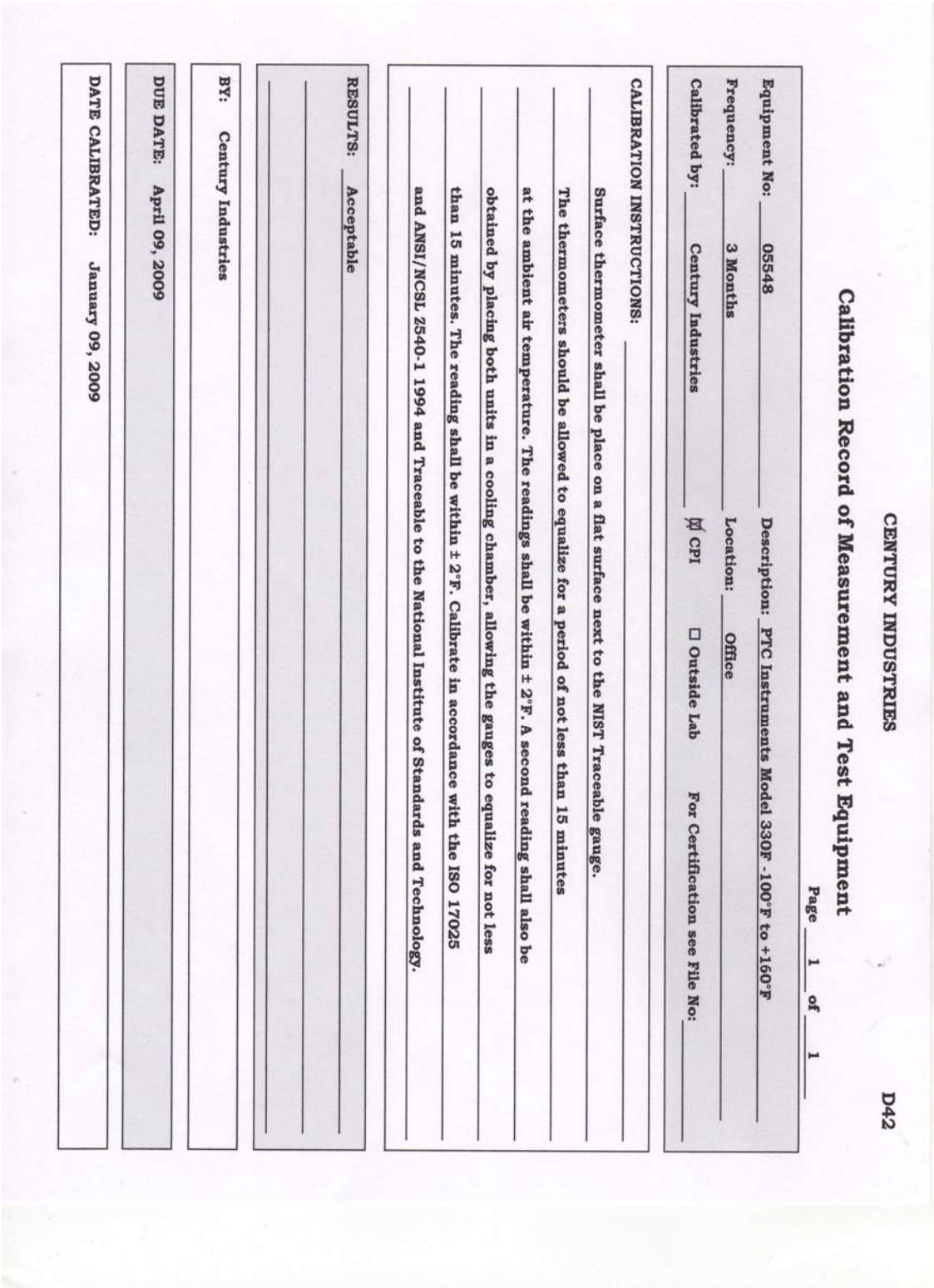
Bill to: _____

Let Dickson remind you the next time your unit is due for calibration. Join Calibration Club and receive calibration reminders free on all of instruments, including all non-Dickson brands of instrumentation. Learn more and register on-line at www.dicksonweb.com

Dickson Calibration Services
930 South Westwood Avenue Addison, Illinois 60101
Phone: 630-543-3747 Fax: 630-543-0498
www.dicksondata.com

E-4

Calibration Record for PTC Surface Thermometer



CENTURY INDUSTRIES D42

Calibration Record of Measurement and Test Equipment

Page 1 of 1

Equipment No: 05548 Description: PTC Instruments Model 330F -100°F to +160°F

Frequency: 3 Months Location: Office

Calibrated by: Century Industries ☒ CPI ☐ Outside Lab For Certification see File No:

CALIBRATION INSTRUCTIONS:

Surface thermometer shall be place on a flat surface next to the NIST Traceable gauge.

The thermometers should be allowed to equalize for a period of not less than 15 minutes

at the ambient air temperature. The readings shall be within ± 2°F. A second reading shall also be

obtained by placing both units in a cooling chamber, allowing the gauges to equalize for not less

than 15 minutes. The reading shall be within ± 2°F. Calibrate in accordance with the ISO 17025

and ANSI/NCSL Z540-1 1994 and Traceable to the National Institute of Standards and Technology.

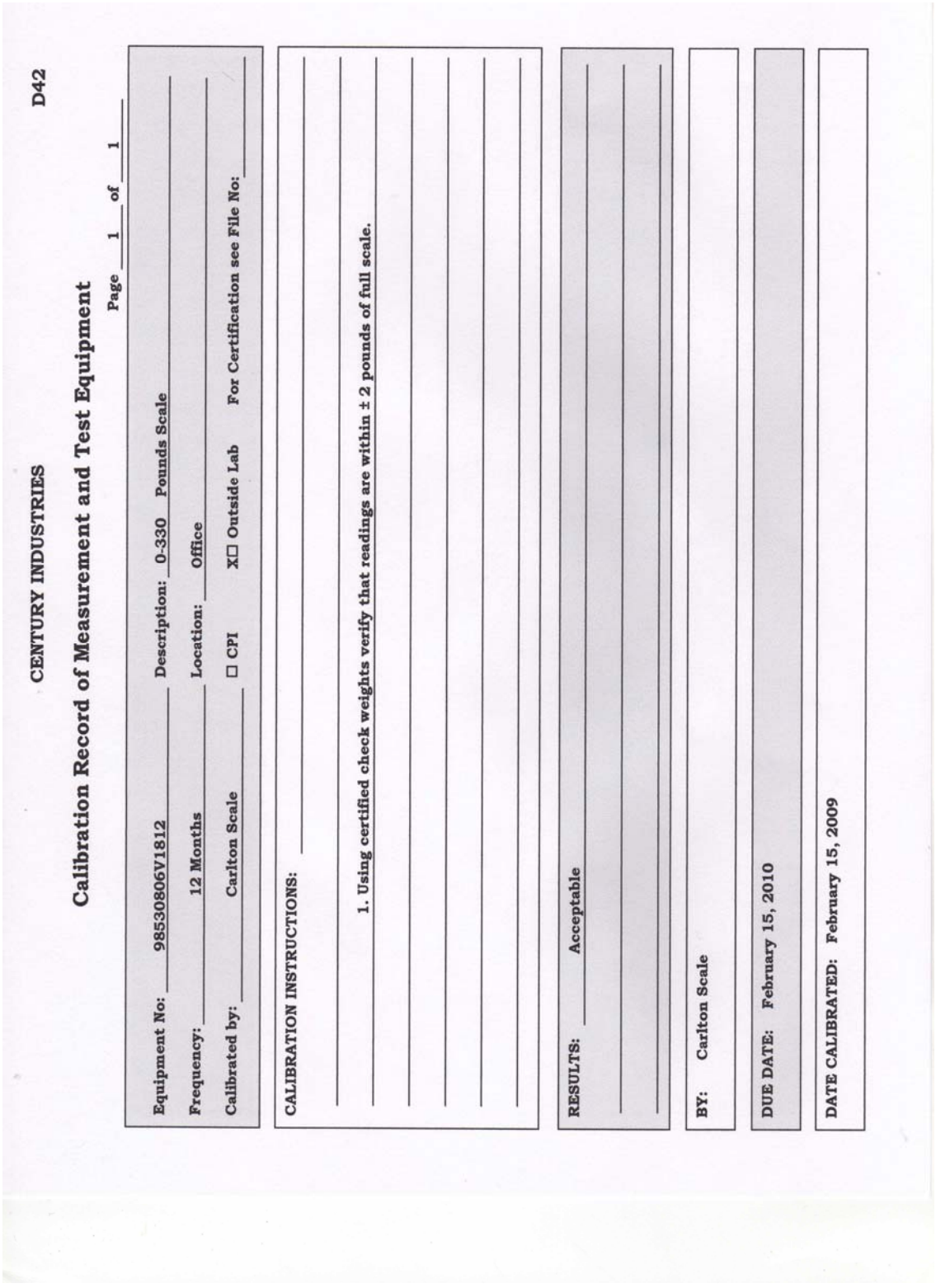
RESULTS: Acceptable

BY: Century Industries

DUE DATE: April 09, 2009

DATE CALIBRATED: January 09, 2009

Floor Scale



CENTURY INDUSTRIES D42

Calibration Record of Measurement and Test Equipment

Page 1 of 1

Equipment No: 985308006V1812 Description: 0-330 Pounds Scale

Frequency: 12 Months Location: Office

Calibrated by: Carlton Scale ☐ CPI X☐ Outside Lab For Certification see File No:

CALIBRATION INSTRUCTIONS:

1. Using certified check weights verify that readings are within ± 2 pounds of full scale.

RESULTS: Acceptable

BY: Carlton Scale

DUE DATE: February 15, 2010

DATE CALIBRATED: February 15, 2009

Indoctrination or Training Session Outline D52

Century Industries
P.O. Box 17084
Bristol, VA 24209
423-646-1864

Page 1 of 1

Title **TEST SPECIFICATION & TEST PLAN FOR THE VERSA-PAC SHIPPING CONTIANER** **Type:** ☑ Indoct. ☑ Training **Recommended Min. Duration:** 40 min.	**Dept** Testing Assistants **Outline No** 4F **Rev.** 0 **APPROVED:** Will M. Hall 2-25-09 **Department Manager** **Date** Will M. Hall 2-25-09 **QA Manager** **Date**

1. **Review duties and responsibilities per:**

   TS-001 Rev. 0 – Versa-Pac Test Specification

   TP-001 Rev. 0 – Versa-Pac Shipping Container Test Plan

E-7

Session Record **D50**

TEST PERSONNEL

Department

Century Industries

P.O. Box 17084
Bristol, VA 24209
423-646-1864

Position/Job Classification: Test Assistant

Outline Number: 4F **Date Completed** 2-25-09 **Duration** 1 HR.

Remarks:

Instructor 2-25-09 Date

The following Personnel have satisfactorily completed the above indoctrination or training outline:

Employee	Employee
Steve Salla	
Jamie Butler	
Drew Sellers	
Teddy Bruce	
Mark Osborne	
Heather Little	