QSA GLOBAL	Document Number **TP186**	Revision **0**

TEST PLAN 186

Model 880 Pipeliner
Type (B) Transport Package Test Results

10 CFR 71, Packaging and Transportation of Radioactive Materials
Subpart F – Package, Special Form, and LSA-III Tests
Sect 71.71 Normal Conditions of Transport
Sect 71.73 Hypothetical Accident Conditions

Originator	Paul Rice	Date: 15 DEC 09

APPROVALS		
Engineering		Date: 15 Dec 09
Regulatory		Date: 16 Dec 09
Quality Assurance	C. Kompton	Date: 16 Dec 09

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Section 1 Introduction

This document describes the mechanical test plan for the Model 880 Pipeliner Projector to meet NRC requirements for Type B(U)-96 packages as described in the Code of Federal Regulations, 10 CFR Part 71 , revised as of January 1, 2009.

The test plan also covers the criteria stated in the International Atomic Energy Agency (IAEA), Safety Standards Series No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, 1996 Edition, Section VI.

This document describes the test package specifications, testing equipment, testing scenario, justifies the package orientations for the different test specimens and provides test worksheets to record key steps in the testing sequence.

This series of tests is intended to evaluate any impact the Pipeliner Jacket assembly may have on the Model 880 Projector.

Section 2 Transport Package Description

Description of the Model 880 Projector Assembly

The radioactive material is sealed in a special form source capsule. The source capsule, stop and connector are swaged to a flexible steel wire to form the source wire assembly. The source wire assembly is held securely to the device by components of the rear plate assembly. One of these components, the sleeve, in conjunction with the selector ring retainer, prevents the stop ball of the source wire from being pulled through the rear of the package. Another component, the lock slide, prevents the stop ball from being pushed out of the front when in the secured position. A cover over the source wire connector prevents access to the source assembly until a keyed lock is actuated and the cover removed. This cover is in place during transport of the package.

The selector ring retainer is fastened to the rear plate with four, #10 stainless steel machine screws. The rear plate is attached to rivnuts assembled on the endplate weldment with four 5/16-18 stainless steel security screws. The endplate weldment consists of the endplate disc, a U-shaped bracket and the four rivnuts. The U-brackets are welded to the endplate disc and the endplate disc is welded to the cylindrical shell.

The shield is fastened within the device at each end by a titanium shield pin. The pin passes through the shield and the U-bracket. The shield is centered in the shell and has the source tube cast into its center. The source tube provides a cavity for the source wire assembly to travel through during use. The source capsule is positioned at the center of the ball of the shield within the source tube cavity when the source wire is in its secured position.

The model 880 uses polyurethane foam to fill the cavity around the depleted uranium shield. The foam prevents contamination to and from the depleted uranium shield.

Previous thermal tests have shown charred polyurethane foam will inhibit the flow of oxygen to the shield and prevent oxidation from occurring during a fire as long as the foam remains confined. This is shown on AEA Technology QSA Test plan number 70.

It has also been shown the charred foam will not support the shield at temperatures of 800°C. The model 880 relies on the shield pins to hold the shield in place at all times. These pins are designed to retain the shield throughout testing without the added support of the foam.

The outlet port, located at the front end, serves to block access into or out of the source tube cavity. Four stainless steel security screws fix the front plate to the endplate rivnuts.

Testing of the Model 880 Projector was performed under the following Test Plan:

- AEA Technology QSA Test Report 108 August 2000

Description of the Pipeliner Jacket Assembly

The Pipeliner Jacket Assembly, Part No PL1000H, consists of:

- The Pipeliner Jacket, Part No PL1013, constructed of cast Polyurethane
    - Pipeliner Axle Nut, Part No PL1025, constructed of Stainless Steel
- The Pipeliner Wheel Assembly, Assembly No PL1010, constructed of cast Polyurethane and:
    - Pipeliner Wheel Hub, Part No PL1023, constructed of 6061-T6 Aluminum
    - Pipeliner Wheel Bushing, Part No PL1024, constructed of Sintered Bronze
- The Pipeliner Wheel Axle Bolt, Part No PL1002, constructed of 303 Stainless Steel
- The Pipeliner Mounting Screws, Part No PL1030, constructed of Stainless Steel

The Pipeliner Jacket Assembly is secured to the Model 880 Projector by six #14 x ¾ Tamperproof screws (IRSS PN PL1030) inserted through existing holes in the Projector shell.
Figure 2.1 shows the Pipeliner Jacket Assembly.

Figure 2.2 shows the transport package with the Pipeliner plastic jacket assembly installed.

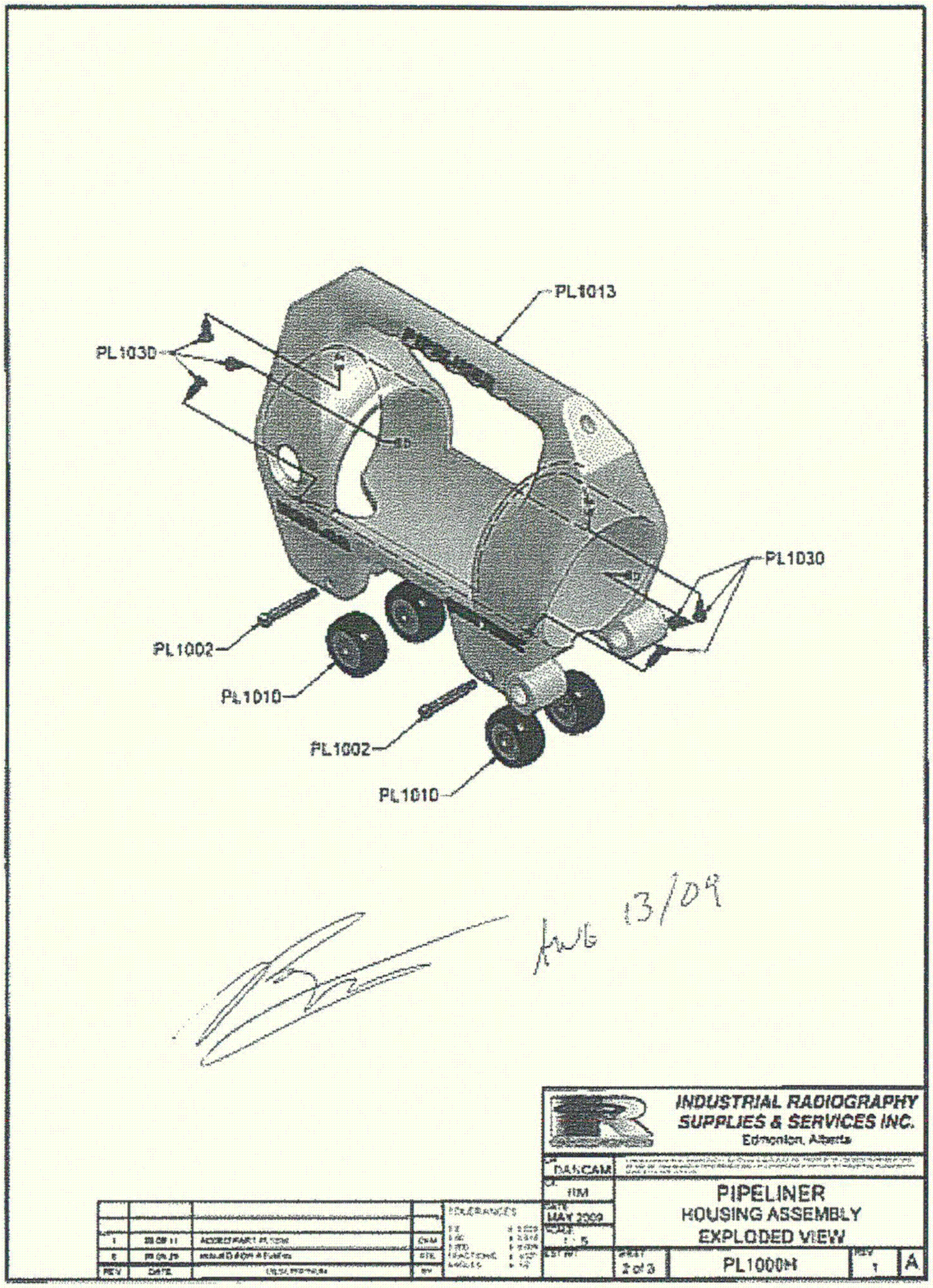
Figure 2.3 shows section views of the transport package with the Pipeliner plastic jacket assembly installed.

Since the jacket will be on the package during transport and its weight will add approximately 8 lbs, this series of tests will be performed with the jacket assembly installed.

In a drop, the plastic jacket may add additional protection for the transport package from further damage by absorbing energy upon impact.

The 4 foot, 30 foot and puncture orientations for these tests will be based on damage observed from orientations previously tested as part of AEA Technology QSA Test Plan 108 and speculative damaging effects the jacket may have on the safety aspects of the package.

The weight of the Model 880 transport package without a jacket installed is not greater than 46 pounds.
The total weight of the package with the Pipeliner jacket installed is not greater than 55 pounds.

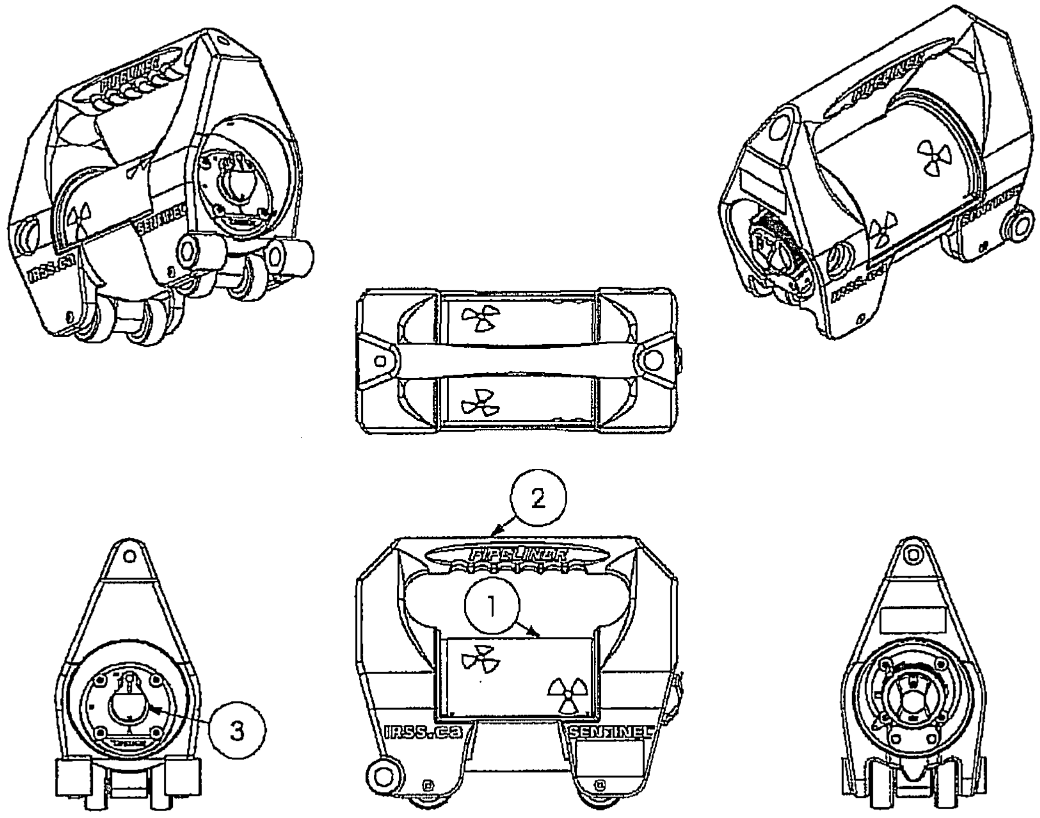


Aug 13/09

PART NO	REV	TITLE
PL1000H	1	Housing Assembly Exploded View
PL1002	3	Wheel Axle Bolt
PL1010	0	Wheel Assembly
PL1023	0	Wheel Hub Machining Details
PL1024	0	Wheel Hub Bushing Machining Details
PL1013	0	Jacket Casting Details & General Dimensions
PL1025	0	Axle Nut Machining Details
PL1030	0	Mounting Screws

FIGURE 2.1 PIPELINER JACKET ASSEMBLY, IRSS PART NO PL1000H

REVISIONS				
REV.	ERF	DESCRIPTION	APPROVALS	DATE
A	2277	INITIAL RELEASE	SEE TITLE BLOCK	



MAXIMUM ASSEMBLY WEIGHT AS SHOWN: 55 LBS

ITEM	NUMBER	QTY	TITLE
4	424-9	1	SIMULATED SOURCE CAPSULE - NOT SHOWN
3	KIT01B	1	FRONT PLATE - DETENT RETROFIT KIT
2	PL1000H	1	PIPELINER JACKET ASSEMBLY
1	88015	1	MODEL 880 150 Ci BODY ASSEMBLY

UNLESS OTHERWISE SPECIFIED:

1. DIMENSIONS ARE IN INCHES.
2. DIMENSIONS APPLY AFTER FINISH.
3. NOTES APPLY TO ALL SHEETS.
4. REMOVE ALL BURR & SHARP EDGES.
5. 63 RMS MAX. SURFACE ROUGHNESS.
6. DO NOT SCALE DRAWING.

TOLERANCES:

FRACTIONAL: ± 1/64
TWO PLACE DECIMAL: ±0.01
THREE PLACE DECIMAL: ±0.005
ANGULAR: MACH±1° & BEND ±5°

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DRAWN 09 Dec 09
APPR. 10 Dec 09
MATERIAL: SEE BOM
FINISH: NA
SAFETY CLASS: A
THIRD ANGLE PROJECTION

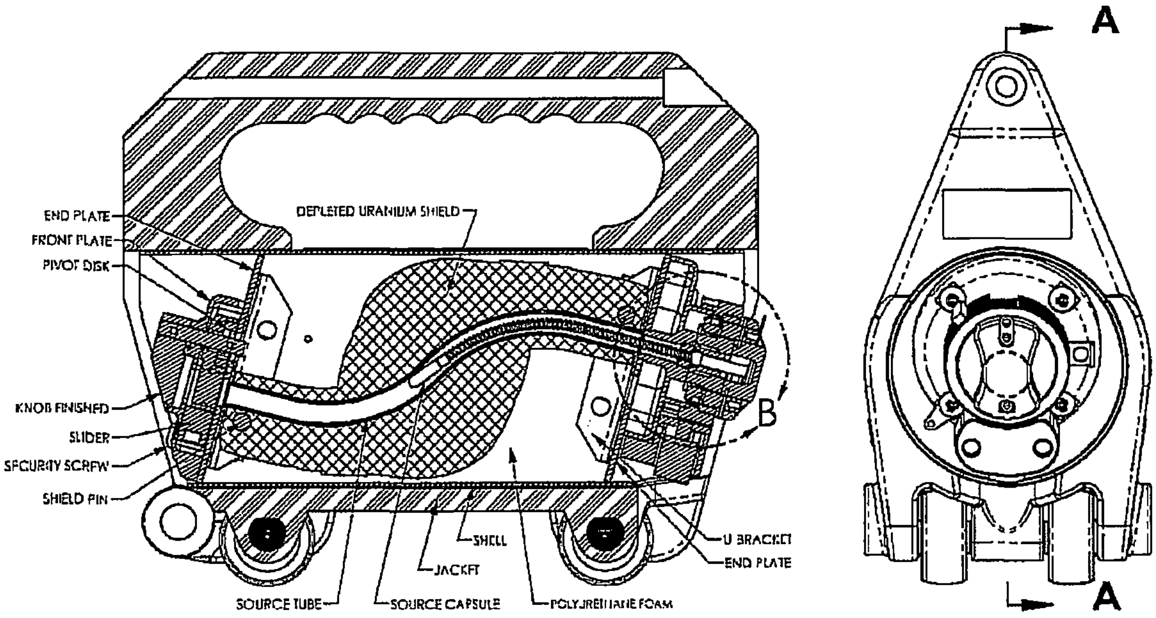
QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803

TITLE: PIPELINER TYPE B
TRANSPORT DEVICE

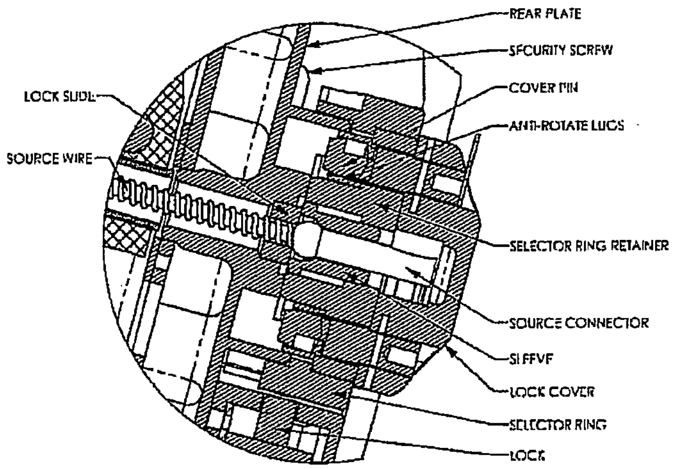
SIZE A
DWG. NO. 88095
REV. A
SCALE: 1:6
SHEET: 1 OF 1

CAD FILE: K:\Product Drawings\880\Solidworks Files\88095.SLDDRW

FIGURE 2.2 MODEL 880 PROJECTOR WITH PIPELINER JACKET, DN 88095 Rev A



SECTION A-A



DETAIL B

FIGURE 2.3 MODEL 880 PROJECTOR WITH PIPELINER JACKET - SECTION VIEWS

Section 3 Regulatory Compliance

The purpose of this plan, which was developed in accordance with QSA WI-E-1808, is to demonstrate that the Model 880 Pipeliner projector complies with the Type B(U)-96 transport package test requirements as described in the Code of Federal Regulations, 10 CFR Part 71 , revised as of January 1, 2009 and the International Atomic Energy Agency (IAEA), Safety Standards Series No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, 1996 Edition, Section VI.

The Model 880 Projector assembly was previously tested and approved for use as a transport package without the addition of a jacket as well as with the standard Sentinel jacket. This series of tests will evaluate the effect of adding the Pipeliner jacket to the Model 880 Projector.

The water spray preconditioning of the package will not be performed as the Model 880 Projector and the Pipeliner Jacket assemblies are constructed of waterproof materials throughout. The water spray would not contribute to any degradation in structural integrity.

The Normal Condition of Transport test to be performed is the 1.2m (Four-foot) free drop test (10 CFR 71.71 (c) (7)). (IAEA, TS-R-1, Para 722 (a)

The Hypothetical Accident Tests (10 CFR 71.73) to be performed are the 9m (30 foot) free drop test and the puncture test. (IAEA, TS-R-1, Para. 727(a) and 727(b))

The Stacking (Compression) Test TS-R-1 para 723 and 10CFR 71.71(c)(9) will not be performed as the Model 880 Projector was previously tested and the Pipeliner Jacket assembly should not adversely affect the results of this test.

The Penetration Test TS-R-1 para 724 and 10CFR 71.71(c)(10) will not be performed as the Model 880 Projector was previously tested and the Pipeliner Jacket assembly should not adversely affect the results of this test.

The Crush Test (10 CFR 71.73(c)(2)) will not be performed because the radioactive contents are qualified as Special-Form radioactive material.

The Thermal Test of (10 CFR 71.73(c)(4)) will not be performed as the Model 880 Projector has previously been evaluated for this requirement and the materials used in the Pipeliner Jacket have no different effect than the original Sentinel jacket. If damage to the 880 itself should occur during testing and there is an opening in the stainless steel shell that could expose the DU shield the waiver of thermal testing will be re-evaluated.

The melting points for the materials of the package are listed below:

TABLE 3.1 MATERIAL MELTING POINTS

Material	Melting Point
Stainless steel	1390°C (2530°F)
Depleted uranium	1135°C (2075°F)
Titanium	1700°C (3100°F)
Tungsten	3410°C (6170°F)
Copper/Brass	1080°C (1980°F)
Aluminum	580°C (1080°F)
Rubber/Plastic	Less than 540°C (1000°F)

The immersion test will not be performed. Only the source capsule (containment vessel) is sealed. . The source capsule is designed and tested to withstand external pressures well in excess of 22 lbf/in^2. All other assemblies are designed to allow equalization of internal and external pressure

Section 4 Discussion on System Failure Modes of Interest

General

The tests in this plan focus on damaging those components of the package which could cause displacement of the source from its stored position within the depleted uranium shield and which affect the integrity of the shield itself.

Normal and Accident Conditions of Transport

The modes of failure under normal and accident conditions that could lead to elevated dose rates include the following:

- Fracture or penetration of the projector weldment.
- Displacement of the shield within the projector weldment and distortion or fracture of the source.
- Failure of the source lock assembly and/or lock mounting screws.

The test conditions specified in this Test Plan are intended to challenge the ability of the Model 880 Pipeliner package with respect to these failure modes.

Orientations to be Tested

Based on previous testing of the 880 camera the area most subject to damage is the Rear Plate Assembly PN 88020. Damage to the Rear Plate Assembly could cause the source to become displaced or loose. Although this area passed all previous testing the Pipeliner jacket is oriented differently than the standard 880 jacket and may not offer the same protection to this assembly. This could affect the results.

Other orientations:

- Bottom Surface Impact; if an impact to the bottom surface caused the jacket to split the wheels would spread out around the body rather than impacting the shell. If the jacket did not split the jacket should absorb the impact of the wheels. In either case there is little likely hood that the shell would be significantly damaged.
- Top & Side Impacts; Impacts to the top or side surfaces might cause the plastic jacket to split, but it is highly unlikely that this would significantly damage the metal shell.

Based on the above, two orientations will be tested, both impacting the Rear Plate Assembly:

- The first orientation will be with the longitudinal axis of the camera vertical
- The second orientation will be with the Rear Plate Assembly parallel to the impact surface

Section 5 Assessment of Package Conformance

Regulatory Requirements

- **Normal Conditions of Transport (10 CFR 71.43(f))**

  There should be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.

  IAEA Safety Standards Series No. TS-R-1, Para 622 (b) stipulates that the loss of shielding integrity should not result in more than a 20% increase in the radiation level at any external surface of the package.

- **Hypothetical Accident Conditions (10 CFR 71.51(a))**

  There should be no escape of radioactive materials greater than A_2 in one week and no external dose rate greater than 1 R/hr at 1m from the external surface with the maximum radioactive contents which the package is designed to carry.

Test Package Contents

The Model 880 Pipeliner projector is designed to carry a special form source. Containment of the radioactive source is tested at manufacture. The source capsule design has been certified in accordance with the performance requirements for special form as specified in 10 CFR Part 71 and IAEA Safety Standards Series No. TS-R-1.

A simulated source assembly, model 424-9, will be used during testing of the package. The radiation levels after testing will be measured by replacing the simulated source with an active source

Section 6 Construction and Condition of Test Specimens

The Model 880 transport package test specimens will be manufactured in accordance with the QSA Global, Inc. (QSA) Quality Assurance Program. The weight of each test specimen per this drawing is not greater than 46 pounds.

The Pipeliner jacket assemblies will be manufactured and supplied by IRSS in accordance with the Industrial Radiography Supplies and Services Inc. (IRSS) Quality Assurance Program, as an approved supplier to QSA. IRSS Certificates of Compliance for the supplied parts and assemblies will be included as part of the final test report.

Assembly of the Pipeliner test specimens used for these tests will be done by QSA staff qualified to perform maintenance on 880 projectors in accordance with Industrial Radiography Supplies and Services Inc. (IRSS) instructions for conversion of a standard Model 880 projector titled "Work instruction for performing Pipeliner Retro Fit" Rev 1.
Inspection of the finished assemblies will be performed by the QSA QC department in accordance with the requirements of Industrial Radiography Supplies and Services Inc. (IRSS) instructions for conversion of a standard Model 880 projector titled "Work instruction for performing Pipeliner Retro Fit" Rev 1.
This represents the process QSA and IRSS intend to use for the manufacture of production units.
Additionally, the test specimens will be inspected in accordance with IIR 88095 Rev

The IRSS assembly instructions include the installation of the Collimator and Shoe assemblies as required for use. These components are not part of the transport container assembly and are not included in this test plan. After the assembly and inspection of each test unit is completed the test units will be reconfigured to the transport condition as specified in IRSS Pipeliner Operations and Maintenance Manual. This involves the removal of the Pipeliner Shoe and Collimator assemblies. A copy of this manual will be included as part of the final test report.

The weight of each test specimen with the Pipeliner jacket is not greater than 55 pounds

The structural materials of the Model 880 are made of AISI Type 300 series stainless steel and titanium.
The shielding materials are depleted uranium and tungsten.
The non-safety related parts are made from aluminum, brass, copper, plastic, and rubber.

The Pipeliner jacket assembly is constructed of cast polyurethane, aluminum, bronze & Type 303 stainless steel.

All tests of this plan will subject the test specimen to an impact from a drop. The mechanical strength and ductility of the critical components of the package must continue to perform as expected at the ambient temperature conditions of –40°F to 100°F.

The fracture toughness, strength and ductility, of the structural materials in the Model 880 Projector do not change significantly at or between the temperatures of –40°F to 100°F. The shielding materials are relatively brittle throughout this entire temperature range.

The Pipeliner jacket material has a rated operating temperature range of approximately –30°F to 200°F. Because this does not meet the minimum -40°F temperature requirement of "10 CFR 71, Sect 71.73 Hypothetical Accident Conditions" this series of tests will be performed with the test units cooled to -40°F.

The primary containment is the source capsule, a special form sealed capsule welded at atmospheric pressure and pressure tested to 290 psi minimum. Except for this capsule the package is open to the atmosphere. The internal operating pressure of the containment system is considered to be in equilibrium with the outside pressure of the package. Therefore, the initial pressure of the Pipeliner system has no effect on these tests.

Section 7 Material and Equipment List

The equipment list worksheets in Section 15 identify the equipment required, with additional space to list other necessary equipment and measuring instruments needed to perform the tests. Additional materials and equipment used to facilitate the tests will be listed as needed.

Section 8 Test Procedure

General

All test specimens are to be tested in the sequence presented below. Each test has been designed to check the integrity of various components of the package. An assessment of transport integrity of the package will be made based on the cumulative effect of the tests performed on the package

The test specimens will have an orientation selected to produce the most damage to the package based on the results of Test Plan 108. The justification and description for this orientation shall be documented.

The tests have the following sequence:

1. Test specimen preparation and inspection
2. 1.2m (Four-foot) free drop test (10 CFR 71.71 (c) (7))
3. 9m (30-foot) free drop test (10 CFR 71.73 (c) (1))
4. Puncture test (10 CFR 71.73 (c) (3))
5. Final test inspection and/or assessment.
    a. The Pipeliner jacket assembly is to be removed prior to profiling.
    b. Repeat the profiling procedure used to inspect QSA PN 88015 prior to testing
6. Test specimen storage.

Roles and Responsibilities

The responsibilities of the groups identified in this plan are:

- **Engineering** executes the tests according to the test plan and summarizes the test results. Engineering also provides technical input to assist Regulatory Affairs and Quality Assurance as needed.
- **Regulatory Affairs** monitors the tests and reviews test reports for compliance with regulatory requirements.
- **Quality Assurance** oversees test execution and test report generation to assure compliance with the QSA Global Quality Assurance Program.
- **Engineering, Regulatory Affairs** and **Quality Assurance** are jointly responsible for assessing test and specimen conditions relative to 10 CFR 71 and IAEA TS-R-1..
- **Quality Control** is responsible for ensuring test and specimen data is measured and recorded throughout the test cycle.

Section 9 Test Specimen Preparation and Inspection

1. Manufacture three Model 880 projectors per QSA Global drawing number B88015, revision C. The projector is profiled per WI-Q1816 as part of this procedure.

2. Mount the three projectors in the Pipeliner jacket assemblies, IRSS part number PL1000H revision 1, per IRSS instructions for conversion of a standard Model 880 projector titled "Work instruction for performing Pipeliner Retro Fit" Rev 1.

3. Clearly and indelibly mark each specimen: "TP186(X)". Where X is an alphabetically incremented letter beginning with "A". One of the three projectors will be used as a spare and used to replace a specimen dropped onto the wrong impact point, if necessary. The spare, if used, will follow the same test sequence as the initially selected specimen.

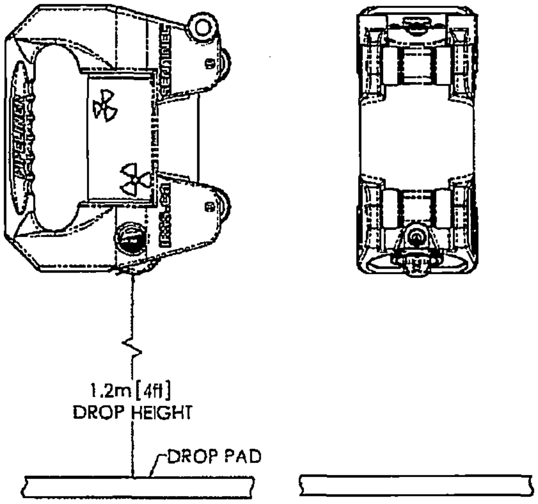
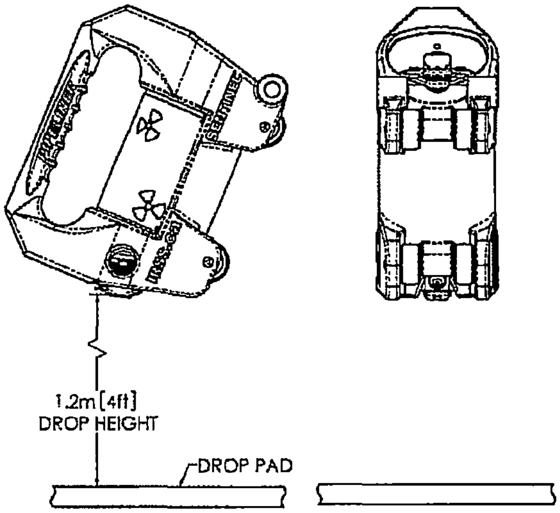
4. Measure and record the weight of each specimen.
   This weight must not exceed the maximum specified 55 lbs

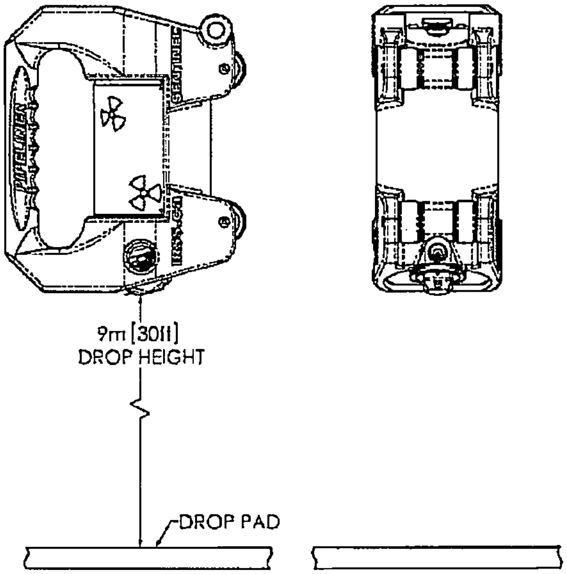
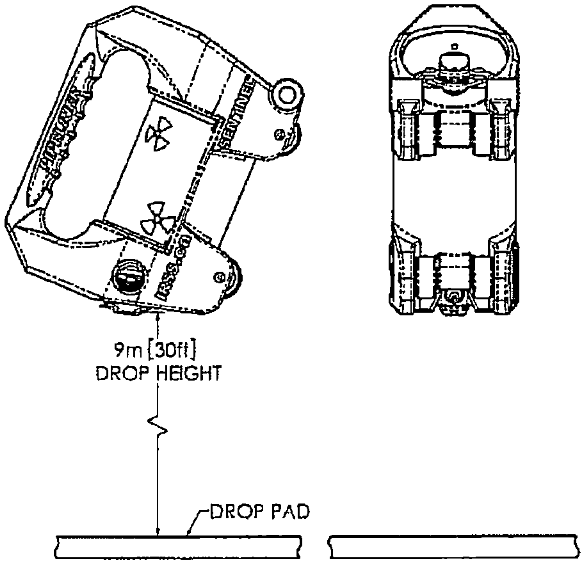
5. Inspect the test specimens to ensure that:

   a. All fabrication and inspection records are documented in accordance with the QSA Global Quality Assurance Program.

   b. The test specimens comply with the requirements of the drawings and the IRSS assembly instructions.

Section 10 Summary of Test Schedule

<table>
<tr><th>Normal Conditions Test</th><th>Para.</th><th>Specimen</th><th>Diagram</th></tr>
<tr><td>1.2m Drop 1.</td><td>71.71(c)(7)</td><td>TP186(A)</td><td>
</td></tr>
<tr><td colspan="4">FIGURE 10.1.1 NORMAL CONDITIONS - 1.2M DROP 1</td></tr>
<tr><td>1.2m Drop 2.</td><td>71.71(c)(7)</td><td>TP186(B)</td><td>
</td></tr>
<tr><td colspan="4">FIGURE 10.1.2 NORMAL CONDITIONS - 1.2M DROP 2</td></tr>
</table>

<table>
<tr><th>Accident Conditions Test</th><th>Para.</th><th>Specimen</th><th>Diagram</th></tr>
<tr><td>9m Drop 1.</td><td>71.73(c)(1)</td><td>TP186(A)</td><td> </td></tr>
<tr><td colspan="4">FIGURE 10.2.1 ACCIDENT CONDITIONS - 9M DROP 1</td></tr>
<tr><td>9m Drop 2.</td><td>71.73(c)(1)</td><td>TP186(B)</td><td> </td></tr>
<tr><td colspan="4">FIGURE 10.2.2 ACCIDENT CONDITIONS - 9M DROP 2</td></tr>
</table>

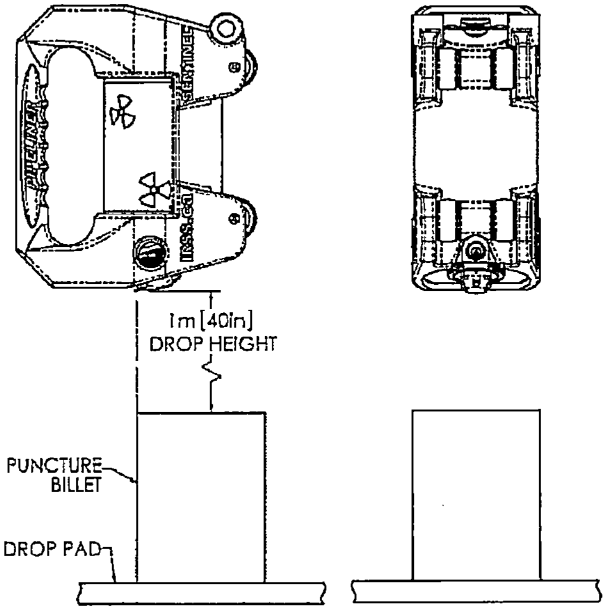
Accident Conditions Test	Para.	Specimen	Diagram
Puncture 1.	71.73(c)(3)	TP186(A)	

FIGURE 10.3.1 ACCIDENT CONDITIONS - PUNCTURE 1

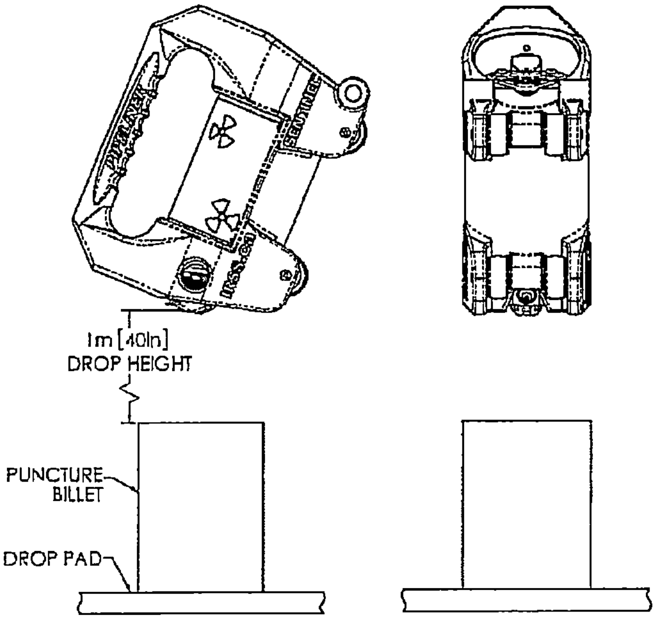
Accident Conditions Test	Para.	Specimen	Diagram
Puncture 2.	71.73(c)(3)	TP186(B)	

FIGURE 10.3.2 ACCIDENT CONDITIONS - PUNCTURE 2

Section 11 1.2m (4-foot) Free Drop Test (10 CFR 71.71(c)(7))

The Normal Transport Conditions Test is the 1.2m (4-foot) free drop test as described in 10 CFR 71.71(c)(7).

The figures of this section illustrate the orientations for the test specimens.

- **1.2m Free Drop Test Set-up**

To set up a package for the 1.2m (4-foot) drop test:

1. Measure and record the weight of the test specimen.
2. Cool the test specimen to -40°F
3. Measure and record the test specimen and ambient temperatures.
4. Position the 1st specimen on the drop surface and position it according to the orientation shown in Figure 11.1.1
5. Raise the package so that the impact target is 1.2m (4 feet) above the drop surface. Ensure the center of gravity is over the impact point
6. Measure and record the ambient temperature.
7. Photograph the set-up.
8. Start the video recorder.
9. Drop the package.
10. Stop the video recorder.
11. Record the damage to the package and take a photographic record.
12. Repeat steps 3 - 10 with the 2^{nd} specimen positioned as shown in Figure 11.1.2

Specimen TP186(A) Orientation for the 1.2m Drop Test

Figure 11.1.1 shows the package orientation for Specimen TP186(A).

The specimen will be dropped with its axis normal to the drop surface with the lock assembly facing down.

The object of the drop is to use the lock cover as leverage to drive the rear plate across the endplate to shear the rear plate mounting screws.

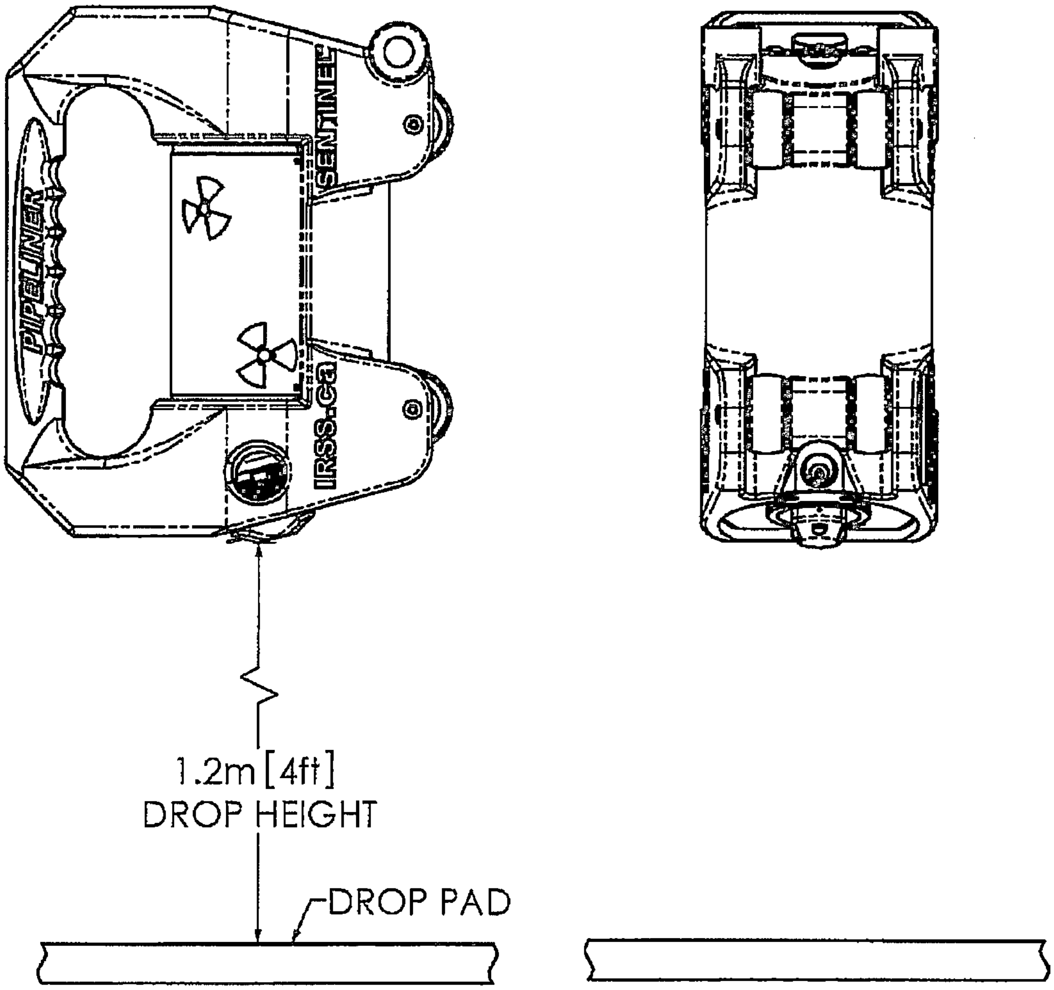


FIGURE 11.1.1 SPECIMEN TP186(A) ORIENTATION FOR THE 1.2M DROP TEST

Specimen TP186(B) Orientation for the 1.2m Drop Test

Figure 11.1.2 shows the package orientation for Specimen TP186(B).

The specimen will be dropped with its axis at approximately 22.5 degrees to the drop surface with the lock assembly facing down.

The object of this drop is to test the integrity of the end plate and to determine the effect of the drop on the depleted uranium shield.

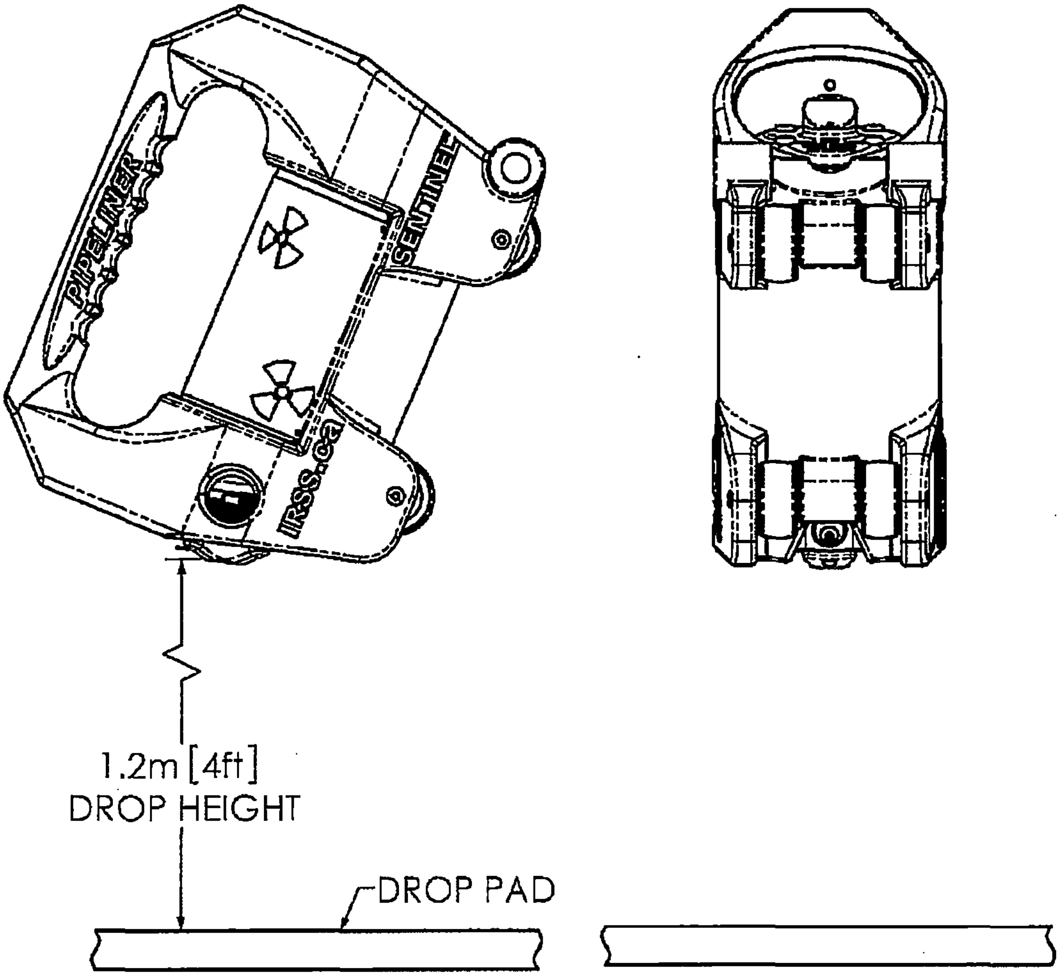


FIGURE 11.1.2 SPECIMEN TP186(B) ORIENTATION FOR THE 1.2M DROP TEST

1.2m Free Drop Test Assessment

Upon completion of each test, **Engineering**, **Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

1. Review the test execution to ensure that each test was performed in accordance with this test plan.
2. Make a preliminary evaluation of the specimens relative to the requirements of 10 CFR 71 and IAEA Safety Standards Series No. TS-R-1.
3. Assess the damage to each specimen to decide whether testing of that specimen is to continue.
4. Evaluate the condition of each specimen to determine what changes, if any, are necessary in package orientation in the 30-foot drop test to achieve maximum damage.

Section 12 9m Free Drop Test (10 CFR 71.73(c)(1))

The first Hypothetical Accident Test is the 9m (30-foot) free drop test as described in 10 CFR 71.73(c)(1).

The figures of this section illustrate the orientations for the test specimen.

- **9m Free Drop Test Set-up**

To set up a package for the 9m (30-foot) drop test:

1. Measure and record the weight of the test specimen.
2. Cool the test specimen to -40°F
3. Measure and record the test specimen and ambient temperatures.
4. Position the 1st specimen on the drop surface and position it according to the orientation shown in Figure 12.2.1
5. Raise the package so that the impact target is 9m (30 feet) above the drop surface. Ensure the center of gravity is over the impact point
6. Measure and record the ambient temperature.
7. Photograph the set-up.
8. Start the video recorder.
9. Drop the package.
10. Stop the video recorder.
11. Record the damage to the package and take a photographic record.
12. Repeat steps 3 - 10 with the 2nd specimen positioned as shown in Figure 12.2.2

Specimen TP186(A) Orientation for the 9m Drop Test

Figure 12.2.1 shows the package orientation for Specimen TP186(A).

The specimen will be dropped with its axis normal to the drop surface with the lock assembly facing down.

The object of the drop is to use the lock cover as leverage to drive the rear plate across the endplate to shear the rear plate mounting screws.

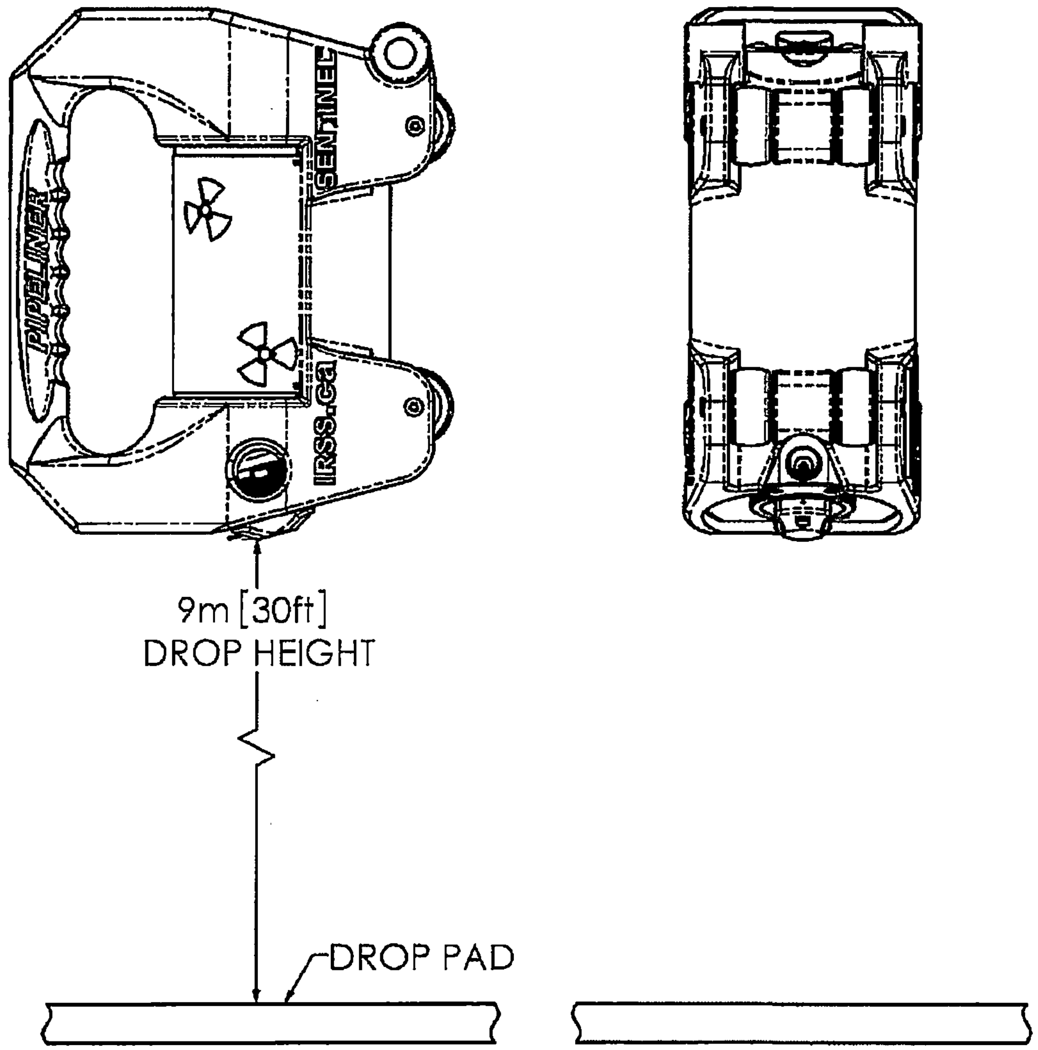


FIGURE 12.2.1 SPECIMEN TP186(A) ORIENTATION FOR THE 9M DROP TEST

Specimen TP186(B) Orientation for the 9m Drop Test

Figure 12.2.2 shows the package orientation for Specimen TP186(B).

The specimen will be dropped with its axis at approximately 22.5 degrees to the drop surface with the lock assembly facing down.

The object of this drop is to test the integrity of the end plate and to determine the effect of the drop on the depleted uranium shield.

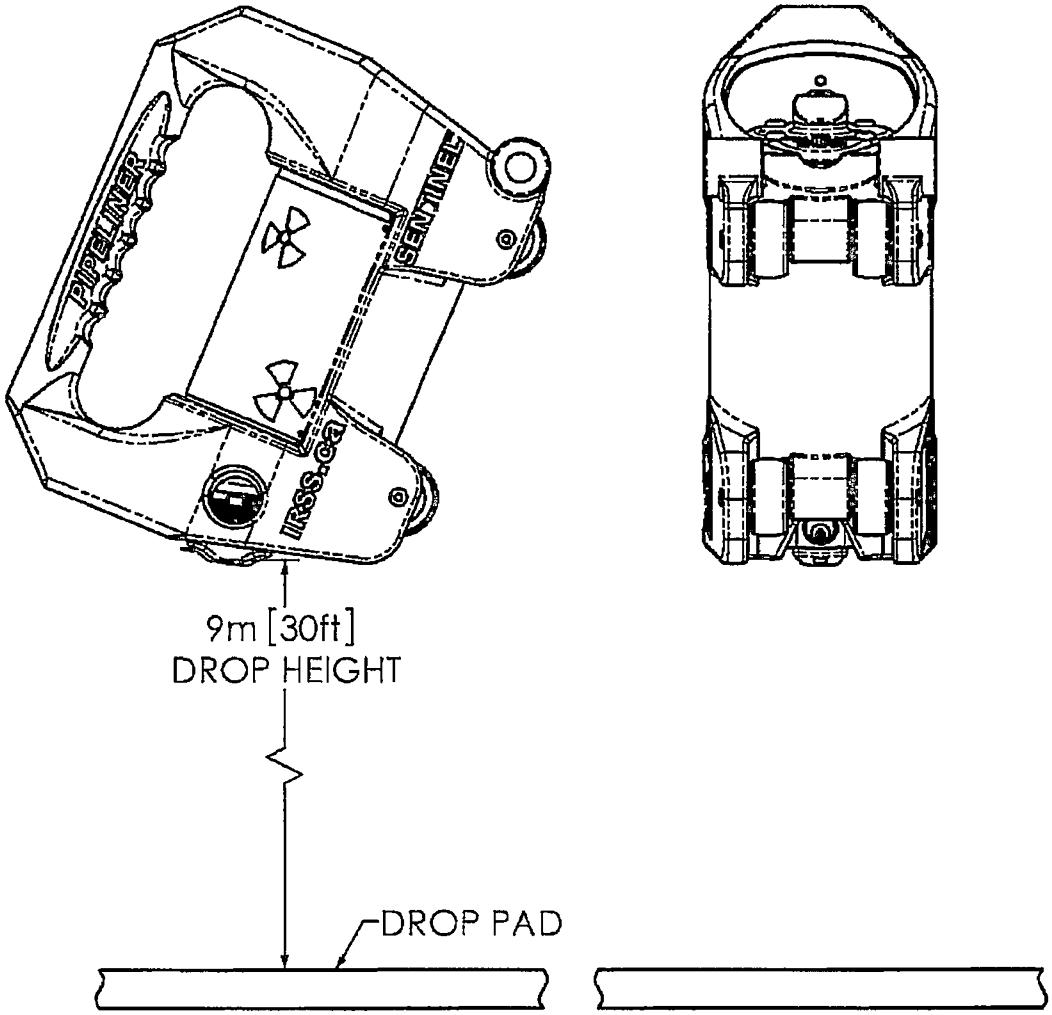


FIGURE 12.2.2 SPECIMEN TP186(B) ORIENTATION FOR THE 9M DROP TEST

9m Free Drop Test Assessment

Upon completion of each test, **Engineering, Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

Review the test execution to ensure that each test was performed in accordance with 10 CFR 71, IAEA Safety Standards Series No. TS-R-1, and this test plan.

Make a preliminary evaluation of the specimens relative to the requirements of 10 CFR 71 and IAEA Safety Standards Series No. TS-R-1.

1. Assess the damage to each specimen to decide whether testing of that specimen is to continue.
2. Evaluate the condition of each specimen to determine what changes, if any, are necessary in package orientation in the puncture test to achieve maximum damage.

Section 13 Puncture Test (10 CFR 71.73(c)(3))

The package is dropped from a height of 1m (40") onto the puncture billet. This test uses the 12" high puncture billet. The billet meets the minimum height (8") required in 10 CFR 71.73(c)(3). The specimen has no projections or overhanging members longer than 12" which could act as impact absorbers, allowing the billet to cause the maximum damage to the specimen. The billet is to be bolted to the drop surface used in the drop tests.

The figures of this section illustrate the orientations for each puncture test.

The justification for each puncture orientation is the same as the orientation for the 30-foot drop test. If the orientation needs to be changed, the new orientation must be documented and approved with a justification describing how it would be a worst condition than the planned orientation.

Puncture Test Set-up

NOTE: *Because each test is designed to add to damage inflicted on a specific component or assembly in the preceding test, it is important that each specimen maintain its identity throughout the battery of tests and that the set-up instructions specific to the specimen are strictly followed.*

To set up a package for the puncture test:

1. Measure and record the weight of the test specimen.
2. Cool the test specimen to -40°F
3. Measure and record the test specimen and ambient temperatures.
4. Position the 1st specimen on the drop surface and position it according to the orientation shown in Figure 13.3.1
5. Raise the package so that the impact target is 1m (40") between the impact point on the package and the top of the puncture billet. Ensure the center of gravity is over the impact point
6. Photograph the set-up.
7. Start the video recorder.
8. Drop the package.
9. Stop the video recorder.
10. Record the damage to the package and take a photographic record.
11. Repeat steps 1 - 9 with the 2nd specimen positioned as shown in Figure 13.3.2

Specimen TP186(A) Orientation for the Puncture Test

The objective of this drop orientation (Figure 13.3.1) is to continue the damage inflicted on the specimen by the 9m-drop test.

The specimen will be dropped with its axis normal to the drop surface with the lock assembly facing down.

The specimen will be offset from the Puncture Billet as shown so that the jacket does not hit first.

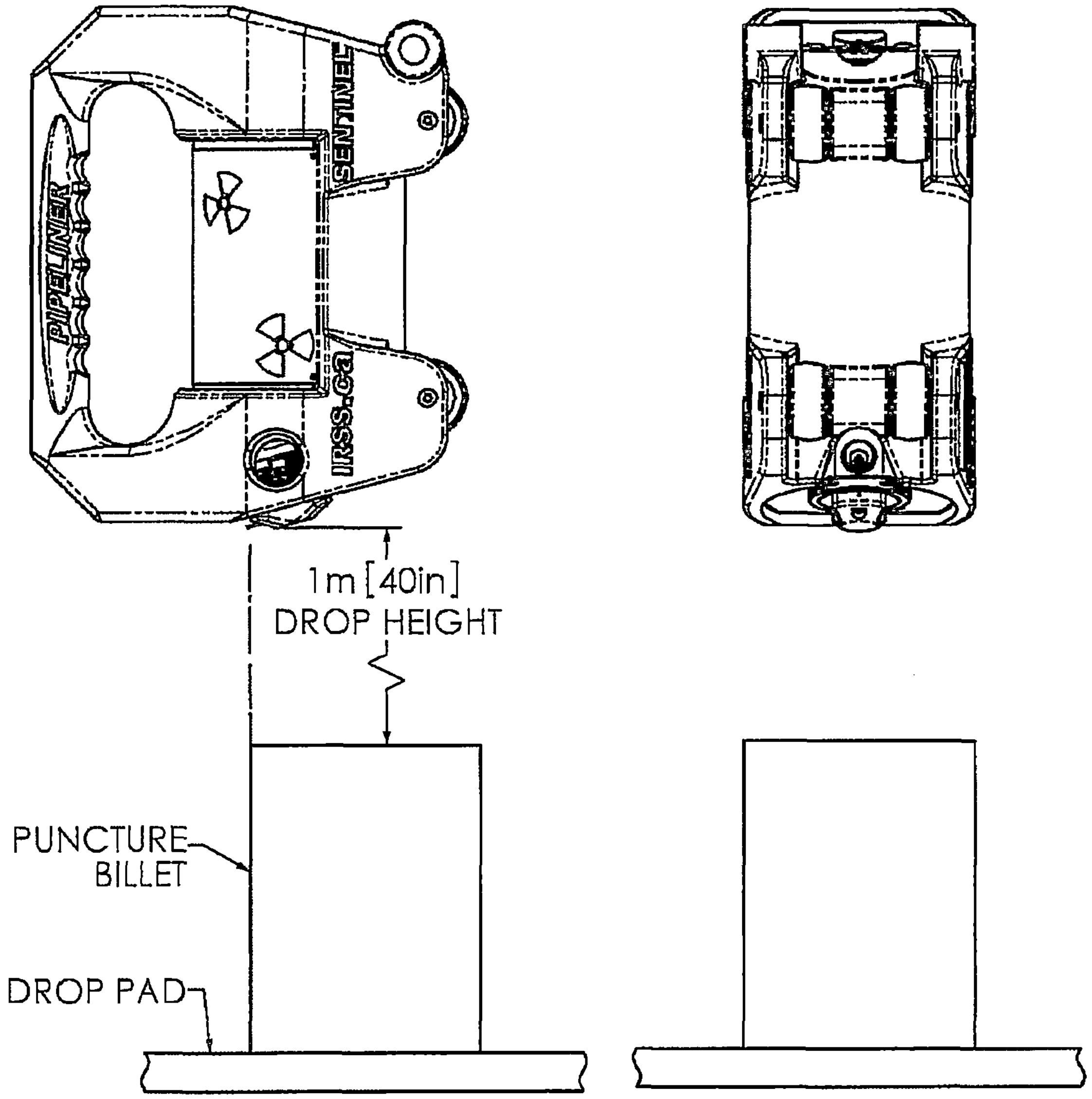


FIGURE 13.3.1 SPECIMEN TP186(A) ORIENTATION FOR THE PUNCTURE TEST

Specimen TP186(B) Orientation for the Puncture Test

The objective of this drop orientation (Figure 13.3.2) is to continue the damage inflicted on the specimen by the 9m-drop test.

The specimen will be dropped with its axis at approximately 22.5 degrees to the drop surface with the lock assembly facing down.

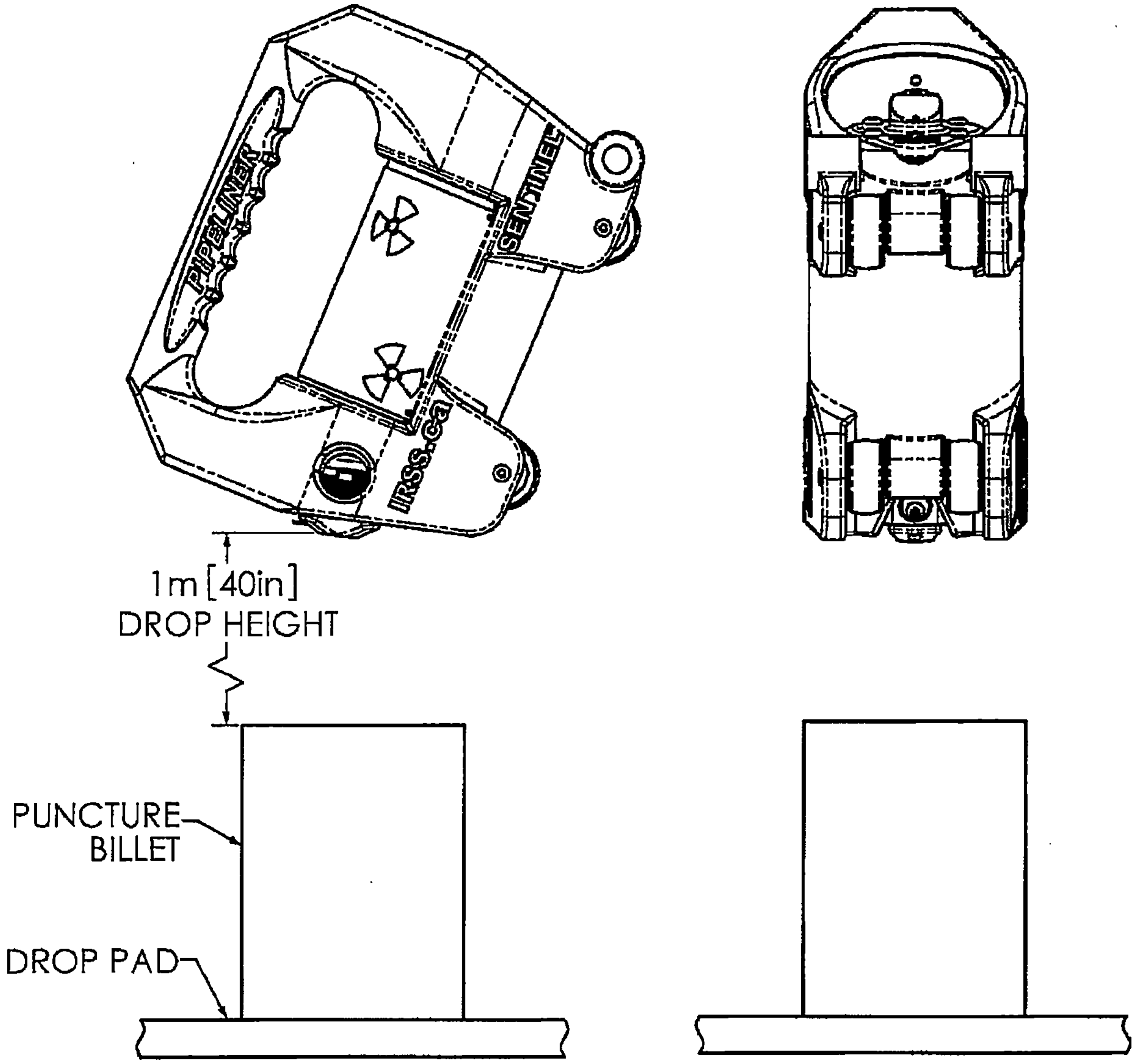


FIGURE 13.3.2 SPECIMEN TP186(B) ORIENTATION FOR THE PUNCTURE TEST

Puncture Test Assessment

Upon completion of the test, **Engineering, Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

Review the test execution to ensure that the tests were performed in accordance with 10 CFR 71, IAEA Safety Standards Series No. TS-R-1, and this test plan.

Make a preliminary evaluation of each specimen relative to the requirements of 10 CFR 71 and IAEA Safety Standards Series No. TS-R-1.

Final Test Inspection and Assessment

Perform the test inspection after the puncture tests.

1. Measure and record the damage to each of the test specimens. Measure and record the package for signs of any permanent strain.
2. Measure and record the location of the source from the front plate.
3. Remove and assess the condition of the simulated source.
4. Reassemble the packages using a representative active source, making sure that the source position and the package configuration are the same as they were immediately after the puncture test.
5. Measure and record a radiation profile of each test specimen in accordance with QSA Work Instruction WI-Q-1806.
6. Assess the significance of any change in radiation at the surface and at one meter from the packages.
7. Determine whether it is necessary to dismantle either of the test specimens for inspection of hidden component damage or failure.
8. If the decision is taken to proceed with the inspection, record and photograph the process of removing any component.
9. Measure and record any damage or failure found in the process of dismantling the test specimens.

Engineering, Regulatory Affairs, and **Quality Assurance** team members will make a final assessment of each test specimen and jointly determine whether the specimens meet the requirements of 10 CFR 71 and IAEA TS-R-1.

Section 15 Worksheets

Use the following worksheets for executing the tests of section 8. Each test shall have three worksheets; an equipment list, a procedure checklist, and a data sheet. Record the information onto copies of these worksheets for each test performed.

Attach a copy of the relevant inspection report or calibration certificate after the range and accuracy of the equipment has been verified.

WORKSHEET 15.1 DROP & PUNCTURE TEST SPECIMEN & EQUIPMENT LIST

Test Specimen & Equipment Documentation

Test Specimen

Configuration	Drawing Number	Serial Number	**Attach IIR	**Attach NCR	**Attach Route Cards
Pipeliner Transport	88095 Rev A	TP180A	Yes	See IIR	See TMI 279
Pipeliner Transport	88095 Rev A	TP180B	Yes	See IIR	See TMI 279
Pipeliner Transport	88095 Rev A	TP180C	Yes	See IIR	See TMI 279

**** Note: Copies of these records are stored on the network in the following directory:**
"K:\4 Design History Files\Model 880 Pipeliner\Verification (Testing)\TP 186 \Test Specimen Records"

Tools & Equipment

Tool Description	Enter the Model and Serial Number Mark NA when not used.	**Attach Inspection Report or Calibration Certificate
Drop Surface, Drawing No. T10740	S/N 001	Yes
Puncture Billet, Drawing No. T10143	S/N 01	Yes
Weight Scale		Yes

Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.

Radiation Meter with Probe	1863 Meter / SHP-270 Probe	Yes

Signature	Print Name	Date
Engineering:		
Regulatory:		
Quality Assurance:		

WORKSHEET 15.2 DROP & PUNCTURE TEST CHECKLIST

Test:

Test Location:

Step	**Data**	
1. Record test specimen serial number:		
2. Record the test specimen weight:		
3. Record the ambient temperature (°C):		Instrument S/N:
3. Record the test unit temperature (°C):		Instrument S/N:
4. Identify set-up orientation figure:		
5. Record drop height.		
6. Photograph set-up in at least two perpendicular planes.		
7. Begin video recording of the test so that impact is recorded.		
8. Release the test specimen.		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.		
10. Record the damage to the test specimen. Use a separate sheet and attach, if needed.		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering:		
Regulatory Affairs:		
Quality Assurance:		

WORKSHEET 15.3 DROP & PUNCTURE TEST DATA SHEET

Test Unit Model/Serial No.:	Test:
Test Date:	Test Time:

Describe drop orientation and drop height:

Describe impact (location, rotation, etc.):

Describe on-site inspection (damage, broken parts, etc.):

On-site test assessment:

- Was the test performed in accordance with 10 CFR 71, IAEA TS-R-1 1996, and this test plan? **Yes or No.**
- Does the test specimen meet the requirements of 10 CFR 71 and IAEA TS-R-1 1996 for this test? **Yes or No.**
- Are any changes to subsequent drop orientations needed to achieve maximum damage? **Yes or No.**
  If yes, then identify and justify.
- Did sufficient damage occur to warrant additional drop? **Yes or No.**
- Should testing continue with this test specimen? **Yes or No.** If yes, next test: ____________________
- Will the test specimen pass the thermal test based on the accumulated damage assessment? **Yes or No**

Engineering: ____________________ **Regulatory:** ____________________ **QA:** ____________________

Describe any post-test disassembly and inspection:

Describe any change in source position (if possible):

Describe results of radiography (if performed):

Completed by:	Date:

WORKSHEET 15.4 TEST INSPECTION DATA SHEET

Test Specimen Serial No.:	Last Test Performed:

Describe and measure (if appropriate) any damage or broken parts, etc.:

Describe and measure (if appropriate) any signs of permanent strain or deformation:

Describe the condition of the simulated source wire assembly.

Reassemble the package using a representative active source, making sure that the source position and the package configuration is the same as they were immediately after the last test.

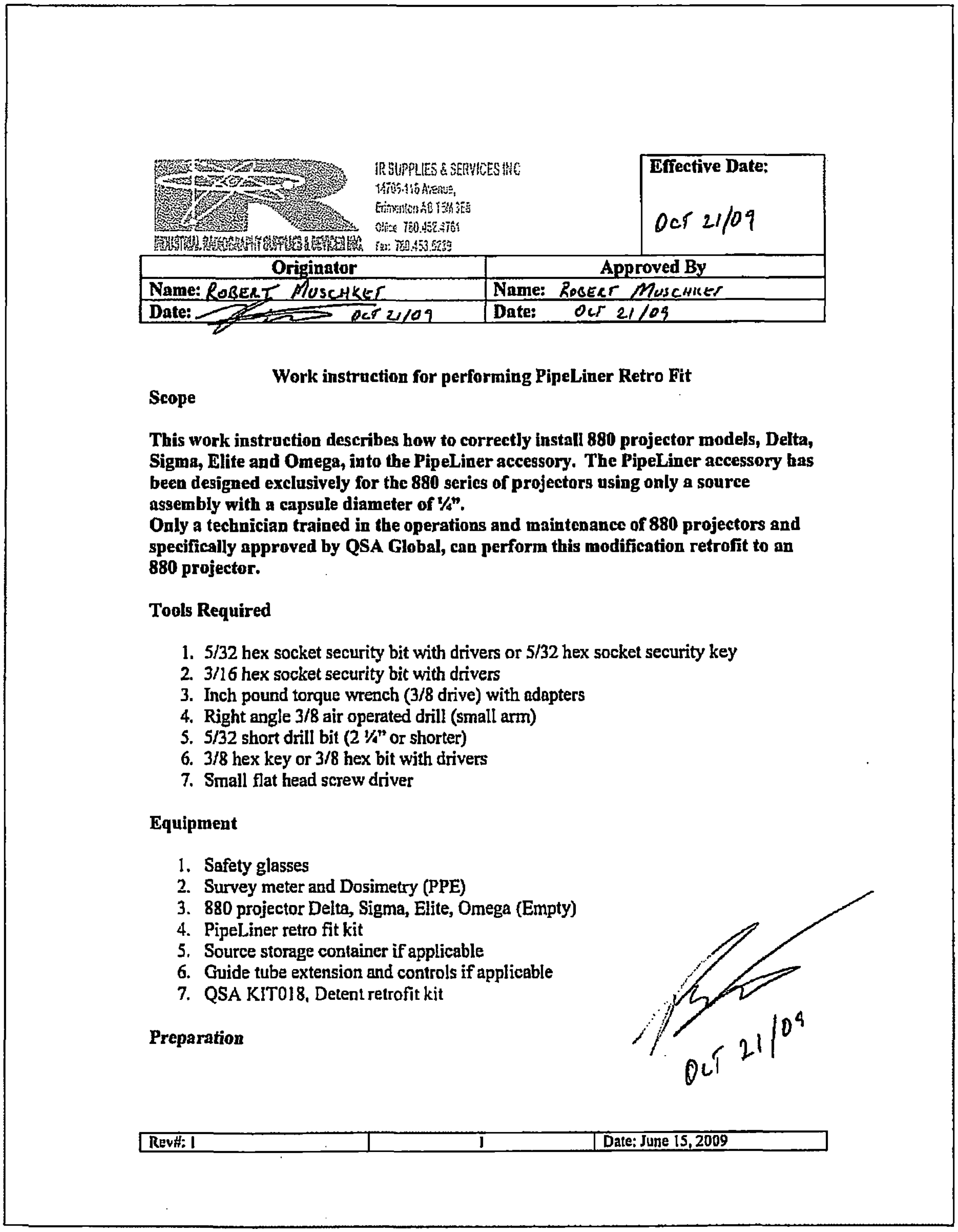
Measure and record a radiation profile of each test specimen in accordance with QSA Global Work Instruction WI-Q-1806.

Compare the pre-test dose levels with post-test dose levels at the surface of the package and at 1 meter from the surface of the package.

Is a radiograph required to inspect for hidden component damage or failure? If radiography is performed, describe any damage or failures found.

Completed by:	Date:

ATTACHMENT 16.1 IRSS "WORK INSTRUCTIONS FOR PERFORMING PIPELINER RETROFIT"



IR SUPPLIES & SERVICES INC
14705-116 Avenue,
Edmonton AB T5M 3E8
Office 780.452.4761
Fax: 780.453.5239

Effective Date: Oct 21/09

Originator	**Approved By**
Name: Robert Muschket	**Name:** Robert Muschket
Date: Oct 21/09	**Date:** Oct 21/09

Work instruction for performing PipeLiner Retro Fit

Scope

This work instruction describes how to correctly install 880 projector models, Delta, Sigma, Elite and Omega, into the PipeLiner accessory. The PipeLiner accessory has been designed exclusively for the 880 series of projectors using only a source assembly with a capsule diameter of ¼".
Only a technician trained in the operations and maintenance of 880 projectors and specifically approved by QSA Global, can perform this modification retrofit to an 880 projector.

Tools Required

1. 5/32 hex socket security bit with drivers or 5/32 hex socket security key
2. 3/16 hex socket security bit with drivers
3. Inch pound torque wrench (3/8 drive) with adapters
4. Right angle 3/8 air operated drill (small arm)
5. 5/32 short drill bit (2 ¼" or shorter)
6. 3/8 hex key or 3/8 hex bit with drivers
7. Small flat head screw driver

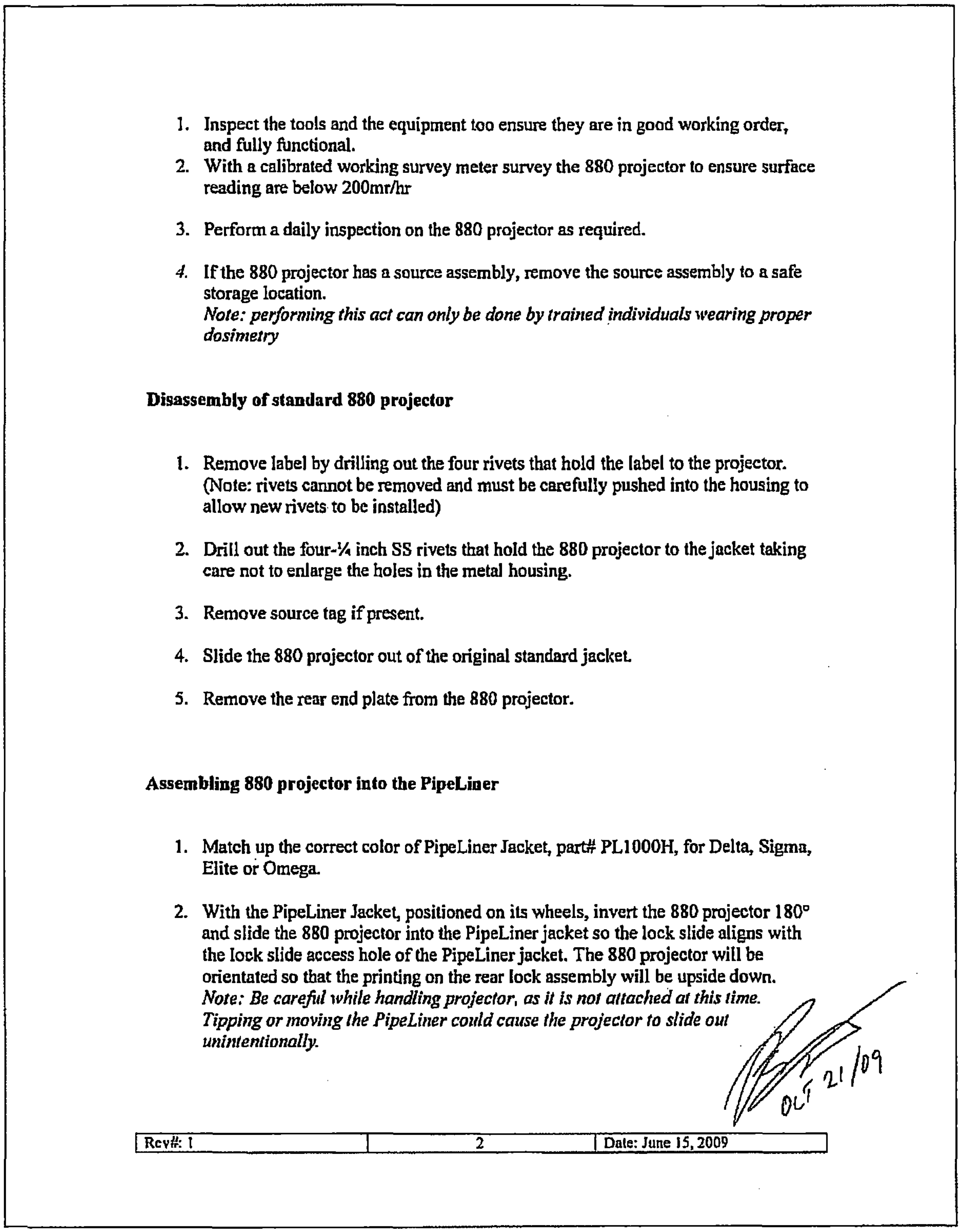
Equipment

1. Safety glasses
2. Survey meter and Dosimetry (PPE)
3. 880 projector Delta, Sigma, Elite, Omega (Empty)
4. PipeLiner retro fit kit
5. Source storage container if applicable
6. Guide tube extension and controls if applicable
7. QSA KIT018, Detent retrofit kit

Preparation

Oct 21/09

Rev#: 1	1	Date: June 15, 2009



1. Inspect the tools and the equipment too ensure they are in good working order, and fully functional.
2. With a calibrated working survey meter survey the 880 projector to ensure surface reading are below 200mr/hr
3. Perform a daily inspection on the 880 projector as required.
4. If the 880 projector has a source assembly, remove the source assembly to a safe storage location.
   Note: performing this act can only be done by trained individuals wearing proper dosimetry

Disassembly of standard 880 projector

1. Remove label by drilling out the four rivets that hold the label to the projector. (Note: rivets cannot be removed and must be carefully pushed into the housing to allow new rivets to be installed)
2. Drill out the four-¼ inch SS rivets that hold the 880 projector to the jacket taking care not to enlarge the holes in the metal housing.
3. Remove source tag if present.
4. Slide the 880 projector out of the original standard jacket.
5. Remove the rear end plate from the 880 projector.

Assembling 880 projector into the PipeLiner

1. Match up the correct color of PipeLiner Jacket, part# PL1000H, for Delta, Sigma, Elite or Omega.
2. With the PipeLiner Jacket, positioned on its wheels, invert the 880 projector 180° and slide the 880 projector into the PipeLiner jacket so the lock slide aligns with the lock slide access hole of the PipeLiner jacket. The 880 projector will be orientated so that the printing on the rear lock assembly will be upside down.
   Note: Be careful while handling projector, as it is not attached at this time. Tipping or moving the PipeLiner could cause the projector to slide out unintentionally.

Oct 21/09

3. Install shoe assembly part# PL1000S. This is accomplished by matching up the shoe with the jacket in the open position; both the wheels of the Jacket and the pipe shoe feet will be flat on the work surface. Use the pipe shoe pivot bolts Part# PL1003 to attach the lower portion of the shoe.

4. Install Collimating guide tube part # PL1017 by matching up the bayonet fitting male connector of the collimator with the female connector of the outlet port. Insert the collimator and turn 90°. Turn outlet port cover 45° to lock in collimator and open outlet port. The collimating guide tube attachment is accomplished in the same fashion as a standard bayonet fitting.

5. Lift up pipe shoe to mate surface of shoe and jacket. Install bolt part# PL1001. Once the bolt is secure, gently tilt entire assembly forward so that the PipeLiner wheels are off the work surface and the Pipe shoe is flat on the work surface (exposure position). The collimating guide tube will now be resting on the inside surface of the shoe. Check alignment of lock slide hole. The lock slide hole may not be perfectly aligned forward to back but should aligned evenly top to bottom and at no point should the hole on the jacket cover any portion of the hole on the 880. Once the projector is in this position the projector is properly aligned and ready for mounting.

6. With the 880 projector still in position and using an angle drill, drill into the PipeLiner jacket through the top mounting hole ½" deep using the 5/32 drill bit and right angle drill. *(Do not drill beyond ½" deep. Tape can be used to mark the drill bit ½" from the tip to accomplish an accurate depth)* Screw the #14 x ¾ tamper proof screw into the top hole. *(Turn screws by hand slowly so urethane doesn't strip out)* Drill and screw the remaining 2 holes securing the rear of the 880 projector.

Note: If a small enough drill isn't available the hole could be marked while the 880 projector is in position and the holes drilled after the 880 projector is removed from the jacket.

7. Tilt the PipeLiner back onto its wheels. Open the shoe by removing the PL1001 bolt, hinge shoe forward and remove the collimating guide tube. Remove shoe by removing the 2 PL1003 hinge bolts.

8. Remove the front end plate.

9. Repeat step #6 on the front end of the projector.

8. Install QSA KIT018, Detent retrofit kit, per instructions included with the kit

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10. Replace the front and rear end plates of the 880 projector according to manufacture specifications.

11. Insert a dummy source into the device

12. Attach the PipeLiner collimating guide tube

13. Perform a function test and cycle the dummy source several times ensuring the projector is functioning properly.

14. Inspect label to ensure it is in good condition, replace if necessary. Drill new holes in label to **match** holes on projector. DO NOT DRILL NEW HOLES IN THE 880 ASSEMBLY. Doing so may damage the shield and will violate Regulatory requirements for the device. Tuck the label under the edges of the PipeLiner jacket and rivet label to projector.

15. The source may now be reinserted and the source tag attached. An area has been designed to accommodate the source ID tag on the rear of the projector.

Oct 21/09

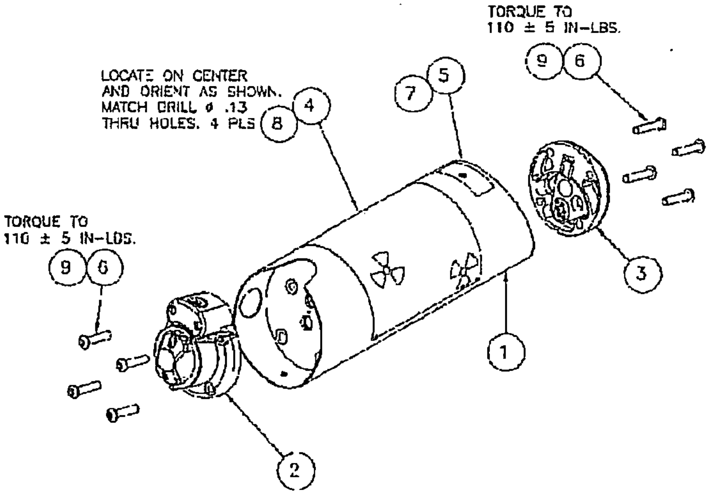
ATTACHMENT 16.2 DRAWING NO 88015 REV C – MODEL 880 150 CI BODY ASSEMBLY

REVISIONS

REV.	ECO/TGR #	DESCRIPTION	APPROVALS	DATE
A	2701	INITIAL RELEASE	SEE TITLE	BLOCK
B	572	CHG. GRAPHICS ON LABEL	PB/MT	30MAY03
C	1815	ADDED ITEM 9 (GRE003) ITEM 7 WAS SCR137		4 Feb

NOTES:

1. TOTAL PACKAGE WEIGHT TO BE 46 LBS. MAX.
2. FUNCTIONAL TEST COMPLETED ASSEMBLY WITH DUMMY SOURCE WIRE.



ITEM	DRAWING NO.	QTY.	DESCRIPTION
9	GRE003	A/R	THREAD LUBRICANT
8	RIV003	4	POP RIVET
7	SCR099	1	BINDER HEAD SCREW, #5-32 X 3/8 LG.
6	SCR154	8	SECURITY SCREW, 5/16-18 X 1-1/2 LG.
5	A88043	1	SOURCE ID TAG
4	B88042-1	1	LABEL, 150 CURIE MAX
3	B88030	1	FRONT PLATE ASSEMBLY
2	B88020	1	REAR PLATE ASSEMBLY
1	B8801	1	BODY WELDMENT, 150 CURIE MAX.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF QSA GLOBAL. IT MAY ONLY BE USED FOR THE PURPOSE FOR WHICH IT WAS ISSUED. IT MAY NOT BE DUPLICATED IN ANY WAY, NOR TRANSMITTED TO ANY THIRD PARTY WITHOUT THE EXPRESS PERMISSION OF QSA GLOBAL.

MATERIALS: SEE PARTS LIST

PROTECTIVE FINISH. NONE

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES.
2. MAX SURFACE TEXTURE: 63/
3. DIMENSIONS APPLY AFTER FINISH.
4. REMOVE BURRS AND SHARP EDGES.
5. DO NOT SCALE DRAWING
6. TOLERANCES: .X ± 0.1
FRACTIONS ± 1/64 .XX ± 0.01
ANGLES ± 1° .XXX ± 0.005

DRAWN	S.GRENIER	15JUN00
CHECKED	NA	
APPR.	M.TREMBLAY	15JUN00

THIRD ANGLE PROJECTION

QUALITY CLASS A

QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803

TITLE: MODEL 880
150 CI BODY ASSEMBLY

SIZE B DWG. NO. 88015 REV C

SCALE: NONE SHEET 1 OF 1

ATTACHMENT 16.3 IRSS PIPELINER OPERATIONS AND MAINTENANCE MANUAL, APR 4, 2007

To be attached as a separate document

INDUSTRIAL RADIOGRAPHY SUPPLIES & SERVICES INC.

THE PIPELINER

OPERATIONS AND MAINTENANCE MANUAL

ACCESSORY FOR SENTINEL 880
DELTA
SIGMA
ELITE
OMEGA

DANGER - IMPORTANT WARNINGS

The IRSS PipeLiner System must be operated only by trained and qualified radiographers who have read and understood this Operations Manual and the 880 Series Source Projector Operating and Maintenance Manual, or by trained assistants working under their direct supervision.

WARNING

The use of radiographic exposure devices by unqualified personnel or when safety procedures are not fully met, could result in life threatening dangers.

Gamma radiography systems emit high levels of penetrating ionizing radiation during use and present a significant health risk to operators and the public including injury, sickness and/or death if appropriate safety and operational procedures are not employed.

Unshielded sources or source assemblies must never come in contact with any body parts under any circumstances.

Since gamma radiation is undetectable by the human senses, strict operating and emergency procedures must be followed. The proper use of PPE must be employed at all times during radiographic operations including calibrated survey meters, direct reading dosimeters, direct alarming dosimeters and the wearing of thermoluminecent dosimeters.

During use of this radiography system, never assume the position of the radiation source. Always conduct a thorough confirmatory survey using a calibrated survey meter to verify the location of the radiation source. Be reminded that a multitude of overexposure incidents which include injuries are directly attributed to a failure of the operator to perform or supervise an adequate confirmatory survey.

It is very important and required by regulation to prevent access by unauthorized persons to radiography equipment and to the area where radiography is performed.

Take advantage of the three basic radiation protection methods to minimize radiation exposure.

TIME

Spend less time near a source of radiation

DISTANCE

Increase your distance in a direction away from a radiation source

SHEILDING

Use effective shielding between you and the source of radiation

DO NOT

Perform any unauthorized modifications to the radiography exposure device or the components of this system

Use components that are not approved for use with this radiography system or after market components as this may compromise the safety designed into the system.

DO

Perform daily safety inspections of the radiography system for defects, wear and tear, replacing components as required. Inspections will be carried out or supervised only by trained and qualified radiographers

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

THE 880 SERIES PROJECTOR PIPELINER ACCESSORY

DESCRIPTION

The PipeLiner is a rugged, easy to use attachment for the Sentinel 880 series of gamma ray radiography projectors to improve utilization and reduce dose rates to operators when performing pipeline radiography, while still maintaining the option of conventional set ups. The addition of the PipeLiner accessory essentially converts the 880 series of projectors into a dual purpose exposure device.

The PipeLiner accessory consists of four main components; the jacket, collimating guide tube, pipe shoe and swing arm assembly

PIPELINER JACKET

The PipeLiner jacket is made of polyurethane for strength, durability and weight reduction The jacket is similar to the stock 880 jacket in design and serves the same functions with a few exceptions. Wheels have been added to the jacket for easy transportation from weld to weld along pipelines. Accommodations have be made for the attachment of the "pipe shoe" and " swing arm assembly" to the front of the jacket.

A significant change, mounts the projector 180° or upside down in contrast to it's current or original jacket orientation. This new position gives a better angle to the control assembly for added durability and the collimating guide tube for ease of operation.

The PipeLiner jacket is attached to the 880 device in the same manner as the original jacket, with four stainless steel rivets.

PIPELINER COLLIMATING GUIDE TUBE

The collimator, guide tube and bayonet fitting are made of tungsten and manufactured as one component producing a unique design that maintains continuous shielding of the source while it is being projected to the beam port.

The beam port of the guide tube has been carefully designed to minimize the size of exclusion areas, reduce dose to operators, virtually eliminate flash dose, while still maintaining proper beam orientation.

The collimating guide tube fits securely inside the "Pipe Shoe" when in use.

PIPE SHOE

The pipe shoe is made from similar polyurethane as the jacket and is designed to sit on the pipe during exposures. It consists of a molded bottom for positioning the exposure device along the center line of the pipe. This portion also includes the focal opening, a transverse groove that is used to align the beam port of the collimating guide tube into the position that best suits the intended geometry of the radiograph.

The top section consists of a raised area and a large indent. The raised portion will not allow the shoe to be closed unless the 880 outlet port cover is either fully closed or in the fully open position with the collimating guide tube attached. The indented area accommodates the collimating guide tube keeping it secure and protected.

The jacket accommodates the pipe shoe at the front by hinging it to the bottom portion of the jacket using two 2 3/4"x 2" socket head shoulder bolts. This hinging action is important as it allows the PipeLiner to be quickly prepared for the use of conventional guide tubes. The connection of the pipe shoe is completed by fastening the top portion of the jacket through the handle with the 3/8" x 12" socket head shoulder bolt.

CLAMP ASSEMBLY

The clamp assembly consists of three main sections, the right side plate including swing arm, the left side plate, and the hook plate that includes strapping, quick release latch and cam buckles.

The swing arm and right side plate is attached to the right side of the pipe shoe and the left side plate is attached to the left side using four 3/4"x 2" socket head shoulder bolts with the two rear bolts also acting to hinge the pipe shoe to the PipeLiner Jacket.

An important safety feature has been built into the Clamp assembly that will not allow the hook plate to be removed from the hook plate pin without depressing the cam buckles, releasing the strapping. This feature will not allow the PipeLiner to prematurely disengage from the pipe and fall to the ground. If the swing arm has not been engaged and the PipeLiner is accidentally allowed to fall uncontrolled it will only swing to the bottom of the pipe where it will hang until it is righted or removed.

APPLICATION

The PipeLiner Accessory has been designed for the industrial applications of gamma radiography of pipeline butt welds using double wall contact and single wall viewing technique.
By hinging open or removing the pipe shoe standard guide tubes can be attached to the 880 projector and conventional radiography performed. (SEE 880 OPERATION and MAINTENANCE MANUAL)

880 PROJECTOR

The PipeLiner is designed specifically for the 880 series of projectors. It is necessary that the operator has been trained and qualified in the operations of the 880 projector. Only those individuals who have received a certificate of competence for the maintenance of 880 devices should perform the jacket replacement. See your nearest Sentinel service center.

SOURCE ASSEMBLIES

The PipeLiner accommodates 1/4" diameter source capsules using TCI 5222 Teleflex cable style source assemblies **only**.
The following source assemblies meet the above requirements:

ISOTOPE	ASSEMBLY MODEL NO.	GAMMA ENERGY RANGE	HALF LIFE	APPROXIMATE STEEL WORKING THICKNESSES
Selenium 75	A424-25W	66-612 keV	120 days	3-29mm
Iridium 192	A424-9	206-612 keV	74 days	12-63mm
Cobalt 60	A424-19	1.17-1.33 MeV	5.27 years	50-150mm

Activities

Authorized isotope activities are dependant on the 880 model, user license, and regulatory restrictions.

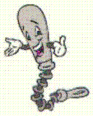
OPERATING DISTANCE/POSITION

All lengths of control assemblies can be used with the PipeLiner accessory. A 5.5 meter (18 feet) PipeLiner control assembly is available that incorporates a short .3 meter (1 foot) return. This control assembly should only be used in conjunction with the PipeLiner accessory.
It is recommended that the operator, under normal conditions, position himself to the rear of the projector and no closer than 5 meters during an exposure.
The shielding characteristics of the collimating guide tube are such that it favors the operator standing directly behind the projector. Directly forward of the projector offers the least protection while the sides as you proceed from front to back will continue to produce a reduction in dose rate until directly behind the projector.

ACCESSORY SPECIFICATIONS

Manufacturer
Industrial Radiography Supplies and Services Inc.
14705 116 Ave
Edmonton, Alberta
Canada T5M 3E8

Primary Application
Industrial Pipeline Gamma Radiography



ACCESSORY FOR:

880 MODEL	ASSEMBLED WEIGHT	LENGTH	WIDTH	HEIGHT	SOURCE ASSEMBLIES
DELTA	65LBS	15”	7.5”	10”	A424-25W, A424-9,A424-19
SIGMA	65LBS	15”	7.5”	10”	A424-25W, A424-9,A424-19
ELITE	55LBS	15”	7.5”	10”	A424-25W, A424-9,A424-19

MATERIALS

Polyurethane jacket and pipe shoe, aluminum and stainless steel

INSPECTION REQUIRMENTS

Daily pre-operational inspection for obvious damage to the system

MAINTENANCE REQUIRMENTS

Clean and dry after each days use

OPERATING TEMPATURE RANGE

-40˚C to 149˚C

NOTICE

*The 880 PipeLiner accessory jacket has been registered as part of the Type B(U)-85 shipping container for AEA Technology QSA Inc. source assemblies and thus can remain on the projector during shipment. However all other parts of the PipeLiner accessory must be removed in their entirety before transport.

The purpose of this manual is to provide information which will assist qualified radiographers in using the PipeLiner accessory with the 880 series of projectors. The user must be thoroughly familiar with the 880 instruction manual and this instruction manual before attempting operation and use of this equipment.

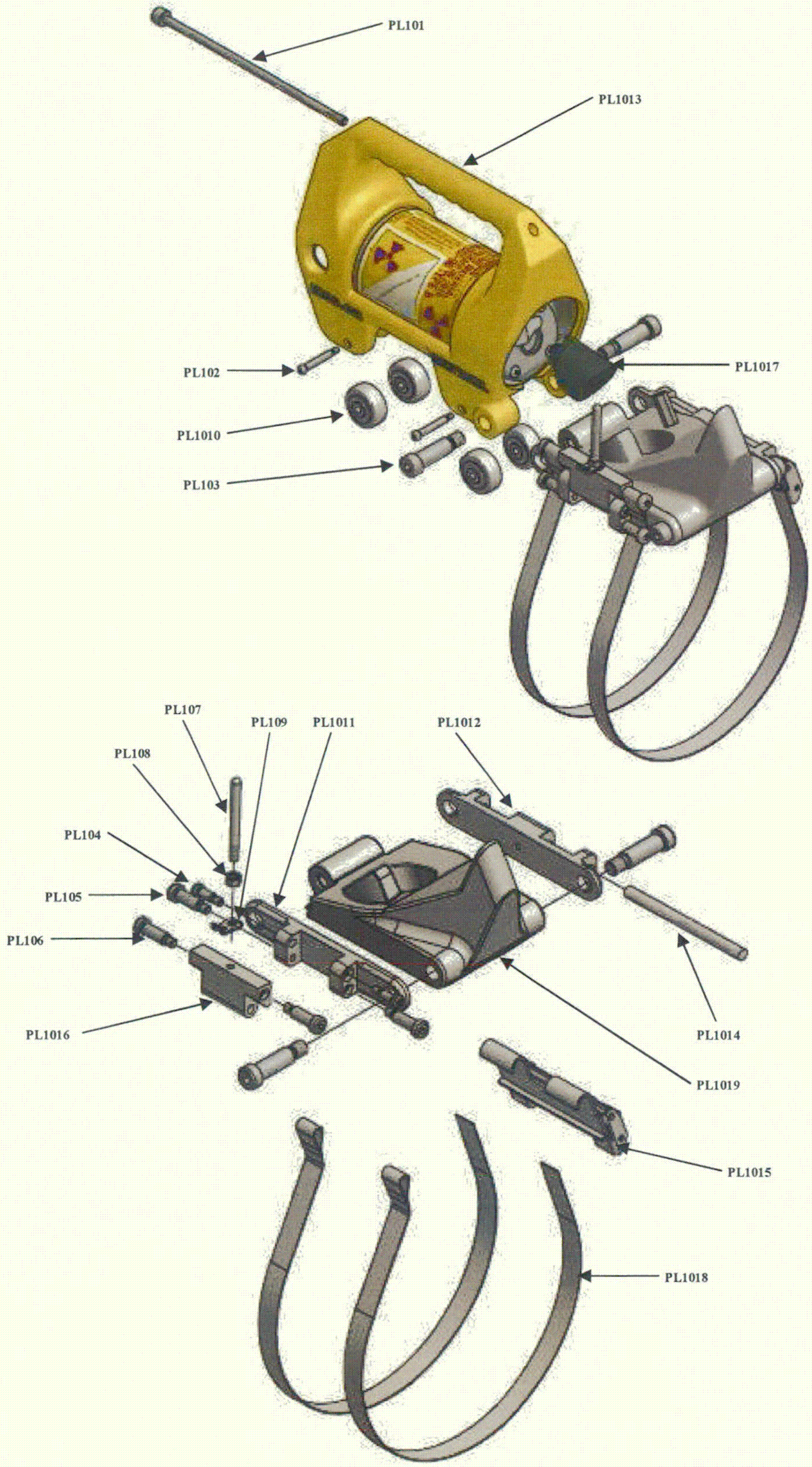
Prior to use of PipeLiner Jacket in conjunction with the 880 projector as a shipping container a registered user certificate specifying the combination must be obtained from the CNSC.

It is the responsibility of the user’s of this equipment to comply with local, national and international regulatory, licensing and transport rules and regulations as they apply in their respective countries.

* to be approved

7

DIAGRAM


PL101
PL1013
PL102
PL1017
PL1010
PL103
PL107
PL109
PL1011
PL1012
PL108
PL104
PL105
PL106
PL1016
PL1014
PL1019
PL1015
PL1018

PARTS LIST

PART NUMBER	QTY	DESCRIPTION
PL101	1	3/8” x 12” SOCKET HEAD CAP BOLT
PL102	4	5/16” x 1 3/4” SOCKET HEAD CAP BOLT
PL103	4	3/4”x 2” SOCKET HEAD CAP BOLT
PL104	2	3/8” x 3/4” SOCKET HEAD CAP BOLTS
PL105	2	1/2” X 1 1/4” SOCKET HEAD CAP BOLTS
PL106	2	1/2” X 1 1/4” SOCKET HEAD CAP BOLTS
PL107	1	SWING ARM HANDLE
PL108	1	SWING ARM HANDLE NUT
PL109	1	BUNGEE CATCH
PL1010	4	WHEELS
PL1011	1	RIGHT SIDE PLATE
PL1012	1	LEFT SIDE PLATE
PL1013	1	PIPELINER JACKET
PL1014	1	HOOK PLATE PIN
PL1015	1	HOOK PLATE
PL1016	1	SWING ARM
PL1017	1	COLLIMATING GUIDE TUBE
PL1018	2	STRAPS
PL1019	1	PIPE SHOE

WARRANTY AND LIMITATION OF LIABILITY

Industrial Radiography Supplies and Services Inc. (IRSS, herein referred to as the manufacturer) warrants its product which it manufactures and sells to be free from defects in material and workmanship for a period of one year from the date of shipment. This warranty shall not apply to any products or parts which have been subjected to misuse, improper installation, repair, alteration, neglect, accident, abnormal conditions of operation, or use in any manner contrary to instruction or intended application.

The manufacturers liability under such warranty shall be limited to replacing or repairing at it's option, any parts found to be defective in such respects, which are returned to the manufacturer, transportation prepaid; or at it's option, to returning the purchase price thereof.

The warranty on other manufacturer's components shall be that of the original manufacturer whose warranty shall be binding.

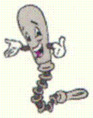
In no event shall the manufacturer be liable for any incidental or consequential damages whether or not such damages are alleged to have resulted from the use of such product in accordance with instructions given by or referred to by the manufacturer.

IRSS assumes no liability or responsibility for the usage of any radioactive material or device generating penetrating radiation used in connection with this product.

All other warranties, except those warranties expressly stated herein, including without limitation warranties of, merchantability and implied warranties of fitness, are expressly excluded.

The warranty on this accessory is specifically limited to its use with the Sentinel 880 series of gamma ray projectors and sealed source assemblies as described on page 4 of this manual.

IRSS shall not be liable for any errors or omissions contained herein and the provision by IRSS of the information set out in this manual does not in it's self constitute acceptance of any liability on the part of IRSS.



OPERATING INSTRUCTIONS

NOTE

This manual assumes that the reader has a thorough understanding of the operation and maintenance of the Sentinel 880 projector. Only personnel trained and qualified in the operation and maintenance of 880 projectors should attempt to use the PipeLiner accessory and only personnel with formal maintenance training should attempt to install an 880 projector into the PipeLiner Jacket.

880 PROJECTOR CONVERSION

Tools required

Only specially trained personnel should attempt this procedure.
SEE SENTINEL 880 SERIES SOURCE PROJECTOR OPERATING AND MAINTENANCE MANUAL OR YOUR LOCAL DISTRIUTOR

Parts Required

IRSS PipeLiner Jacket
PipeLiner Label
4 - 1/4” Stainless Steel Rivets
***Retrofitted 880 Projector**

***NOTE: 880 Projectors to be converted for use with the PipeLiner Accessory must have been retrofitted by a trained technician before conversion can be performed. See your Sentinel dealer for information on the necessary retrofits needed for your specific 880 projector.**

Conversion

In order to use the PipeLiner accessory with the 880 projector the projector must be removed from it’s original jacket and reinstalled into the PipeLiner jacket. **This can only be performed with an empty projector.** Remove the rear end plate, labels and four stainless steel rivets holding the projector to the jacket. (See Sentinel 880 Series Source Projector Operating and Maintenance Manual)

Once the projector has been removed from its original jacket it is rotated 180° and inserted into the PipeLiner jacket, making sure that the plunger lock access holes in the jacket and projector line up correctly, and then riveted into place. The rear end plate and new labels can now be re-installed and the source assembly transferred back to the device. This completes the jacket installation.

At this point the 880 projector can be operated using conventional guide tubes and controls, the only difference in operation being the upside down positioning of the device to its original orientation. Operators will soon become accustomed to this new position that provides improved support of control assemblies.

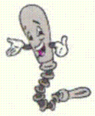
PIPELINER ASSEMBLY

Tools Required

3/8” T Handle Allen Key (Supplied)

Parts Required

Converted 880 Projector
Pipe Shoe
Right Side Plate with Swing Arm
Left Side Plate
Tungsten Collimating Guide Tube
Hook Plate
Polyurethane Straps
4 - 3/4” x 2” Socket Head Cap Bolts
1 - 3/8”x 12” Socket Head Cap Bolt



Pipe Shoe Attachment

Place the Pipe Shoe foot side down, hinge joint in front of the projector with the 880 projector on it's wheels. Approaching from the right side, plunger lock opening to your left, slide the pipe shoe back toward the projector inserting the pipe shoe hinge joint between the PipeLiner jacket hinge joints.
Align the over right side plate bolt hole, swing arm handle pointing up, with the jacket hinge joint bolt hole and insert the 3/4" x 2" socket head cap bolt and tighten loosely. Align the over right side plate bolt hole with the bolt hole in the front of the pipe shoe and insert a 3/4" x 2" socket head cap bolt through the hole and hand tighten using the T handle Allen key wrench.
Approaching the projector from the opposite side attach the left side plate in the same manner as the over right side plate using the two remaining 3/4" x 2" socket head cap bolts. With the front bolts securely fastened the rear bolts can now be securely hand tightened using the T handle Allen key wrench. The pipe shoe is now effectively hinged to the PipeLiner jacket.

Attaching The Collimating Guide Tube

The collimating guide tube has been manufactured with a bayonet connector, all as one piece. The swivel bayonet connector used with conventional guide tubes is not used with the PipeLiner accessory.
Connect the collimating guide tube in the same manner a you would a conventional guide tube remembering that the 880 projector is now upside down or 180° to its original position. (See step 2 "Connecting the Source guide tube(s)" pg.2.3, in the Sentinel 880 Series Source Projector Operating and Maintenance Manual)
Once the collimating guide tube is attached and the outlet port cover fully rotated clockwise until it stops, the pipe shoe can be lifted up, closing it over the collimating guide tube sealing from view, the front of the device. The 3/8" x 12" socket head cap bolt is then inserted through the carrying handle of the jacket and tightened securely using the T handle Allen key wrench.

Attaching The Clamping Plate

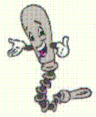
Select a strap length that best suits the diameter of pipe being radiographed. The proper length should leave a minimum of 6" of strapping material or tag end, projecting out of the cam buckles.
Placing the hook plate, hook side down, thread about 8" to 12" of the urethane strapping, unlooped end under the cam buckle. Reversing the direction, thread the strapping back and through the cam buckle jaw. Perform the same steps for the other cam buckle. The straps are now secured to the hook plate.
There are four horizontal posts attached to the over right side plate and swing arm. Two fixed "fulcrum" posts below and two posts that pivot as part of the swing arm. Attach the looped end of the strapping to the swing arm posts by sliding the loops over the ends. The hook plate should be positioned so that the hook points away from you and the straps should not be twisted or crossed but remain parallel.
Next lift the hook plate to create slack in the strap and force it between the gap made between the fixed fulcrum post and the over right side plate attachment bolt, positioning the strap behind the fixed fulcrum post. Repeat for the other strap.
This completes the assembly of the Sentinel 880 PipeLiner accessory.

Disassembly

If the operator wishes to use conventional guide tubes only the 3/8" x 12" socket head cap bolt needs to be removed to allow the pipe shoe to hinge open. Enough space is provided to attach conventional guide tubes. If the operator wishes to remove the pipe shoe entirely, in addition to the 3/8" x 12" socket head cap bolt, the two 3/4" x 2" hinge bolts are all that need to be removed. This procedure will leave the swing arm assembly attached to the pipe shoe for quick reattachment later.

NOTE

The 880 series of projectors are not approved for transport of sealed sources while the pipe shoe remains attached to the Jacket.



OPERATION

Set up

Place the PipeLiner accessory, wheels first, pipe shoe forward, on the pipeline and roll it to within a few inches of the weld to be radiographed. Number belts or other identification markers can be attached to the pipe adjacent to the weld at this time. The projector is then tilted forward off it's wheels so that it is resting on the feet of the pipe shoe. The feet of the pipe shoe are designed to accommodate piping as small as 2" diameter and will automatically align the beam port along the center line of the pipe.

Position the focal opening, the apex of the transverse groove in the bottom of the pipe shoe, directly above the weld. This position can be arranged to the front or rear of the weld depending on the intended resultant radiograph.

Working from the right side of the PipeLiner with the swing arm handle in the "open" or down position, keep one hand on the PipeLiner and either reach over or under the pipeline, grasp the hook plate then hooking it onto the left side plate hook pin.

While still holding the device in place with one hand, grasp the tag ends of the straps with the your free hand and pull in a downward direction until the straps are tight. If the straps have been tightened properly it should be impossible to remove the hook plate from the hook pin without loosening the straps. In some cases, and especially with small diameter pipe, 3" and under, it is useful to give the straps one or two quick tugs to ensure the straps are sufficiently tight. Now lift the swing arm handle to lock the device securely to the pipe. It should now require a force much greater than the weight of the device to move the projector around the radius of the pipe. The larger the diameter of the pipe the greater the force required to move it, or the less tension required to hold the device in place.

The remote control assembly can now be connected to the projector and the exposure performed. (See Sentinel 880 Series Source Projector Operating and Maintenance Manual Step 3 pg.2.5).

360° Rotation Around the Pipe

In order to position the PipeLiner to produce radiographs of the entire weld, it needs to be rotated into various positions around the circumference of the pipe. To accomplish this, first grasp the PipeLiner near the plunger lock opening with your left hand, curling your fingers over and around the end of the jacket. Next grasp the swing arm handle and lower it slightly to release just enough tension so that the projector can be pushed or pulled and rotated into the position required. The swing arm handle can, in this fashion, be used as a break providing the operator a high degree of control. Once you have attained the desired position, the swing arm handle is lifted locking the projector into position. This maneuver requires very little effort and can be accomplished with considerable accuracy with only a little practice.

Positioning of Film or Flexible Imaging Plates

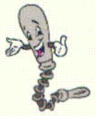
Provisions for the attachment of bungee cord or similar material to the hook plate and a catch to fasten the bungee cord to, has been added to the swing arm handle so that film cassettes or imaging plates can be held firmly in place.

Moving to the Next Welded Joint

Once the required number of radiographs have been produced and it is time to move to the next welded joint, the PipeLiner is rotated back to the upright position on top of the pipe. If the remote control assembly is wound around the pipe it should unwound at this time and the pistol grip hung over the pipe close to and in front of the PipeLiner.

With your left hand holding firmly onto the PipeLiner, remove the hook plate from the hook pin by depressing the quick release mechanism with your right hand and allow it to fall under the pipe. Tilt the PipeLiner back onto it's wheels. Retrieve number belts and/or other identification markers and again with your right hand, reach under the pipe and retrieve the clamping plate. Position the clamping plate comfortably in your left hand while still maintaining a grip on the PipeLiner handle. This may seem awkward at first but becomes quite routine very quickly.

Pick up the pistol grip with your right hand and begin rolling the PipeLiner along the pipe to the next welded joint. The set up procedure is now repeated.



INSPECTION AND MAINTENANCE

NOTE

Maintenance instructions in this manual for the PipeLiner accessory apply only to the parts listed in this manual. For maintenance instruction for the 880 projector, remote control assemblies or other Sentinel products not listed herein please refer to the Sentinel 880 Series Source Projector Operation and Maintenance Manual or the original product Operations Manual.

Daily Inspection of the Radiography System

A daily inspection of the gamma radiography system for obvious defects is essential.
The daily inspection ensures that the equipment is in a safe and proper operating condition.
It is important that all radiographers perform or supervise this inspection prior to the first radiographic exposure of the shift regardless of any previous inspections that may have been performed that day. As an example, damage to a component of the system may occur during transport of the equipment to the job site. If damaged equipment were used without detection, the result may be the inability to retract the source assembly into the exposure device and secure it.
The result of a daily inspection should be recorded and include the date, name of the inspector and what specific equipment was inspected. If any defective or damaged components are discovered during daily inspection, the component must be removed from service and identified with a status indicator (tag, label, tape) to prevent inadvertent use by other radiography personnel.. Defective or damaged components must be repaired or replaced before reuse in radiography operations. The main components of the radiography system consisting of the radiographic exposure device, remote controls, source guide tubes must be inspected in addition to accessories such as lab stands, collimators, jigs, j-tubes, and pipe clamping apparatus.
Radiographers must take a proactive roll in preventing incidents, by performing or directly supervising a simple but thorough daily inspection of the radiography system. The implications that effect safety and the importance of the daily inspection must be emphasized and understood by the entire radiography staff.

Daily Inspection of the PipeLiner Accessory

1. Before starting any inspection, survey the surface of the exposure device to ensure that the radiation level is less than 2mSv/hr (200mR/hr).This survey provides a function test of the survey instrument, that it is responding to radiation, in addition to providing the radiographer with a reference measurement that can be compared to confirmatory surveys after terminating each radiographic exposure.

2. Inspect the labels on the exposure device to ensure they are legible and securely attached. The warning label containing the trefoil should be legible from a distance of 1 meter (approximately 3 feet). Inspect the legibility and attachment of the source identification tag that describes the radioactive source contained within the exposure device.

3. Check the PipeLiner jacket for cracks and gouges that could pinch or cut hands and fingers or wear damage that could affect the safe operation of the exposure device. Replace or repair as necessary.
It is common for the polyurethane material of the jacket to darken in color over time especially if the jacket is in direct sunlight for long periods. This is natural and will not affect the function of the jacket or the device.
Inspect the wheels for smooth rotation, and the tires for wear, gouges or chunks missing. Replace as needed.

4. Inspect the collimating guide tube for obvious damage. Ensure the guide tube is free of dirt or debris. Check the bayonet fitting for burrs, cracks or dents. If damaged is found to the bayonet fitting the collimating guide tube should be replaced. Ensure the bayonet fitting engages and rotates smoothly into place in the outlet port by installing and removing it. A crunchy or gritty feeling indicates that dirt and/or sand has entered the outlet port mechanism and it must be serviced before use.

5. Inspect the pipe shoe for rough or sharp edges these should be filed smooth to prevent injury. Inspect the feet for excessive wear. The feet of the pipe shoe receives the most wear from contact with the pipe and will eventually wear to a point that the shoe will need to be replaced. Check the apex of the focal opening and of the concave between the feet for cracks. Ensure the indent that houses the collimating guide tube is free of dirt or debris and is sound with no wear through areas, allowing dirt into the collimating guide tube.

6. Inspect the entire swing arm assembly, right and left side plates, for obvious damage or wear and nicks or sharp edges that could cause injury. These can be filed smooth. The over swing arm should operate smoothly, the fulcrum and swing arm posts should be free of bends or burrs.
Check the straps for wear, cuts or abrasions. Check the loops, paying special attention to the inside of the loop where it rubs against the posts. If the straps show obvious fatigue or wear they need to be replaced.
Inspect the operation of the cam buckles, they should open and close smoothly, firmly grasping the strapping.
Check the hook plate and hook plate pin for damage and deformities.

7. During the initial set up of the days work and with the PipeLiner on the pipeline, the following exercise needs to be performed to ensure all components of the PipeLiner accessory are functioning together as intended.
Engage the hook plate onto the hook plate pin, tighten the straps and check to ensure the hook plate cannot be removed from the hook plate pin without releasing the quick release cam buckles first.
Next rotate the entire device 120° away from you and engage the swing arm. Put slight hand pressure on the PipeLiner with the intent of trying to force it further towards the bottom of the pipe. Now rotate the device from the top of the pipeline 120° in a direction towards you and engage the over centering mechanism. Again put slight hand pressure on the PipeLiner with the intent of trying to force it further towards the bottom of the pipe. Return the device to the top of the pipeline. If the device failed to hold sufficiently at any time, retighten the straps and repeat the above tests until the projector is held securly.

MAINTENANCE
Daily (routine) and annual (complete) maintenance requirements

Radiographic exposure devices and associated equipment must be maintained regularly by trained and qualified personnel to ensure consistent and safe operation of the radiographic system. The routine inspection and maintenance also ensures the integrity of the Type B(U)-85 transport packages are maintained in compliance with the package certification number USA/9296/B(U)-85.

Manufacturers base the recommended inspection and maintenance requirements on the system's design, application, materials, anticipated work cycles, environmental factors of use under the normal and abnormal conditions of industrial radiography and while in the transport system. A program of systematic maintenance will prolong the working life of the radiographic exposure device and associated equipment in addition to ensuring safety during use. By most national regulations, routine maintenance of the systems is required at intervals not to exceed 3 months in addition to the radiographer's daily inspections for obvious defects. The complete annual servicing ensures the integrity of the system.

Maintenance program administrators must recognize the need for maintenance intervals that are less than the required 3 month interval especially in cases where the systems are used in severe environmental conditions. Maintenance program administrators must ensure the systems are completely serviced immediately after certain jobs in severe conditions. Extreme or severe conditions may include, but is not limited to:

- Conditions where the equipment was immersed in water or mud.
- Subjected to high-concentrations of particulate such as fly ash or sand.
- Subjected to hot radiography conditions.
- Subjected to salt-water conditions, caustic or acidic materials.
- Subjected to accidental drops or falling objects.
- Whenever subjected to extreme environmental conditions.

The routine maintenance of the PipeLiner accessory performed daily requires cleaning, inspection and operational checks of the system. The complete maintenance (performed once a year) involves a complete disassembly, cleaning, inspection and operational tests of the entire system.

Equipment maintenance can be performed by trained and qualified individuals within the licensee's organization. AEA Technology QSA service engineers are available to provide maintenance on the systems at the licensee's premises or at on of he service centers.

Routine Daily Maintenance Requirements

At the end of each days use the PipeLiner accessory needs to be cleaned of any obvious debris, mud, dirt, or other foreign material. Use a soft wire brush or stiff bristle brush to remove dried mud and to reach tight spaces. Mild detergent and water can be used to remove dirt and grime with a damp rag. Spilled chemicals or other chemical compounds should be removed immediately using proper methods approved for the chemical involved.

NOTE: **Safety glasses** should be worn when using brushes to remove dirt and mud.

Yearly Maintenance Requirements

Once a year the entire system should be dismantled and thoroughly cleaned and inspected. (see inspection portion of this manual)

The PipeLiner uses no lubricants or does it require regular replacement of parts. Simple cleaning and a thorough inspection of all parts including bolts is all that is necessary.

Records

The results of the inspections, repairs and maintenance should be recorded and retained. Reports should contain the name of the person(s) involved, dates, location and should identify the specific equipment that was serviced.

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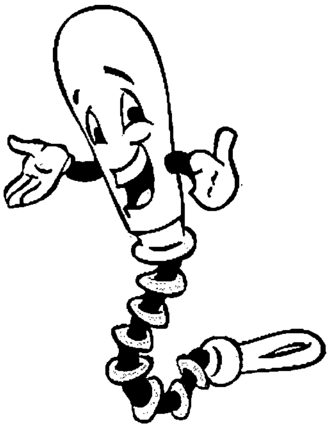


Section 8.3 Profile Reports

QSA GLOBAL

SHIELDING PROFILE AND INSPECTION FORM (SPIF)
F-Q-1806-2

Re-Profile Drop Test Unit (TP186A) Sheet 1 of 1

Shield Data

Model: 880 Delta	Serial # 5520	Radionuclide: Ir-192	Max. Capacity 150 Ci
Shield P/N: 88001	Shield Heat # 866-D48	Lot # 09169.00203	

Profile Process Data

Source Model: 424-9	Source Ser. # 60864B	Radionuclide: Ir-192	Activity: 125.2 Ci
Survey Inst. 1 ND-500P	Serial # 42363	Date Cal. 8/18/05	Date Due: 8/18/10
Survey Inst. 2 E600	Serial # 2750	Date Cal. 4/2/05	Date Due: 4/2/10
Inst. Prob: 1 101-03	Serial # P11973	Inst. Probe: 2 HB-270	Serial # 706
Capacity Correction Factor: 1.20			

	Measured Dose Rate mR/hr				Adjusted Dose Rate mR/hr		
Location	At Surface	Surface Corr. Factor	At 30 Cm [Note 2]	At One Meter	At Surface	At 30 Cm [Note 2]	At One Meter [Note 1]
Top	*	*	NA	.7	*	NA	.8
Right				.7			.8
Front				.7			.8
Left				.8			1.0
Rear				1.2			1.4
Bottom	↓	↓	↓	.7	↓	↓	.8
			Acceptance Criteria:		< 200	NA	≤ 2.0
			Result: (Check one)	Accept		Reject	

Inspector: ______________ Date: 4/10/10 NCR # ______________

Comments:
* Refer ~~to Auto-Profiler printout for Data~~
(1 meter used E600, 3055, Cal due 8/28/10)

Notes:
1. Refer to F-Q-1806-1, Shield Efficiency Testing Surface Correction Factors for an existing device model, or F-Q-1806-3, Shield Profile Worksheet for One meter acceptance limit.
2. The 30cm readings are only required when specifically requested.
3. Additional sheets may be used to describe results or indicate reading locations using sketches. Number all sheets and indicate total number of sheets. Make sure shield Identification is included on each sheet.
4. Attach auto-profiler print out to this sheet if used.

QSA GLOBAL

880 Shielding Profile and Inspection Form
(SPIF) F-Q-1806-4 Delta & Sigma

(TP186A)

Sheet 1 of 1

Shield Data

Model:	880D/S	Serial # 5520	Radionuclide: Ir192	150 Ci Capacity Correction Factor:	1.32
		Shield Heat # 866-D48	Lot # 0216500203	130 Ci Capacity Correction Factor:	1.15

Profile Process Data

Source Model	424-9	Source Ser.# 53962B	Radionuclide: Ir192	Activity (Ci)	113.4	Acceptance Criteria		
Instrument	ND-500P	Serial # 42363	Date Cal. 4/7/09	Date Due:	4/7/10	At Surface < or =	200	mr/hr
	E-600	Serial # 2578	Date Cal. 12/8/08	Date Due:	12/8/09	At One Meter < or =	2	mr/hr

Measured Dose Rate mR/hr			Surface Corr. Factors			880 Delta Adj. Dose Rate mR/hr			880 Sigma Adj. Dose Rate mR/hr		
Location	At Surface	At One Meter	Auto Profiler	ND-500P *	E-600 *	ND-500P	E-600	At One Meter	ND-500P	E-600	At One Meter
Top	*	.7	1.17	1.18	1.28	NA	NA	.9	NA	NA	NA
Right		.7	1.17	1.18	1.28			.9			
Front		.6	1.17	1.08	1.13			.8			
Left		.7	1.17	1.18	1.28			.9			
Rear		1.0	1.17	1.07	1.11			1.3			
Bottom	↓	.8	1.17	1.18	1.28	↓	↓	1.1	↓	↓	↓

Result: (Check One)	Accept as:	880 Delta	✓	880 Sigma		Reject
		Shield P/N	88001		88040	NCR #

Inspector: Date: 7 JUL 09 Reviewer: Date: 9 Jul 09

Comments:

* ND-500P and E-600 results are for manual profiles only. Refer to auto-profiler print out for data if blank.

1 Meter performed using E600, SN 1863, cal 2/24/09, due 2/24/10

Notes: Additional sheets may be used to describe results or indicate reading locations using sketches. Number all sheets and indicate total number of sheets. Make sure shield identification is included on each sheet.

QSA GLOBAL

SHIELDING PROFILE AND INSPECTION FORM
(SPIF)
F-Q-1806-2

Re-Profile Drop Test Unit (TP186B) Sheet 1 of 1

Shield Data			
Model: 880 Delta	Serial # D5523	Radionuclide: Ir-192	Max. Capacity 150 Ci
Shield P/N: 88001	Shield Heat # 866-D40	Lot # 0916900203	
Profile Process Data			
Source Model: 424-9	Source Ser. # 60865B	Radionuclide: Ir-192	Activity: 117.2 Ci
Survey Inst. 1 ND-500P	Serial # 42363	Date Cal. 8/18/09	Date Due: 8/18/10
Survey Inst. 2 E600	Serial # 2750	Date Cal. 4/2/09	Date Due: 4/2/10
Inst. Probe: 1 101-03	Serial # P11973	Inst. Probe: 2 HB-270	Serial # 706
Capacity Correction Factor: 1.28			

	Measured Dose Rate mR/hr				Adjusted Dose Rate mR/hr		
Location	At Surface	Surface Corr. Factor	At 30 Cm [Note 2]	At One Meter	At Surface	At 30 Cm [Note 2]	At One Meter [Note 1]
Top	*	*	NA	.6	*	NA	.8
Right				.6			.8
Front				.6			.8
Left				.6			.8
Rear				.9			1.2
Bottom	↓	↓	↓	.6	↓	↓	.8
				Acceptance Criteria:	≤200	NA	≤ 2.0
			Result: (Check one)	Accept		Reject	

Inspector: Date: 4/10/10 NCR # ________

Comments:

* Refer to Auto Profiler Printout for Data
(1 meter used E600, 3055, cal due 8/28/10)(initial profiled on 4/10/10, activity = 116.1
CCF = 1.29

Notes:

1. Refer to F-Q-1806-1, Shield Efficiency Testing Surface Correction Factors for an existing device model, or F-Q-1806-3, Shield Profile Worksheet forOne meter acceptance limit
2. The 30cm readings are only required when specifically requested.
3. Additional sheets may be used to describe results or indicate reading locations using sketches. Number all sheets and indicate total number of sheets. Make sure shield Identification is included on each sheet.
4. Attach auto profiler print out to this sheet if used.

QSA GLOBAL

880 Shielding Profile and Inspection Form
(SPIF) F-Q-1806-4 Delta & Sigma

(TP186B)

Sheet 1 of 1

Shield Data

Model:	880D/S	Serial # 5523	Radionuclide:	Ir192	150 Ci Capacity Correction Factor:	1.25
		Shield Heat # 866 D40	Lot # 09169 00203		130 Ci Capacity Correction Factor:	1.08

Profile Process Data

Source Model	424-9	Source Ser.# 53962B	Radionuclide: Ir192	Activity (Ci)	119.9	Acceptance Criteria		
Instrument	ND-500P	Serial # 42363	Date Cal. 4/7/09	Date Due:	4/7/10	At Surface < or =	200	mr/hr
	E-600	Serial # 2578	Date Cal. 12/8/08	Date Due:	12/8/09	At One Meter < or =	2	mr/hr

Measured Dose Rate mR/hr			Surface Corr. Factors			880 Delta Adj. Dose Rate mR/hr			880 Sigma Adj. Dose Rate mR/hr		
Location	At Surface	At One Meter	Auto Profiler	ND-500P *	E-600 *	ND-500P	E-600	At One Meter	ND-500P	E-600	At One Meter
Top	*	.5	1.17	1.18	1.28	NA	NA	.6	NA	NA	NA
Right		.6	1.17	1.18	1.28			.8			
Front		.6	1.17	1.08	1.13			.8			
Left		.6	1.17	1.18	1.28			.8			
Rear		.9	1.17	1.07	1.11			1.1			
Bottom	↓	.6	1.17	1.18	1.28	↓	↓	.8	↓	↓	↓

Result: (Check One)	Accept as:	880 Delta	✓	880 Sigma		Reject	
		Shield P/N	88001		88040	NCR #	

Inspector: Date: 7/1/09 Reviewer: C. [illegible] Date: 9/6/09

Comments:

* ND-500P and E-600 results are for manual profiles only. Refer to auto-profiler print out for data if blank.

1 meter performed using E600, SN 1863, cal 2/24/09, due 2/24/10

Notes: Additional sheets may be used to describe results or indicate reading locations using sketches. Number all sheets and indicate total number of sheets. Make sure shield identification is included on each sheet.

QSA GLOBAL

Sheet 1 of 1

Inspection Instruction And Record	Originator/Date Tom Shea 14 Aug.09	Rev. B	Part No. T10740	Reg. Approval/Date C. Rendken 20 Aug 09	
	QA Approval/Date: JJ Beaudry 21Aug09	CM. NA	PIL NA	Eng. Approval/Date TBR 14 AUG 09	

Item Description 8 X 8 DROP PAD-BURLINGTON

Characteristics	Tolerance	MTE	AQL	1	2	3	4	5	6	7	8	9
General Visual	NA	Visual	C/100%	0 / 1	REF 150568							
Cracks in Concrete	NA	Note & Photograph	C/100%	0 / 1	N/A							
1/2-13 threaded hole, four (4) places	Go/NoGo	Thread Gage	C/100%	1 / 0	0 / 1							
Pitch of Slab 1/2, N-S Corners	+/-1/4	Level & Scale	C/100%	0 / 1	N/A							
Surface Condition of Steel Plate	NA	Note & Photograph	C/100%	0 / 1	N/A							

Comments:

Calibration: Re-Inspect Prior to use. Inspection to be valid 60 days only !

F-Q1807-1, rev. 3

	1	2	3	4	5	6	7	8	9
PO / WO #	N/A	N/A							
Traveler	N/A	N/A							
Lot / Serial #	001	001							
Lot Qty.	1	1							
Qty. Rej / NCR	RWK / 150568	0 / N/A							
Qty. Acc.	0	1							
Insp / Date	JU / 15AUG09	MO / 3SEPT 09							

AEA TECHNOLOGY QSA

PERIODIC MAINTENANCE

Sheet 1 of 1

Inspection Instruction And Record	Originator/Date 18 Sep 01	Rev C	Part No. T10143	Supplier ENGINEERING
	QA Approval/Date 18 Sept 01	CM NA	PIL NA	Eng. Approval/Date 19 SEPT 01

Item Description: Puncture Test Billet

Characteristics	Tolerance	MTE	AQL	1	2	3	4	5	6	7	8	9
General Visual	N/A	N/A	C / 100%	0 / 1	0 / 1							
Securely Mounts to Drop Test Pad	N/A	N/A	C / 100%	0 / 1	0 / 1							

Comments	Due Date	19 Sept 02	07 JULY 2010							
	Freq / Days	365 / Days	365 / DAYS							
	Serial #	01	01							
	Lot Qty.	1	1							
	Qty. Rej / NCR	0 / NA	0 / NA							
	Qty. Acc.	1	1							
	Insp / Date	19 Sept 01	JM / 07 JUL 09							

S/N: T-198776

ESSCO CALIBRATION LABORATORY
DIVISION OF WALSH ENGINEERING SERVICES, INC.
CALIBRATION/REPAIR OF ALL TYPES OF ELECTRONIC / MECHANICAL TEST EQUIPMENT
27 INDUSTRIAL AVE, CHELMSFORD, MA 01824-4102
TEL: (800) 325-2201 (978) 250-0880 www.esscolab.com

ISSUE DATE: 2/22/2010

CERTIFICATE OF CALIBRATION

Certificate #: 296477

BARCODE: 1030907

Page 1 of 2

CUSTOMER / LOCATION
QSA GLOBAL INC
40 NORTH AVENUE
BURLINGTON MA 01803

DEPT:
PURCHASE ORDER: P32150

EQUIPMENT INFORMATION

MANUFACTURER: OMEGA
MODEL NO: CL23A
SERIAL NO: T-198776
CONTROL NO: ENG-20
TYPE: CALIBRATOR

CONDITION RECEIVED

IN TOLERANCE

CONDITION RETURNED

IN TOLERANCE

METHOD / ENVIRONMENT

PERFORMED: IN LAB
TEMPERATURE (deg C): 23
RELATIVE HUMIDITY (%RH): 21
METHOD: OMEGA CL23A/24/25/26

CALIBRATION

CALIBRATION DATE: 2/22/2010
CALIBRATION DUE: 2/22/2011

METROLOGIST:

E1540	KAYE K140-4 ICE-POINT REFERENCE	178302	5/15/2009	5/14/2010
E2483	FLUKE 8508A REFERENCE MULTIMETER	257701	5/27/2009	4/27/2010
E706	FLUKE 5700A\03 CALIBRATOR	276832	1/7/2010	4/7/2010

✓JK

The ESSCO Quality System is certified to ISO 9001:2008

The results above relate only to the item(s) calibrated. Unless otherwise stated, a minimum TUR of 4:1 was used.

This certifies that the unit conformed to applicable specifications upon successful completion of the calibration. The standards used are traceable to NIST or a National Measurement Institute. This certificate shall not be reproduced, except in full, without written approval of ESSCO.

The signature to the right signifies responsibility for the quality system.

This calibration was performed in compliance with the ESSCO Quality Manual, ECL 1, Rev. 26, 29 September 2008, and complies with ISO 9001:2008, ANSI/NCSL Z540-1, QS9000 (exp), MIL-STD-45662A (exp), ISO 10012:2003, 10CFR21, and the calibration requirements of ISO 13485.

Kevin R. Pistey
Quality Assurance Manager

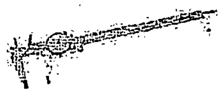
cate #: 296477 BARCODE: 1030907 Page 2 of 2

[illegible]

[illegible]	[illegible]	Nominal	Tolerance	[illegible]	[illegible]	[illegible]	[illegible]
1	1 MTR IN K 0.000 mV	32.0	32.5 31.5	DEG F	31.9	31.9	+/- 0.5 DEG F
2	2 MTR IN K 54.856 mV	2500.0	2502.0 2498.0	DEG F	2500.4	2500.4	+/- 2.0 DEG F
3	3 MTR IN J 0.000 mV	32.0	32.5 31.5	DEG F	31.7	31.7	+/- 0.5 DEG F
4	4 MTR IN T 0.000 mV	32.0	32.5 31.5	DEG F	31.7	31.7	+/- 0.5 DEG F
5	5 CAL OUT K 32.0 F	0.000	0.011 -0.011	mV	0.008	0.008	+/- 0.011 mV
6	6 CAL OUT K 2500.0F	54.856	54.894 54.818	mV	54.867	54.867	+/- 0.038 mV
7	7 CAL OUT J 32.0 F	0.000	0.014 -0.014	mV	0.012	0.012	+/- 0.014 mV
8	8 CAL OUT T 32.0 F	0.000	0.011 -0.011	mV	0.007	0.007	+/- 0.011 mV

End of Data
Note: A = Adjusted F = Failed L = Limited

O'Haus Digital Scale – 0009986-6CE



Hunt Metrology Service, Inc.

121 Ferry Street
Lawrence, MA 01841
(978) 688-7278
(978) 794-4632
Hmsi@verizon.net

Calibration Certificate

HMSCC-22922-12-P Total Pages: 15

Tech: Paul Rabs

QSA Global
40 North Avenue
Burlington, MA 01803

Purchase Order No: P31363-00
Date Cal: September 24, 2009 Due: September 24, 2010

The calibration performed on the following measuring and test equipment (M&TE) of this document is traceable to the National Institute of Standards and Technology (N.I.S.T.) through N.I.S.T. number 821/276493-08; Certificate number 09-69006A dated May 29, 2009 for dimensional calibration.

The M&TE have been cleaned and lubricated, as needed. Our technician(s) have calibrated, adjusted and/or reset the M&TE, affixed a calibration label to the M&TE, updated the corresponding record(s), and provided this calibration certificate. The standard(s) utilized to perform the calibration have been calibrated, certified and maintained in our laboratory which sustains a temperature of 68 degrees (+/-2ø) and less than 50% relative humidity. All records pertaining to our standards, and the masters utilized to calibrate them, are kept on file in our laboratory for a period of no less than 3 years. The services provided, traceability to the N.I.S.T., and Hunt Metrology Service's calibration system comply with the requirements of ANSI/NCSL Z540-1-1994, ISO 10012-1:1002 (E) and ISO/IEC 17025. The reported value is both "as found" and "as left" data, unless otherwise specified. A calibration uncertainty ratio of at least 4:1 is maintained unless otherwise stated. This calibration certificate cannot, in any way, be reproduced, except in full, without prior written consent from a representative of Hunt Metrology Service, Inc.

David Dickinson, President

Hunt Metrology Service, Inc. **Data Sheet**

HMSCC-22922-12-P

P.O. No.: P31363-00
Date Cal.: 09/24/09
Date Due: 09/24/10
Technician: PR
Cal Proc. No: 01

Customer: **QSA GLOBAL**

ID No: 411
2 ID No:
Department:
Deviation u:
Accuracy: +/-4%
Accuracy:
Temperature: 73.7°
Humidity: 52%

Manufacturer: O'HAUS
Serial No: 0009986-6CE
Model No: CD11ZE0
Standard No: 018 Cal: 03/31/09 Due: 03/31/10
Standard No: 057 Cal: 03/31/09 Due: 03/31/10
Standard No: Cal: Due:

Gage Type: **0-130lb DIGITAL SCALE**

REQUIRED	DEVIATION	ACTUAL
0.500	0.00	0.50
1.000	0.00	1.00
2.000	0.00	2.00
5.000	0.00	5.00
10.000	0.00	10.00
20.000	0.00	20.00
30.000	+0.02	30.02
40.000	+0.02	40.02
50.000	+0.02	50.02
50.000	+0.04	60.04
80.000	+0.04	80.04
100.000	+0.04	100.04
120.000	+0.08	120.08

2.12.12 USDOT Special Form Certificate USA/0392/S-96 Rev 11

U.S. Department
of Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

**East Building, PHH-23
1200 New Jersey Avenue Southeast
Washington, D.C. 20590**

IAEA CERTIFICATE OF COMPETENT AUTHORITY
SPECIAL FORM RADIOACTIVE MATERIALS
CERTIFICATE USA/0392/S-96, REVISION 11

This certifies that the source described has been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2] for the transport of radioactive material.

1. Source Identification - QSA Global, Inc. Model 875 Capsule.

2. Source Description - Cylindrical single encapsulation made of Type 304 or 304L stainless steel and tungsten inert gas or laser welded. Approximate exterior dimensions are 5.2 mm (0.205 in.) in diameter and 7.84 mm (0.309 in.) in length. Inside dimensions vary, but minimum wall thickness is 0.482 mm (0.019 in.). Construction shall be in accordance with attached QSA Global, Inc. Drawing No. R875 INNER, Rev. C.

3. Radioactive Contents - No more than either 8.9 TBq (240.0 Ci) of Cobalt-60 or 14.8 TBq (400.0 Ci) of Iridium-192 in the form of metallic wafers or pellets.

4. Quality Assurance - Records of Quality Assurance activities required by Paragraph 310 of the IAEA regulations[1] shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the applicable requirements of Subpart H of 10 CFR 71.

5. Expiration Date - This certificate expires on January 31, 2018.

---

[1] "Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised)," published by the International Atomic Energy Agency(IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

CERTIFICATE USA/0392/S-96, REVISION 11

This certificate is issued in accordance with paragraph 804 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the January 07, 2013 petition by QSA Global, Inc., Burlington, MA, and in consideration of other information on file in this Office.

Certified By:

for Dr. Magdy El-Sibaie
Associate Administrator for Hazardous Materials Safety

Jan 24 2013
(DATE)

Revision 11 - Issued to extend the expiration date.

Security-Related Information Figure Withheld Under 10 CFR 2.390.

APPROVALS	DATE
	25 Jul 07
	25 Jul 07

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES:
FRACTIONS ± 1/8
X.X ± 0.12
X.XX ± 0.06
X.XXX ± 0.020

QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE 875 SERIES INNER CAPSULE

SIZE A
DWG. NO. R875 INNER
REV C
SCALE: NONE
SHEET 1 OF 1

ERF # 1739

2.12.13 USDOT Special Form Certificate USA/0335/S-96 Rev 10

U.S. Department
of Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

East Building, PHH-23
1200 New Jersey Avenue SE
Washington, D.C. 20590

IAEA CERTIFICATE OF COMPETENT AUTHORITY
SPECIAL FORM RADIOACTIVE MATERIALS
CERTIFICATE NUMBER USA/0335/S-96, REVISION 10

This certifies that the sources described have been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and United States of America[2] for the transport of radioactive material.

1. Source Identification - QSA Global, Inc. Model 875 Series.

2. Source Description - Cylindrical single or double encapsulations with the outer capsule made of Type 304L stainless steel and tungsten inert gas or laser welded. Approximate outer dimensions are 6.35 mm (0.25 in.) in diameter and either 19.05 mm (0.75 in.) or 24.2 mm (0.954 in.) in length. Inner capsules, when present, are made of stainless steel or titanium. Construction of the outer capsule shall be in accordance with attached QSA Global, Inc. Drawing No. R875 OUTER, Rev. C. Construction of any inner capsule shall be in accordance with attached QSA Global, Inc. Drawing No. R875 INNER, Rev. C or QSA Global, Inc. Drawing No. R87527-40, Rev. A.

3. Radioactive Contents - No more than either 14.8 TBq (400 Ci) of Iridium-192 as a solid metal; 8.14 TBq (220 Ci) of Cobalt-60 as a solid metal; 5.56 TBq (150 Ci) of Selenium-75 as an encapsulated solid metal; 1.11 TBq (30 Ci) of Cesium-137 as encapsulated $CsCl_2$; 1.85 TBq (50 Ci) of Thulium-170 as Tm_2O_3; or 7.4 TBq (200 Ci) of Ytterbium-169 as Yb_2O_3.

4. Quality Assurance - Records of Quality Assurance activities required by Paragraph 310 of the IAEA regulations[1] shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the applicable requirements of Subpart H of 10 CFR 71.

5, Expiration Date - This certificate expires June 30, 2017.

This certificate is issued in accordance with paragraph 804 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the June 01, 2012 petition by QSA Global, Inc., Burlington, MA, and in consideration of other information on file in this Office.

Certified by:

Dr. Magdy El-Sibaie
Associate Administrator for
Hazardous Materials Safety

JUN 26 2012
(DATE)

Revision 10 - Issued to extend the expiration date.

---

[1] "Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised)," published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100 - 199, United States of America.

Security-Related Information Figure Withheld Under 10 CFR 2.390.

ERF # 1739

APPROVALS	DATE
	7-24-07
	24Jul07

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES:
FRACTIONS ± 1/8
X.X ± 0.12
X.XX ± 0.06
X.XXX ± 0.020

QSA GLOBAL
40 NORTH AVE. BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE 875 SERIES SSDR OUTER CAPSULE

SIZE A
DWG. NO. R875 OUTER
REV C
SCALE: NONE
SHEET 1 OF 1

Security-Related Information Figure Withheld Under 10 CFR 2.390.

APPROVALS	DATE
	25 Jul 07
	25 Jul 07

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES:
FRACTIONS ± 1/8
X.X ± 0.12
X.XX ± 0.06
X.XXX ± 0.020

QSA GLOBAL
40 NORTH AVE. BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE 875 SERIES INNER CAPSULE

SIZE A
DWG. NO. R875 INNER
REV C
SCALE: NONE
SHEET 1 OF 1

ERF # 1739

Security-Related Information Figure Withheld Under 10 CFR 2.390.

APPROVALS	DATE
	7-24-07
	24 Jul 07

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES:
FRACTIONS ± 1/8
X.X ± 0.12
X.XX ± 0.06
X.XXX ± 0.020

QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE X540N CAPSULE ASSEMBLY

SIZE A

DWG. NO. R87527-40

REV A

SCALE: NONE

SHEET 1 OF 1

ERF # 1739

2.12.14 USDOT Special Form Certificate USA/0502/S-96 Rev 8

U.S. Department
of Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

**East Building, PHH-23
1200 New Jersey Avenue Southeast
Washington, D.C. 20590**

IAEA CERTIFICATE OF COMPETENT AUTHORITY
SPECIAL FORM RADIOACTIVE MATERIALS
CERTIFICATE USA/0502/S-96, REVISION 8

This certifies that the sources described have been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2] for the transport of radioactive material.

1. Source Identification - QSA Global, Inc. Model Nos. X54 (Manufactured before January 1, 1998), X540 (Manufactured on or after February 17, 1981), and X540/1 (Manufactured on or after September 27, 2000).

2. Source Description - Tungsten inert gas or laser seal welded cylindrical single or double encapsulations. The outer encapsulation is made of titanium or stainless steel and the inner encapsulation, if used, is made of titanium, stainless steel, or aluminum. Approximate exterior dimensions are 5.15 mm (0.2 in.) maximum diameter and 15.15 mm (0.6 in.) in length (Model X54); and 5.16 mm (0.2 in.) in diameter and 7.65 mm (0.3 in.) in length (Models X540 and X540/1). Construction shall be in accordance with attached Amersham Drawing No. A10639, Issue C (Model X54) or QSA Global Inc. Drawing No. R87527, Rev. G (Models X540 and X540/1).

3. Radioactive Contents - No more than 17.0 TBq (459.5 Ci) of Cobalt-60 (Model X54); or no more than either 20.0 TBq (540.5 Ci) of Cobalt-60, 17.0 TBq (459.5 Ci) of Iridium-192, or 5.56 TBq (150.3 Ci) of Selenium-75 (Models X540 and X540/1). The Co-60, Ir-192, and Se-75 are in the form of a metal.

4. Quality Assurance - Records of Quality Assurance activities required by Paragraph 310 of the IAEA regulations[1] shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the applicable requirements of Subpart H of 10 CFR 71.

5. Expiration Date - This certificate expires on July 31, 2017.

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[1] "Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised)," published by the International Atomic Energy Agency(IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

This certificate is issued in accordance with paragraph 804 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the July 06, 2012 petition by QSA Global, Inc., Burlington, MA, and in consideration of other information on file in this Office.

Certified By:

Jul 10 2012
(DATE)

for Dr. Magdy El-Sibaie
Associate Administrator for Hazardous Materials Safety

Revision 8 - Issued to extend the expiration date.

DRG NO. A10639

Item	Description	Material	Drawing No.	No.off
1	BODY	STAIN.STL.	A10636 ITEM.1	1
2	PLUG	STAIN.STL.	A10638	1
◇C 3	ACTIVE MATERIAL			—

Security-Related Information Figure Withheld Under 10 CFR 2.390.

TOLERANCES
———
UNLESS OTHERWISE STATED

MATERIAL
———

SURFACE TEXTURE
———
UNLESS OTHERWISE STATED

FINISH
———
REMOVE ALL BURRS

GENERAL NOTES

THIRD ANGLE PROJECTION

MODIFICATIONS INDICATED BY ISSUE IN ◇

THIS DRAWING CONFORMS TO BS308.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

DO NOT SCALE

APPROVAL
THIS DRAWING IS NOT TOO BE USED FOR ANY PURPOSE UNLESS SIGNED AS APPROVED

SCALE	ISSUE	MOD No.	DATE	DRAWN	CHECKED	APPROVED	QA APPROVED
10:1	C	MS1211	4.1.95	M.A.			

Amersham
The Health Science Group

TITLE ASSEMBLY OF CAPSULE X54

USED ON ———

SHT. SIZE A3

DRG NO. A10639

SHT 1 OF SHTS 1

Security-Related Information Figure Withheld Under 10 CFR 2.390.

APPROVALS	DATE
D. Price	30May06
	30May06

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES:
FRACTIONS ± 1/8
X.X ± 0.12
X.XX ± 0.06
X.XXX ± 0.020

QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE X540 CAPSULE SERIES

SIZE A

DWG. NO. R87527

SCALE: NONE

SHEET 1 OF 1

REV G

ERF # 1402

2.12.15 Test Plan 206 (Sep 2013)

QSA GLOBAL	Document Number F-E-1808-1 Test Plan Cover Sheet	Revision 0

TEST PLAN 206

MODEL 880SC TRANSPORT PACKAGE TYPE B TRANSPORT PACKAGE

Originator		Date: 3 Sept 13

APPROVALS		
Engineering		Date: 3 SEP 17
Regulatory		Date: 2 Sep 13
Quality Assurance		Date: 3 Sep 13

TEST PLAN 206

MODEL 880SC SOURCE CHANGER TYPE (B) TRANSPORT PACKAGE TESTS

As of

September, 2013

Contents

List of Figures and Tables

Test Plan No. 206

Section 1 Introduction

This document describes the mechanical test plan for the Model 880SC Source Changer to meet NRC requirements for Type B(U)-96 packages as described in the Code of Federal Regulations, 10 CFR Part 71, revised as of January 26, 2004. The test plan also covers the criteria stated in the IAEA TS-R-1 (1996 Edition – as Amended 2003)

This document describes the test package specifications, testing equipment, testing scenario, justifies the package orientations for the different test specimens and provides test worksheets to record key steps in the testing sequence.

Section 2 Transport Package Description

Figure 2.1 describes the Model 880SC Source Changer transport package. Figure 2.2 shows the transport package schematic. Figure 2.3 shows the transport package with the plastic jacket. Fig 2.4 shows the transport package overall dimensions without the Jacket.

The radioactive material is sealed in a special form source capsule. The source capsule, stop ball and connector are swaged to a flexible steel wire to form the source wire assembly. Two source wire assemblies can be loaded into the 880SC Source Changer, one in the front and one in the rear. The source wire assemblies are held securely to the device by components of the Source Lock Assembly. There are two Source Lock Assemblies, on each end of the container assembly. The lock assembly sleeve, prevents the stop ball of the source wire from being pushed through the package. Another component, the lock slide, prevents the stop ball from being pulled out of the package when in the secured position. A keyed lock prevents the lock slide from being actuated.

The Top Lock Plate is fastened to the Bottom Lock Plate with four, 1/4-20 stainless steel machine screws. The Bottom Lock Plate is attached to rivnuts assembled on the endplate weldment with four 5/16-18 stainless steel security screws. The endplate weldment consists of the endplate disc, a U-shaped bracket and the four rivnuts. The U-brackets are welded to the endplate disc and the endplate disc is welded to the cylindrical shell.

The shield is fastened within the device at each end by a titanium shield pin. The pin passes through the shield and the U-bracket. The shield is centered in the shell and has the source tube cast into its center. The source tube provides a cavity for the source wire assemblies to travel through during use. The source capsules are positioned in the center of the ball of the shield within the source tube cavity when the source wire is in its secured position.

The model 880SC uses polyurethane foam to fill the cavity around the depleted uranium shield. The foam prevents contamination to and from the depleted uranium shield.

Previous thermal tests have shown charred polyurethane foam will inhibit the flow of oxygen to the shield and prevent oxidation from occurring during a fire as long as the foam remains confined. This is shown on QSA Global Test plan number Report 74.

It has also been shown the charred foam will not support the shield at temperatures of 800°C. The model 880SC relies on the shield pins to hold the shield in place at all times. These pins are designed to retain the shield throughout testing without the added support of the foam.

The plastic jacket is an optional part of the Type B transport package and has been demonstrated to be less damaging during transport testing on the 880D packages (ref. TP Report 108) therefore the 880SC will be tested without the jacket as the worst case condition for the type B transport testing. The absence of the jacket will present a worst case 30-foot drop and puncture test condition. In a drop, the plastic jacket protects the transport package from further damage by absorbing energy upon impact.

The weight of the Model 880SC transport package without the jacket is not greater than 46 pounds. The total weight of the package with the jacket is not greater than 52 pounds.

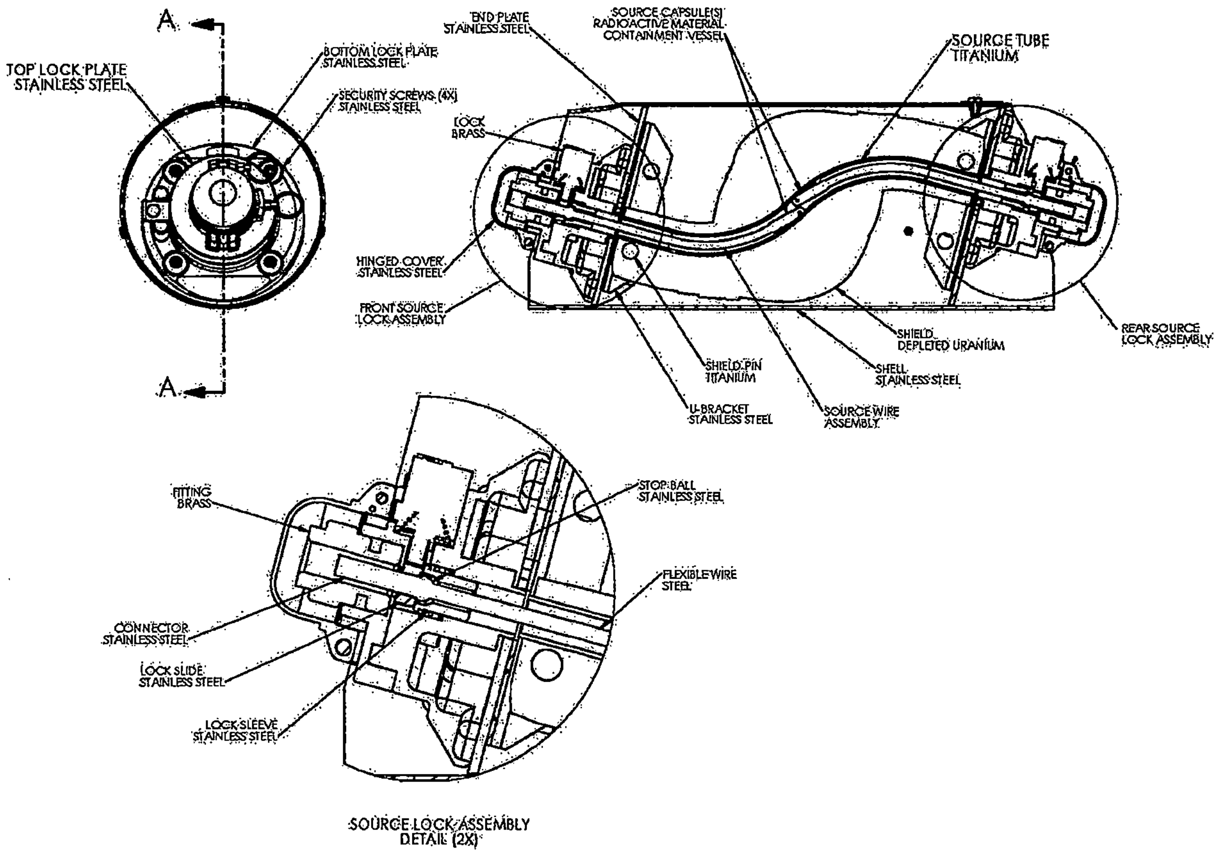


FIGURE 2.1: MODEL 880SC SOURCE CHANGER TRANSPORT PACKAGE

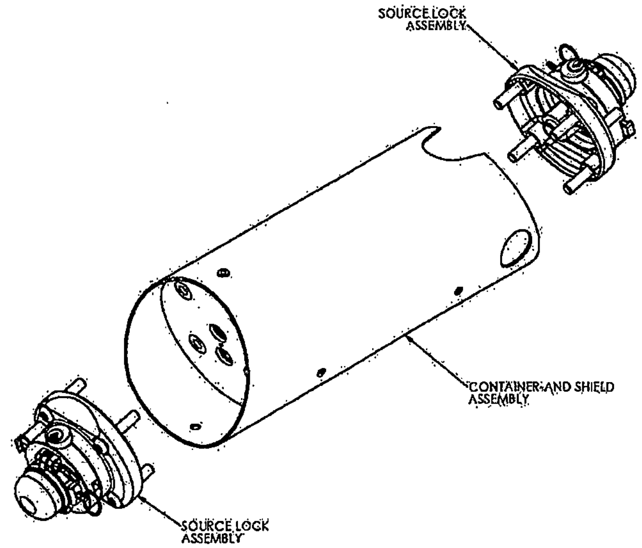


FIGURE 2.2: MODEL 880SC SOURCE CHANGER SCHEMATIC

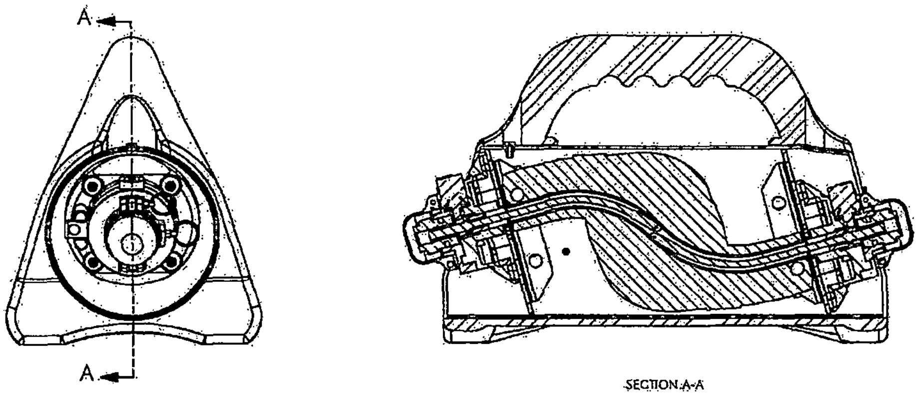


FIGURE 2.3: MODEL 880SC SOURCE CHANGER WITH JACKET

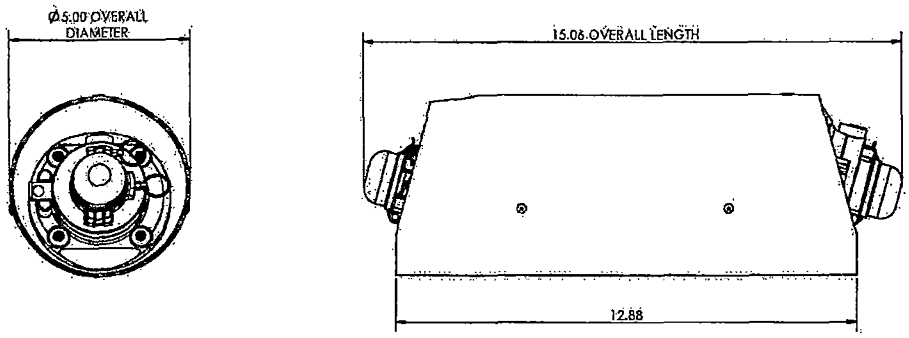


Figure 2.4: MODEL 880SC SOURCE CHANGER OVERALL DIMENSIONS

Section 3 Regulatory Compliance

The main purpose of this test plan is to demonstrate that the Model 880SC transport package complies with the Type A and Type B(U)-96 transport package test requirements of 10 CFR 71 and IAEA TS-R-1.

All test specimens are first subjected to the required normal conditions of transport tests 10 CFR Part 71.71 followed by the hypothetical accident condition tests of 10 CFR Part 71.73.

3.1 Normal Conditions of Transport (NCT) Tests

The ***water spray test*** per 10 CFR 71.71 (c) (6) and IAEA TS-R-1 Section VII, paragraph 721 of the package will not be performed as the Model 880SC transport package is constructed of waterproof materials throughout. Water spray will not degrade the structural integrity of the Model 880SC transport package.

The ***compression or stacking test*** per 10 CFR 71.71 (c) (9) and IAEA TS-R-1 Section VII, paragraph 723 will not be performed. This test was conducted as part of the Model 880 Transport Package Evaluation (see Test Plan Report No. 100).

The Model 880SC transport package shall be subjected to the ***penetration test*** of 10 CFR 71.71 (c) (10) and IAEA TS-R-1 Section VII, paragraph 724 and then the ***1.2 meter free drop test*** per 10 CFR 71.71 (c) (7) and IAEA TS-R-1 Section VII, paragraph 722

The Model 880SC transport package shall be tested as stated above to demonstrate its ability to withstand normal conditions of transport as identified in 10 CFR 71.71 and IAEA TS-R-1. Successfully passing the NCT tests means there is no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.

IAEA TS-R-1 Section VI, paragraph 646 stipulates the same criteria except that it also requires that the loss of shielding integrity should not result in more than a 20% increase in the radiation level at any external surface of the package.

3.2 Hypothetical Accident Condition (HAC) Tests

The ***crush test*** 10 CFR 71.73 (c) (2) and IAEA TS-R-1 Section VII, paragraph 727 (c) will not be performed because the Model 880SC transport package is not designed to transport radioactive contents greater than 1000 A_2 not as special form radioactive material.

The Model 880SC transport package shall be subjected to the ***9-meter free drop test*** per 10 CFR 71.73 (c) (1) and IAEA TS-R-1 Section VII, paragraph 727 (a), and then the ***puncture test*** per 10 CFR 71.73 (c) (3) and IAEA TS-R-1 Section VII, paragraph 727 (b).

The ***thermal test*** per 10 CFR 71.73 (c) (4) and IAEA TS-R-1 Section VII, paragraph 728 will not be performed it will be assessed.

The ***immersion test – fissile material test*** per 10 CFR 71.73 (c) (6) and IAEA TS-R-1 Section VII, paragraph 733. will not be performed. The Model 880SC transport package does not transport fissile material.

The ***immersion test – all packages test*** per10 CFR 71.73 (c) (6) and IAEA TS-R-1 Section VII, paragraph 729 will not be performed. Only the source capsule (containment vessel) is sealed and able to pressurize as a result of 50 feet of water depth. The source capsules intended for transport in these containers are designed and tested to withstand a minimum external pressure of 290-lbf/in^2 (minimum ANSI HPS N43.6-1997 pressure classification of 3). This will ensure that the containment can meet the 22-lbf/in^2 limit specified in the regulations.

The materials used in the construction of the Model 880SC transport package are impervious to water and are not structurally affected when immersed in water of at least 15 meters (50 feet).

The Model 880SC transport package shall be subjected to the cumulative effects of the tests as stated above to demonstrate its ability to withstand the hypothetical accident conditions of transport as identified in 10 CFR 71.73 and IAEA TS-R-1. A successful pass shall indicate; there is no escape of radioactive materials greater than A_2 in one week and no external dose rate greater than 1 R/hr at 1m from the external surface with the maximum radioactive contents which the package is designed to carry.

The melting points for the materials of the package are listed below:

Material	Melting Point
Stainless steel	1390°C (2530°F)
Depleted uranium	1135°C (2075°F)
Titanium	1700°C (3100°F)
Tungsten	3410°C (6170°F)
Copper/Brass	1080°C (1980°F)
Aluminum	580°C (1080°F)
Rubber/Plastic	Less than 540°C (1000°F)

Section 4 Discussion on System Failure Modes of Interest

4.1 General

The tests in this plan focus on damaging those components of the package which could cause displacement of the source(s) from its stored position within the depleted uranium shield and which affect the integrity of the shield itself.

4.2 Normal and Accident Conditions of Transport

The modes of failure under normal and accident conditions that could lead to elevated dose rates include the following:

4.2.1 Fracture or penetration of the Source Changer weldment.

4.2.2 Displacement of the shield within the Source Changer weldment and distortion or fracture of the source.

4.2.3 Failure of the source lock assemblies and/or lock mounting screws.

4.2.4 Fracture or cracking in the depleted uranium shield.

The test conditions specified in this Test Plan are intended to challenge the ability of the Model 880SC transport package with respect to these failure modes.

Section 5 Assessment of Package Conformance

5.1 Regulatory Requirements

5.1.1 Normal Conditions of Transport (71.43(f))

There should be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.

IAEA TS-R-1 para. 646 stipulates the same criteria except that it states in paragraph 646(b) that the loss of shielding integrity would not result in more than a 20% increase in the radiation level at any external surface of the package.

5.1.2 Hypothetical Accident Conditions (71.51(a))

There should be no escape of radioactive materials greater than A_2 in one week and no external dose rate greater than 1 R/hr at 1m from the external surface with the maximum radioactive contents which the package is designed to carry.

5.2 Test Package Contents

The Model 880SC Source Changer is designed to carry either one or two special form sources. Containment of the radioactive source is tested at manufacture. The source capsule design has been certified in accordance with the performance requirements for special form as specified in 10 CFR Part 71 and IAEA TS-R-1.

This test plan therefore does not discuss/specify tests of the containment of the radioactive source. The purpose of the tests is to demonstrate that the sources remain shielded within the limits specified by the regulations.

Since source integrity has been demonstrated through special form testing, simulated sources will be used during testing of the package. The radiation levels after testing will be measured by replacing the simulated sources with active sources. The post-test measurements will be compared with pre-test measurements to verify the sources have not shifted within the shield.

5.3 Test Orientation Assessment

The following is an assessment of all the possible test orientations for the Model 880SC transport package. Only the test orientations deemed necessary for causing failure relative to the failure modes described in section 5.1 will be used in the Penetration, 1.2 meter, 9 meter, and Puncture tests of this plan.

The Model 880SC transport package is a cylindrically shaped container. On each end of the container is an identical lock assembly. The assemblies are parallel to one another but at a 15 degree angle. The center of gravity is located essentially at the geometric center of the package.

The objective in every test is to cause significant damage to the extent that it would directly compromise the radiological safety of the package or adversely influence the results of subsequent tests in the test sequence. Dropping or penetrating the package just to cause damage without affecting the radiological safety consequences is not necessary.

Figure 8.5.2.1 is the first Penetration Test orientation. The penetration bar will impact the lock in its most vulnerable location potentially causing failure of the lock. The penetration bar may also produce a large enough force which could shear the lock assembly attachment screws.

Figure 8.5.3.1 is the second Penetration Test orientation. The penetration bar will impact the lock slide. This impact could shear the lock slide or cause significant damage.

Figure 8.6.2.1 is the first 1.2m Drop orientation (end drop). This orientation is based on the center of gravity of the 880SC and should cause the 880SC to impact on the cap of the lock assembly. The impact from this drop could shear the lock assembly attachment screws on the first lock assembly. This impact will also damage the cap which may shear off and allow for damage to the other components of the lock assembly. The cap may also collapse during impact and provide some level of dampening since it is constructed of relatively thin stainless steel. The collapse or damage of the cap during this test will reduce any dampening from the cap during the 9m Drop test.

Figure 8.6.3.1 is the second 1.2m Drop orientation (end drop). This orientation is based on the center of gravity of the 880SC for the opposing (2^{nd}) lock assembly and should cause the 880SC to impact on the cap of the lock assembly. The impact from this drop could shear the lock assembly attachment screws on the 2^{nd} lock assembly. This impact will also damage the cap which may shear off and allow for damage to the other components of the lock assembly. The cap may also collapse during impact and provide some level of dampening since it is constructed of relatively thin stainless steel. The collapse or damage of the cap during this test will reduce any dampening from the cap during the 9m Drop test.

Figure 8.6.4.1 is the third 1.2m Drop orientation (oblique drop). The object of this drop is to try and shear off the lock assembly attachment screws. This orientation is a worst case. The center of mass for the lock assembly on the right (as shown in Figure 8.6.4.1) is at a further point from the initial corner of impact on the 880SC than for the lock assembly on the left, and will therefore create a larger moment of inertia.

Neither the side drop nor the corner drop will be performed for the 1.2m Drop. Orientation 8.6.2.1 and 8.6.3.1 will create the larger shear force on the attachment screws, at the same time damaging the lock assembly.

Figure 8.7.2.1 is the first 9m Drop orientation (end drop). The object is to continue to inflict damage from the 1.2m Drop orientation (Figure 8.6.2.1). The cap may have been damaged or collapsed during the 1.2m drop and this will increase the possibility of the lock assembly attachment screws shearing off. The 9m drop may cause damage to the other components of the lock assembly.

Figure 8.7.3.1 is the second 9m Drop orientation (end drop). The object is to continue to inflict damage on the opposing lock assembly as shown in the 1.2m Drop orientation (Figure 8.6.2.1). The cap may have been damaged or collapsed during the 1.2m drop and this will increase the possibility of the lock assembly attachment screws shearing off. The 9m drop may cause damage to the other components of the lock assembly.

Figure 8.7.4.1 is the third 9m Drop orientation (oblique drop). The object of this drop is to try and shear off the lock assembly attachment screws. This orientation is a worst case. The center of mass for the lock assembly on the right (as shown in Figure 8.7.4.1) is at a further point from the initial corner of impact on the 880SC than for the lock assembly on the left, and will therefore create a larger moment of inertia.

Neither the side drop nor the corner drop will be performed for the 9m Drop. Orientation 8.7.2.1 and 8.7.3.1 will create the larger shear force on the attachment screws, at the same time damaging the lock assembly.

8.8.2.1 is the first Puncture test orientation (end drop). The justification for this drop orientation is the same as for the 1.2m and 9m Drops. This test will continue to inflict damage on the lock assembly.

8.8.3.1 is the second Puncture test orientation (end drop). The justification for this drop orientation is the same as for the 1.2m and 9m Drops. This test will continue to inflict damage on the lock assembly.

8.8.4.1 is the third Puncture test orientation (oblique). Hitting on the corner of the billet is a worst case.

Neither the side drop nor the corner drop will be performed for the 9m Drop. Orientation 8.8.2.1 and 8.8.3.1 will create the larger shear force on the attachment screws, at the same time damaging the lock assembly.

5.4 Vibration Conditions

Vibration normally occurring in transport is not expected to adversely affect the structural aspects of the Model 880SC transport package. The lock assembly attachment screws and thread locking adhesive are identical to the 880D Transport package. The weight of the 880SC lock assembly is similar to the weight of the 880D Rear plate assembly.

Section 6 Construction and Condition of Test Specimens

The Model 880SC transport package test specimens will be constructed in accordance with QSA Global drawing 880SC-TP206 revision 2 and the QSA Global Quality Assurance Program. The weight of the test specimens per this drawing is not greater than 46 pounds.

The structural materials of the Model 880SC are made of AISI Type 300 series stainless steel and titanium. The shielding materials are depleted uranium and tungsten. The non-safety related parts are made from aluminium, brass, copper, plastic, and rubber.

With the exception of the Penetration Test all tests of this plan will subject the test specimen to an impact from a drop. The mechanical strength and ductility of the critical components of the package must continue to perform as expected at the ambient temperature conditions of –40°F to 100°F.

The fracture toughness, strength and ductility, of the structural materials in the Model 880SC do not change significantly at or between the temperatures of –40°F to 100°F. The shielding materials are relatively brittle throughout this entire temperature range. Therefore, any temperature within the –40°F to 100°F range for the 4-foot, 30-foot, and puncture tests will have the same result. So, the test specimen will be dropped at ambient temperature at time of testing.

The internal operating pressure of the containment system, namely the source capsule, is considered to be in equilibrium with the outside pressure of the package. The sealed capsules are welded at atmospheric pressure and except for the capsules, the package is open to the atmosphere. Therefore, the initial internal pressure of the containment system is considered to be insignificant.

Section 7 Material and Equipment List

The equipment list worksheets in Section 9 identify the equipment required, with additional space to list other necessary equipment and measuring instruments needed to perform the tests. Additional materials and equipment used to facilitate the tests will be listed as needed.

Section 8 Test Procedure

8.1 General

All test specimens are to be tested in the sequence presented below. Each test has been designed to check the integrity of various components of the package. An assessment of transport integrity of the package can be made based on the cumulative effect of the tests performed on the package.

A plastic jacket (as shown in figure 2.3) is used to carry the package and is normally present during shipping. There are instances where the jacket may not be present but the 880SC Transport package will be shipped. For this reason the jacket will not be used during testing since it may provide some level of impact absorption during the 1.2m Drop, 9m Drop and Puncture tests and would not provide a worst case for testing. All testing will be conducted without the jacket but the drop heights will be adjusted to compensate for the maximum potential weight of 52lbs vs. the actual weight of the test specimens. Drop height compensation calculations are to be included on each Drop & Puncture Test Data Sheet.

The tests have the following sequence:

1. Test specimen preparation and inspection (including initial profile).
2. Penetration test (10 CFR 71.71(c)(10)) – NCT Test
3. 1.2m (Four-foot) free drop test (10 CFR 71.71(c)(7)) – NCT Test
4. 9m (30-foot) free drop test (10 CFR 71.73(c)(1)) – HAC Test
5. Puncture test (10 CFR 71.73(c)(3)) – HAC Test
6. Test inspection.
7. Final test inspection and/or assessment (including post test profile).
8. Test specimen storage.

Note:
After testing, the package results will be evaluated in the Test Plan Report for impact of the reverse sequence of the 9m Drop and Puncture Testing to determine compliance with IAEA TS-R-1 #727 & #728.

8.2 Roles and Responsibilities

The responsibilities of the groups identified in this plan are:

- **Engineering** executes the tests according to the test plan and summarizes the test results. Engineering also provides technical input to assist Regulatory Affairs and Quality Assurance as needed.

- **Regulatory Affairs** monitors the tests and reviews test reports for compliance with regulatory requirements.

- **Quality Assurance** oversees test execution and test report generation to assure compliance with the QSA Global Quality Assurance Program.

- **Engineering, Regulatory Affairs** and **Quality Assurance** are jointly responsible for assessing test and specimen conditions relative to 10 CFR 71 and IAEA TS-R-1.

- **Quality Control** is responsible for ensuring test and specimen data is measured and recorded throughout the test cycle.

8.3 Test Specimen Preparation and Inspection

1. Manufacture five Model 880SC Source Changers per QSA Global drawing number 880SC-TP206, revision 1. Clearly and indelibly mark each specimen: "TP206(X)". Where X is an alphabetically incremented letter beginning with "A". One of the five Source Changers will be used as a spare and used to replace a specimen dropped onto the wrong impact point, if necessary. The spare, if used, will follow the same test sequence as the initially selected specimen.

2. Measure and record the weight of each specimen.

3. Inspect the test specimens to ensure that:

    - All fabrication and inspection records are documented in accordance with the QSA Global Quality Assurance Program.

    - The test specimens comply with the requirements of the drawing.

4. Measure and record the location of the source from the front plate using the source location tool.

5. Perform and record the radiation profile in accordance with QSA Global Work Instruction WI-Q-1806.

6. **Engineering, Regulatory Affairs** and **Quality Assurance** will jointly verify that the test specimens comply with the drawings and the QSA Global Quality Assurance Program.

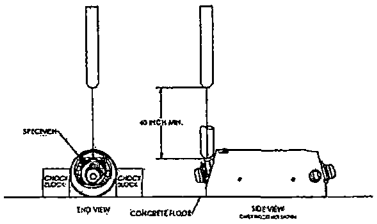
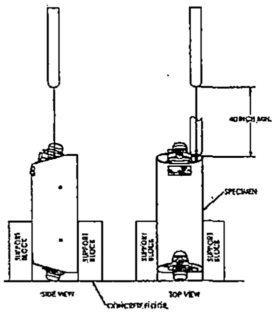
7. Prepare the test specimens for transport.

8.4 Summary of Test Schedule

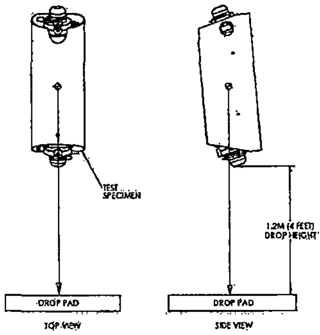
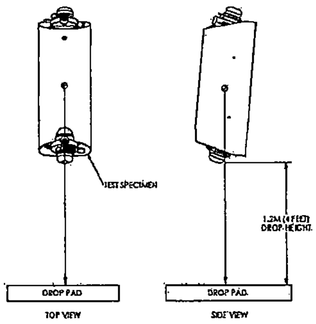
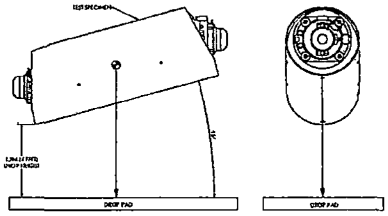
This section provides an overall view of the test specimen orientations for each test.

Normal Conditions of Transportation (NCT) Tests:

Penetration

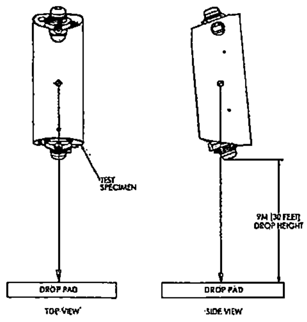
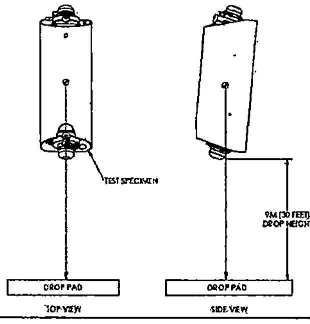
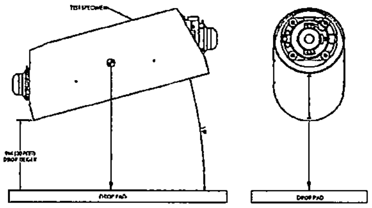
NCT	Para.	Specimen	Diagram
Penetration 1	71.71(c)(10)	TP206(A)	
Penetration 2	71.71(c)(10)	TP206(B)	

1.2m Drop

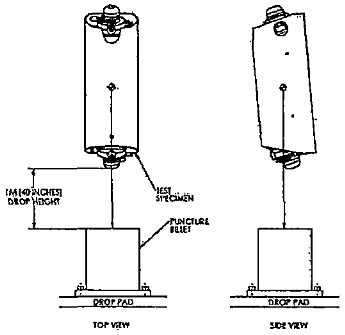
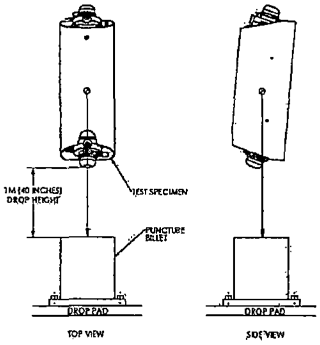
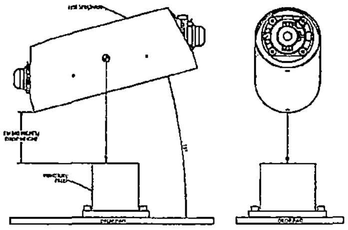
NCT	Para.	Specimen	Diagram
1.2m Drop 1.	71.71(c)(7)	TP206(A)	
1.2m Drop 2.	71.71(c)(7)	TP206(B)	
1.2m Drop 3.	71.71(c)(7)	TP206(C)	

Hypothetical Accident Condition (HAC) Tests:

9m Drop

HAC	Para.	Specimen	Diagram
9m Drop 1.	71.73(c)(1)	TP206(A)	
9m Drop 2.	71.73(c)(1)	TP206(B)	
9m Drop 3.	71.73(c)(1)	TP206(C)	

Puncture

HAC	Para.	Specimen	Diagram
Puncture 1.	71.71(c)(3)	TP206(A)	
Puncture 2.	71.71(c)(3)	TP206(B)	
Puncture 3.	71.71(c)(3)	TP206(C)	

8.5 Penetration Test (10 CFR 71.71 (c) (10))

The penetration test is a normal condition of transport test. Impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1.25 in) diameter and 6 kg (13 lbs) mass, dropped from a height of 1 m (40 in) onto the exposed surface of the package that is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.
The impact of the steel cylinder may be sufficient to damage the Lock Source assembly. There are two specific areas that are vulnerable, the Lock and the Lock Slide.

8.5.1 Penetration Test Set-up

1. Orient each specimen according to the specimen-specific orientation shown in Figure 8.5.2.1 or Figure 8.5.3.1
2. Raise the penetration bar
3. Measure and record the ambient temperature.
4. Photograph the set-up.
5. Drop the penetration bar.
6. Record the damage to the package and take a photographic record.

8.5.2 Specimen TP206(A) Orientation for the Penetration Test

Figure 8.5.2.1 shows the package orientation for Specimen TP206(A). The object of the drop is to puncture or damage the Lock mechanism.

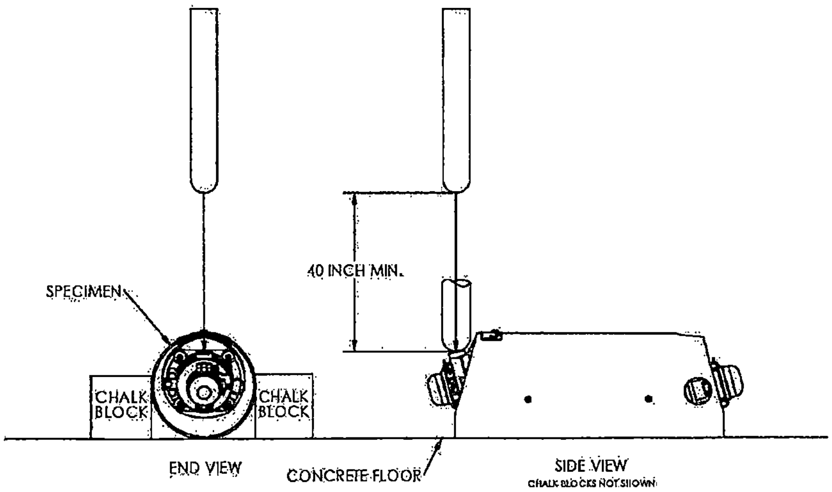


Figure 8.5.2.1: Specimen TP206(A) Orientation for the Penetration Test

8.5.3 Specimen TP206(B) Orientation for the Penetration Test

Figure 8.5.3.1 shows the package orientation for Specimen TP206(B). The object of the drop is to puncture or damage the Lock Slide.

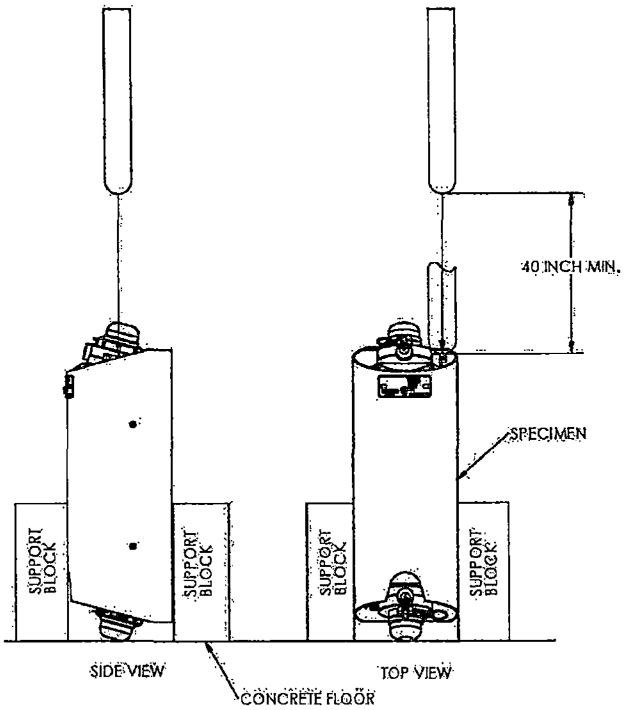


Figure 8.5.3.1: Specimen TP206(B) Orientation for the Penetration Test

8.5.4 Penetration Test Assessment

Upon completion of the test, **Engineering, Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

- Review the test execution to ensure that the test was performed in accordance with 10 CFR 71, IAEA TS-R-1 1996, and this test plan.
- Make a preliminary evaluation of the specimens relative to the requirements of 10 CFR 71 and IAEA TS-R-1 1996.
- Assess the damage to each specimen to decide whether testing of that specimen is to continue.

8.6 1.2m (4-foot) Free Drop Test (10 CFR 71.71(c)(7))

The Normal Transport Conditions Test is the 1.2m (4-foot) free drop test as described in 10 CFR 71.71(c)(7).

The figures of section 8.6.2.1, 8.6.3.1, and 8.6.4.1 illustrate the orientations for the test specimens.

8.6.1 1.2m Free Drop Test Set-up

To set up a package for the 1.2m (4-foot) drop test:

1. Place each specimen on the drop surface and position it according to the specimen-specific orientation shown in Figure 8.6.2.1, Figure 8.6.3.1, or Figure 8.6.4.1
2. Raise the package so that the impact target is 1.2m (4 feet) + Weight compensated distance, above the drop surface. Ensure the center of gravity is over the impact point
3. Measure and record the ambient temperature.
4. Photograph the set-up.
5. Start the video recorder.
6. Drop the package.
7. Stop the video recorder.
8. Record the damage to the package and take a photographic record.

8.6.2 Specimen TP206(A) Orientation for the 1.2m Drop Test

Figure 8.6.2.1 shows the package orientation for Specimen TP206(A). The object of the drop is to damage the Lock Cap and Lock and possibly shear the attachment screws.

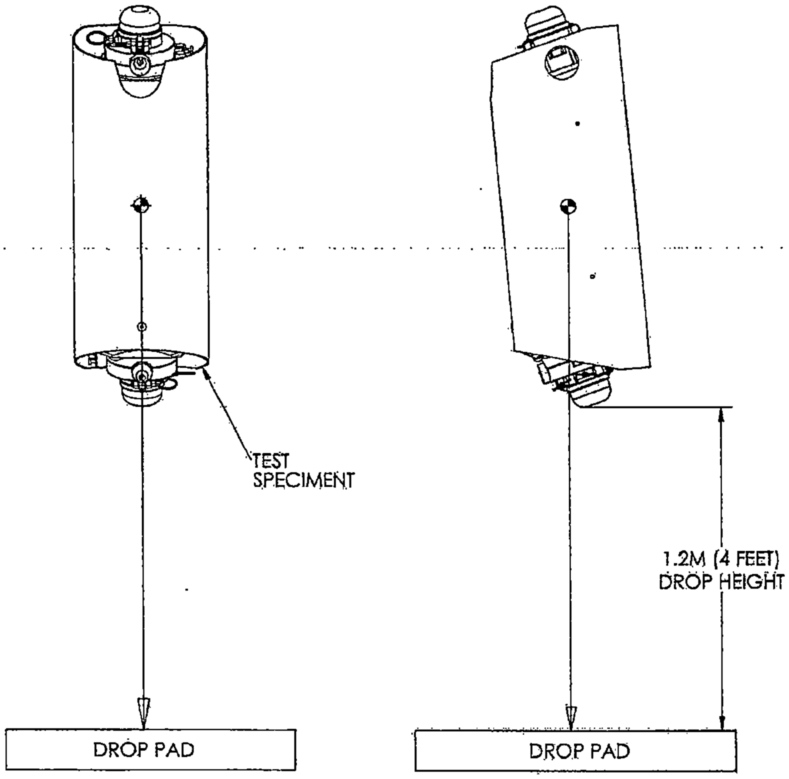


Figure 8.6.2.1: Specimen TP206(A) Orientation for the 1.2m Drop Test

8.6.3 Specimen TP206(B) Orientation for the 1.2m Drop Test

Figure 8.6.3.1 shows the package orientation for Specimen TP206(B). Since the 880SC Transport package has a Lock assembly on each end, and the ends are at different angles the object of this drop is to damage this Lock Cap and Lock or shear the attachment screws.

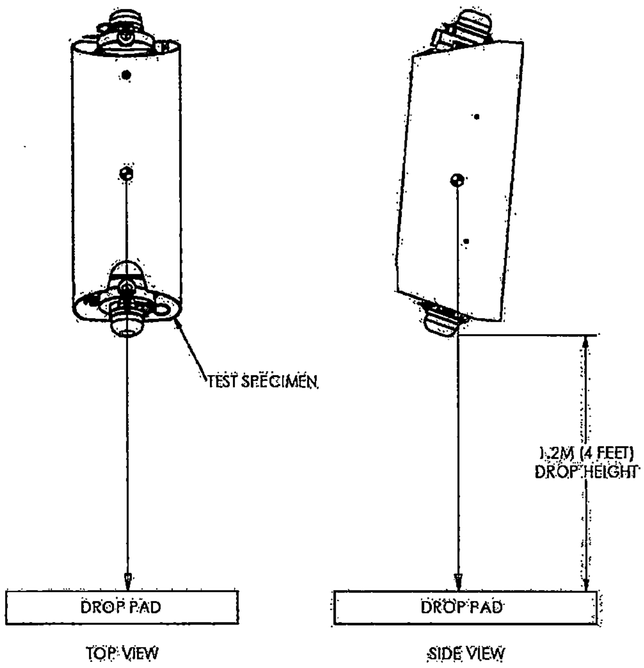


Figure 8.6.3.1: Specimen TP206(B) Orientation for the 1.2m Drop Test

8.6.4 Specimen TP206(C) Orientation for the 1.2m Drop Test

Figure 8.6.4.1 shows the package orientation for Specimen TP206(C). The object of this drop is to try and shear off the attachment screws. This orientation is a worst case. The center of mass for the Lock Slide on the right (as shown in Figure 8.6.4.1) is at a further point from the initial corner of impact on the 880SC than for the Lock Slide on the left, and will therefore create a larger moment of inertia.

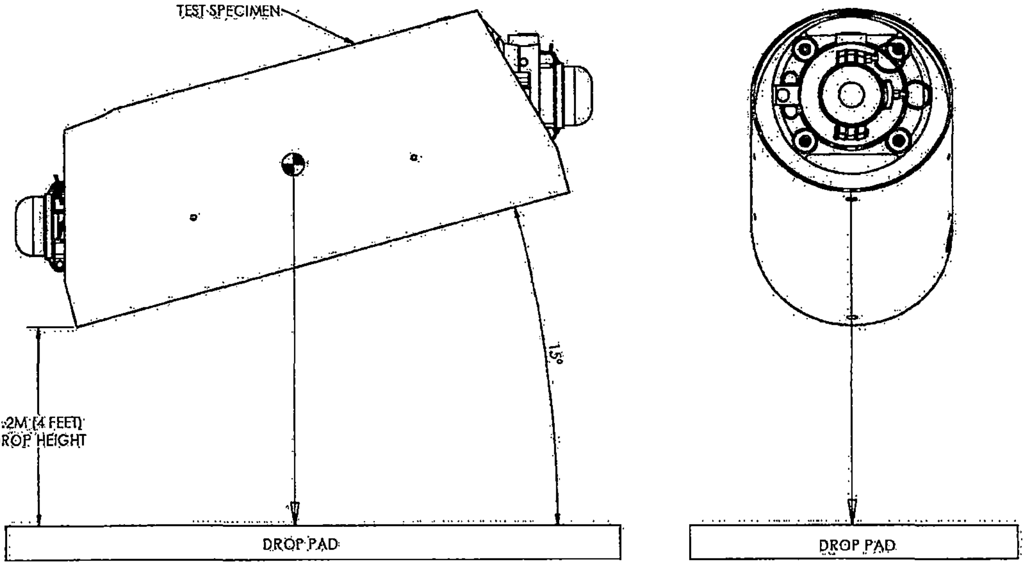


Figure 8.6.4.1: Specimen TP206(C) Orientation for the 1.2m Drop Test

8.6.5 1.2m Free Drop Test Assessment

Upon completion of each test, **Engineering**, **Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

- Review the test execution to ensure that each test was performed in accordance with 10 CFR 71, IAEA TS-R-1, and this test plan.

- Make a preliminary evaluation of the specimens relative to the requirements of 10 CFR 71 and IAEA TS-R-1.

- Measure and record a radiation profile of each test specimen in accordance with QSA Global Work Instructions WI-Q1806.

- Assess the damage to each specimen to decide whether testing of that specimen is to continue.

- Evaluate the condition of each specimen to determine what changes, if any, are necessary in package orientation in the 30-foot drop test to achieve maximum damage.

8.7 9m Free Drop Test (10 CFR 71.73(c)(1))

The first Hypothetical Accident Test is the 9m (30-foot) free drop test as described in 10 CFR 71.73(c)(1).

The figures of section 8.7.2.1, 8.7.3.1, and 8.7.4.1 illustrate the orientations for the test specimen.

8.7.1 9m Free Drop Test Set-up

To set up a package for the 9m (30-foot) drop test:

1. Measure and record the weight of each of the test specimens.
2. Place each specimen on the drop surface and position it according to the specimen-specific orientation as shown in Figure 8.7.2.1, Figure 8.7.3.1, or Figure 8.7.4.1.
3. Raise the package so that the impact target is 9m (30 feet) + Weight Compensated distance, above the drop surface. Ensure the center of gravity is over the impact point.
4. Measure and record the ambient temperature.
5. Photograph the set-up.
6. Start the video recorder.
7. Drop the package.
8. Stop the video recorder.
9. Record the damage to the package and take a photographic record.

8.7.2 Specimen TP206(A) Orientation for the 9m Drop Test

Figure 8.7.2.1 shows the package orientation for Specimen TP206(A). The object of the drop is to use lock cap to drive the rear plate across the endplate to shear the rear plate mounting screws.

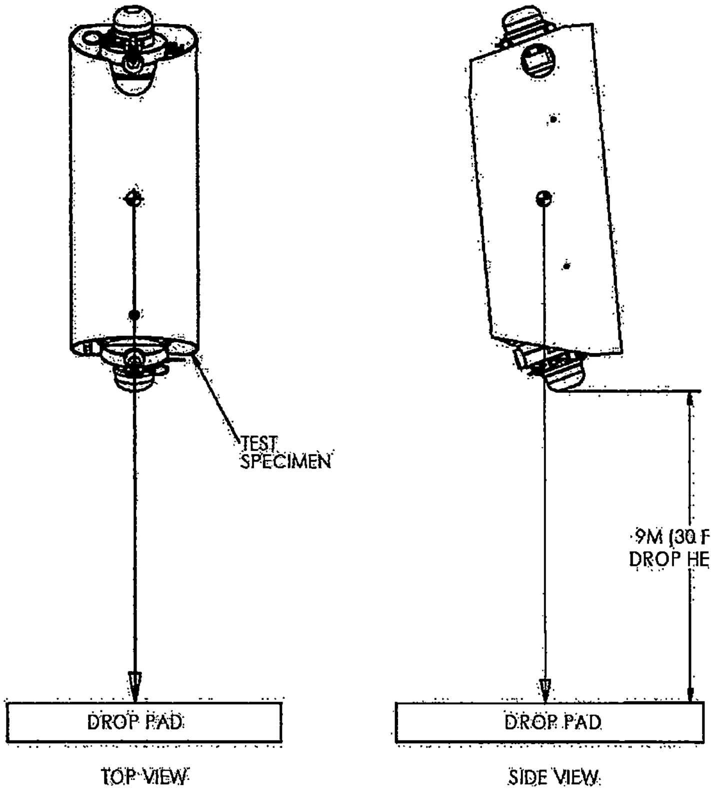


Figure 8.7.2.1: Specimen TP206(A) Orientation for the 9m Drop Test

8.7.3 Specimen TP206(B) Orientation for the 9m Drop Test

Figure 8.7.3.1 shows the package orientation for Specimen TP206(B). The object of the drop is to use lock cap to drive the rear plate across the endplate to shear the rear plate mounting screws.

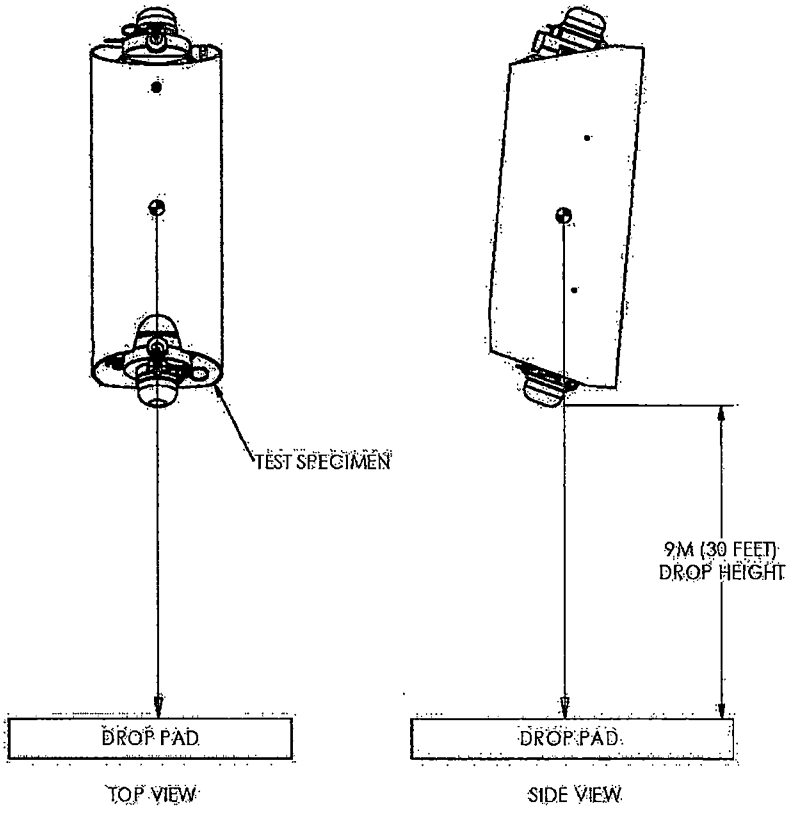


Figure 8.7.3.1: Specimen TP206(B) Orientation for the 9m Drop Test

8.7.4 Specimen TP206(C) Orientation for the 9m Drop Test

Figure 8.7.4.1 shows the package orientation for Specimen TP206(C). The object of this drop is to try and shear off the attachment screws. This orientation is a worst case. The center of mass for the Lock Slide on the right (as shown in Figure 8.7.4.1) is at a further point from the initial corner of impact on the 880SC than for the Lock Slide on the left, and will therefor create a larger moment of inertia.

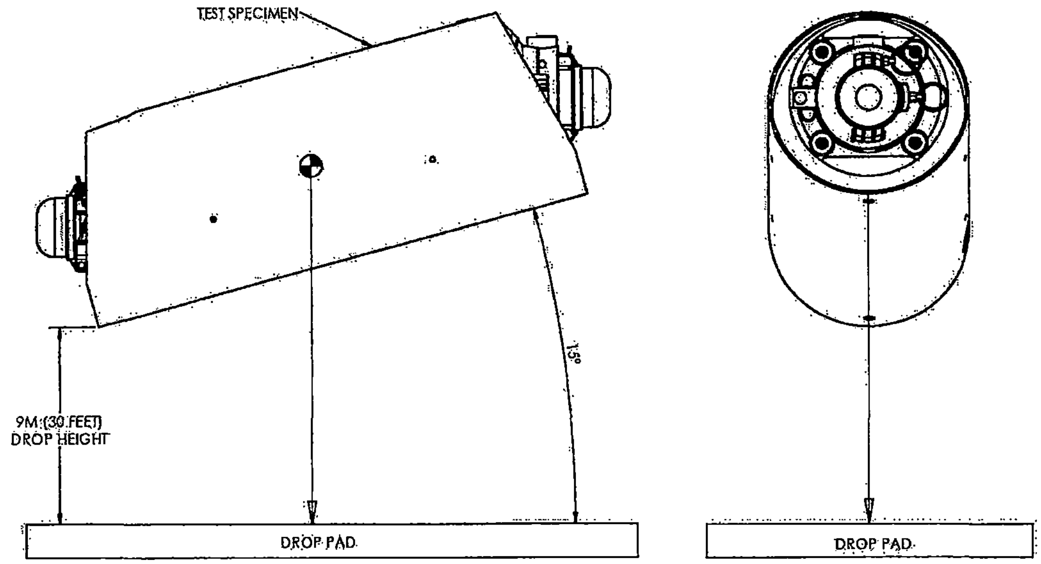


Figure 8.7.4.1: Specimen TP206(C) Orientation for the 9m Drop Test

8.7.5 9m Free Drop Test Assessment

Upon completion of each test, **Engineering, Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

- Review the test execution to ensure that each test was performed in accordance with 10 CFR 71, IAEA TS-R-1, and this test plan.
- Make a preliminary evaluation of the specimens relative to the requirements of 10 CFR 71 and IAEA TS-R-1.
- Assess the damage to each specimen to decide whether testing of that specimen is to continue.
- Evaluate the condition of each specimen to determine what changes, if any, are necessary in package orientation in the puncture test to achieve maximum damage.

8.8 Puncture Test (10 CFR 71.73(c)(3))

The package is dropped from a height of 1m (40") onto the puncture billet. This test uses the 12" high puncture billet. The billet meets the minimum height (8") required in 10 CFR 71.73(c)(3). The specimen has no projections or overhanging members longer than 12" which could act as impact absorbers, allowing the billet to cause the maximum damage to the specimen. The billet is to be bolted to the drop surface used in the drop tests.

The figures: 8.8.2.1, 8.8.3.1 and 8.8.4.1 illustrate the orientations for each puncture test.

The justification for each puncture orientation Drop 1 and Drop 2 is the same as the orientation for the 30-foot drop test (Drop 1 and Drop 2). If the orientation needs to be changed, the new orientation must be documented and approved with a justification describing how it would be a worst condition than the planned orientation.

8.8.1 Puncture Test Set-up

NOTE: *Because each test is designed to add to damage inflicted on a specific component or assembly in the preceding test, it is important that each specimen maintain its identity throughout the battery of tests and that the set-up instructions specific to the specimen are strictly followed.*

To set up a package for the puncture test:

1. Measure and record the weight of the test specimen.
2. Measure and record the ambient temperature.
3. Position the test package according to the specimen-specific orientation shown in figures 8.8.2.1, 8.8.3.1, or 8.8.4.1.
4. Raise the package so that the impact target is 1m (40") + Weight Compensated distance, between the impact point on the package and the top of the puncture billet. Ensure the center of gravity is over the impact point.
5. Photograph the set-up.
6. Start the video recorder.
7. Drop the package.
8. Stop the video recorder.
9. Record the damage to the package and take a photographic record.

8.8.2 Specimen TP206(A) Orientation for the Puncture Test

The objective of this drop orientation (Figure 8.8.2.1) is to continue the damage inflicted on the specimen by the 9m-drop test.

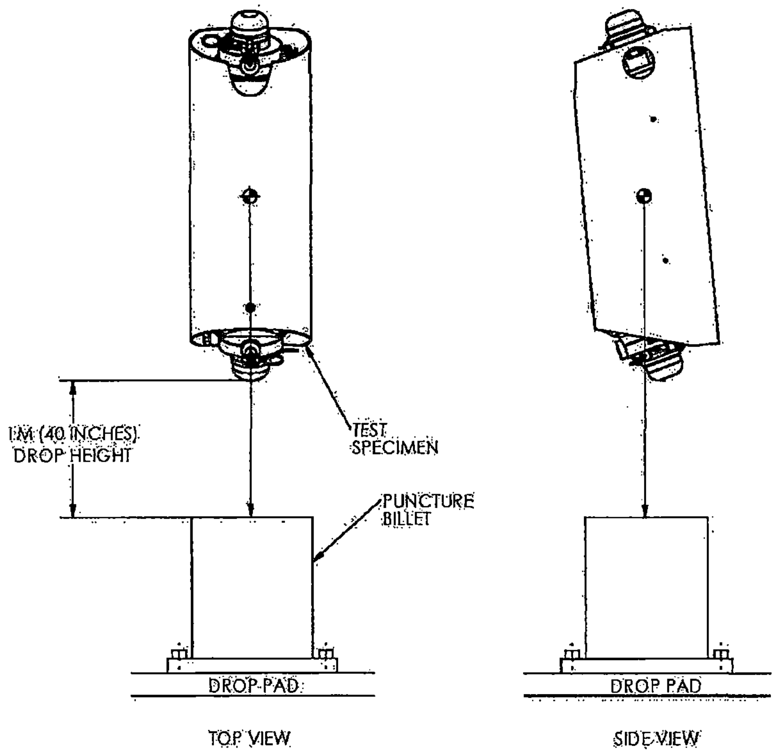


Figure 8.8.2.1: Specimen TP206(A) Orientation for the Puncture Test

8.8.3 Specimen TP206(B) Orientation for the Puncture Test

The objective of this drop orientation (Figure 8.8.3.1) is to continue the damage inflicted on the specimen by the 9m-drop test.

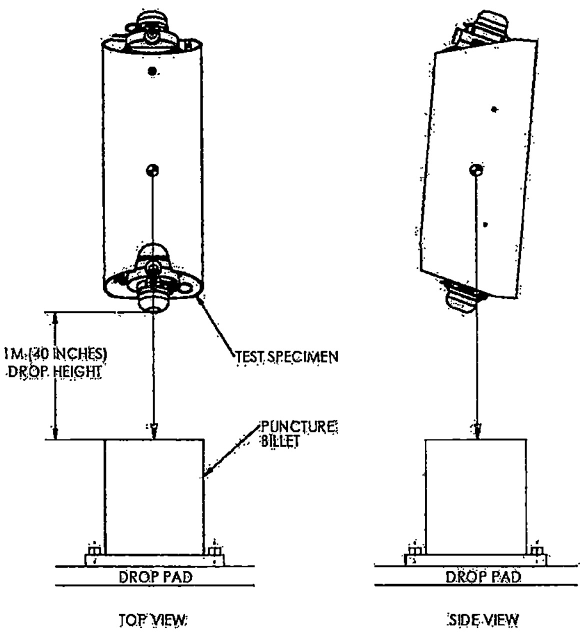


Figure 8.8.3.1: Specimen TP206(B) Orientation for the Puncture Test

8.8.4 Specimen TP206(C) Orientation for the Puncture Test

The objective of this drop orientation (Figure 8.8.4.1) is to puncture the shell of the 880SC.

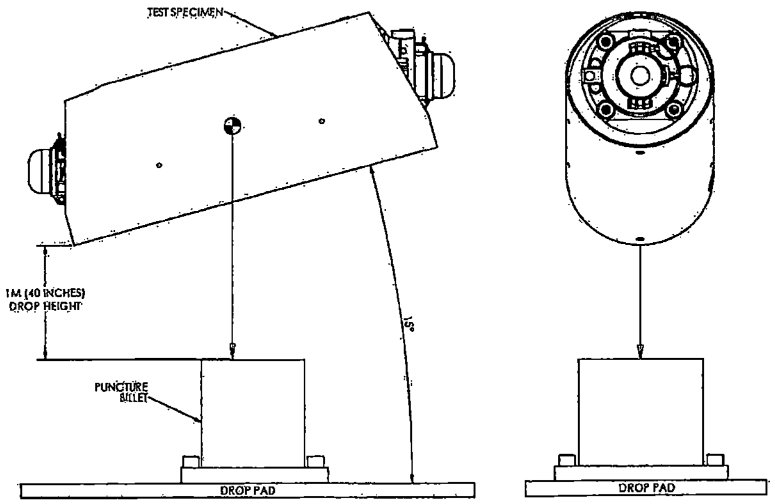


Figure 8.8.4.1: Specimen TP206(C) Orientation for the Puncture Test

8.8.5 Puncture Test Assessment

Upon completion of the test, **Engineering, Regulatory Affairs** and **Quality Assurance** team members will jointly take the following actions:

- Review the test execution to ensure that the tests were performed in accordance with 10 CFR 71, IAEA TS-R-1, and this test plan.
- Make a preliminary evaluation of each specimen relative to the requirements of 10 CFR 71 and IAEA TS-R-1.

8.9 Test Inspection

Perform the test inspection after the puncture tests.

1. Measure and record the damage to each of the test specimens. Measure and record the package for signs of any permanent strain.
2. Measure and record the location of the source from the front plate using the source location tool.
3. Remove and assess the condition of the simulated source.
4. Reassemble the packages using a representative active source, making sure that the source position and the package configuration are the same as they were immediately after the puncture test.
5. Measure and record a radiation profile of each test specimen in accordance with QSA Global Work Instruction WI-Q1806.
6. Assess the significance of any change in radiation at the surface and at one meter from the packages.
7. Determine whether it is necessary to radiograph the test specimens for inspection of hidden component damage or failure.
8. Record any damage or failure found in radiograph of the test specimens, if performed.

8.10 Thermal Test (10 CFR 71.73(c)(4))

The Thermal test will be assessed.

8.11 Test Specimen Storage

Place the test specimens in an appropriate container and store the container in the "low level" waste room. Dispose the test specimens only when authorized in writing by RA and QA.

Section 9 Worksheets

Use the following worksheets for executing the tests of section 8. Each test shall have three worksheets; an equipment list, a procedure checklist, and a data sheet. Record the information onto copies of these worksheets for each test performed.

Attach a copy of the relevant inspection report or calibration certificate after the range and accuracy of the equipment has been verified.

Test Specimen Documentation

Test Specimen – 880SC-TP206

Serial Number	**Drawing Number & Revision**	**Attach IIR's**	**Attach NCR**	**Attach TMI**

Signature	**Print Name**	**Date**
Engineering:		
Regulatory:		
Quality Assurance:		

Drop & Puncture Test Equipment List

Test:		
Description *** Mark NA when not used.**	**Enter the Model and Serial Number**	**Attach Inspection Report or Calibration Certificate**
Test Specimen, Drawing No.		
Drop Surface, Drawing No.		
* Puncture Billet, Drawing No.		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:		
Verified by:		

Drop & Puncture Test Checklist

Test:

Test Location:

Step	**Data**	**Measuring Instrument**
1. Record test specimen serial number:		
2. Record the test specimen weight:		
3. Record the ambient temperature (°C):		
4. Record set-up orientation figure:		
5. Verify set-up orientation and drop height.		
6. Photograph set-up in at least two perpendicular planes.		
7. Begin video recording of the test so that impact is recorded.		
8. Release the test specimen.		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.		
10. Record the damage to the test specimen on a separate sheet and attach.		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering:		
Regulatory Affairs:		
Quality Assurance:		

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.:	Test:
Test Date:	Test Time:
Describe drop orientation and drop height:	
Describe impact (location, rotation, etc.):	
Describe on-site inspection (damage, broken parts, etc.):	
On-site test assessment: Engineering: Regulatory: QA:	
Describe any post-test disassembly and inspection:	
Describe any change in source position:	
Describe results of radiography:	
Completed by:	Date:

2.12.16 Test Plan 206 Report #1 minus Appendices D & E (Nov 2013)

QSA GLOBAL	Document Number **F-E-1808-2** **Test Report Cover Sheet**	Revision 0

TEST REPORT #1
FOR TEST PLAN 206

Model 880SC Transport Package

Normal Conditions of Transport (NCT) Test Results

Revision: 0

Originator		Date: 19NOV13

APPROVALS		
Engineering		Date: 20 NOV 2013
Regulatory		Date: 21 NOV 2013
Quality Assurance		Date: 21 Nov 2013

TEST PLAN 206 – REPORT #1

MODEL 880SC TRANSPORT PACKAGE

NORMAL CONDITIONS OF TRANSPORT (NCT) TEST

REV 0

Contents

Test Plan No. 206

Section 1 Introduction

This report documents the Normal Conditions of Transport (NCT) test results described on Test Plan 206 performed on the Model 880SC transport package. The results confirm the Model 880SC transport package in its heaviest configuration tested in the most vulnerable drop orientation passes all the NCT test requirements specified in Test Plan 206, the Code of Federal Regulations, 10 CFR Part 71, revised as of January 26, 2004 and criteria stated in the IAEA Regulations for the Safe Transport of Radioactive Material, No. TS-R-1 (1996 Edition – as Amended 2003).

The Model 880SC transport package is tested to demonstrate its ability to withstand normal conditions of transport as identified in 10 CFR 71.71 and IAEA TS-R-1. Successfully passing the NCT tests means there is no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.

IAEA TS-R-1 Section VI, paragraph 646 stipulates the same criteria except that it also requires that the loss of shielding integrity shall not result in more than a 20% increase in the radiation level at any external surface of the package.

Section 2 Construction and Condition of Test Specimens

The test specimens are constructed in accordance with QSA Global engineering drawings and Quality Assurance Program. The drawings and manufacturing documents accurately depict the intended design at the time of testing along with methods for building and verifying the finished product. There were no deviations and/or changes to the test specimen before testing.

The test specimens (4) built for this test are the Model 880SC. **Figures 2.1** and **2.2** shows test specimens, specimen numbers TP206(A) through TP206D. TP206D was assembled as a spare. This unit was not required for the NCT testing. Shipping labels and nameplates were not attached for testing.

Figures 2.1 and 2.2 shows the major assemblies and common components of the Model 880SC transport package. The nomenclature used in **Figures** 2.1 and 2.2 are referenced throughout this report.

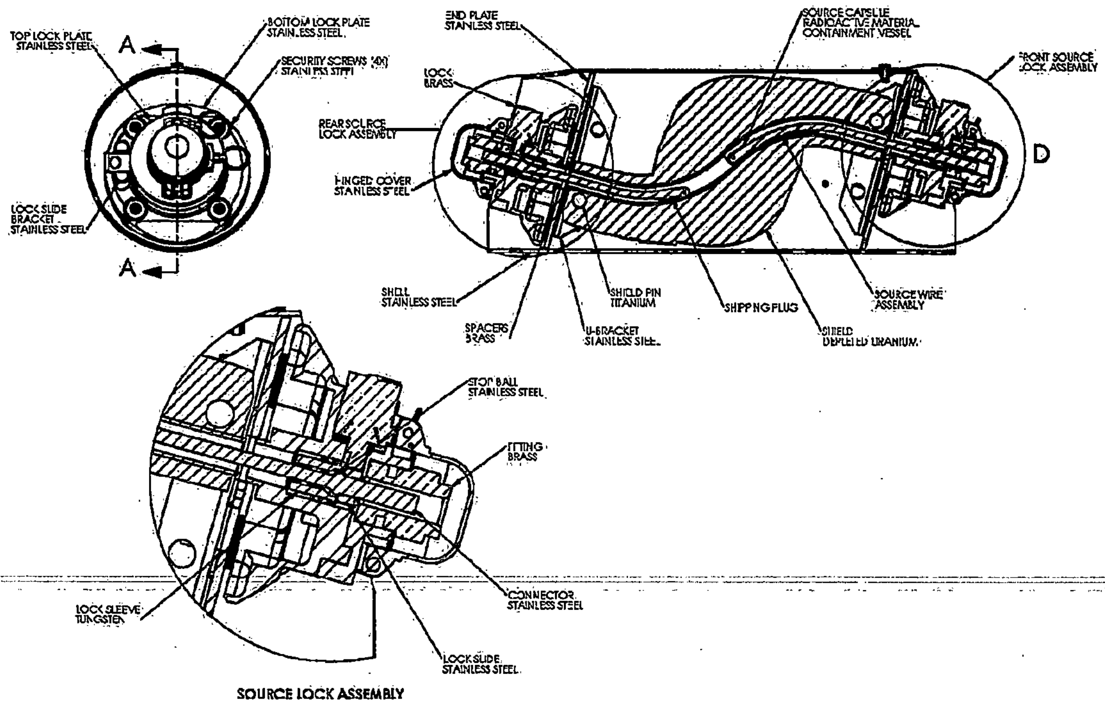


FIGURE 2.1: MODEL 880SC SOURCE CHANGER TRANSPORT PACKAGE
(without optional Jacket)

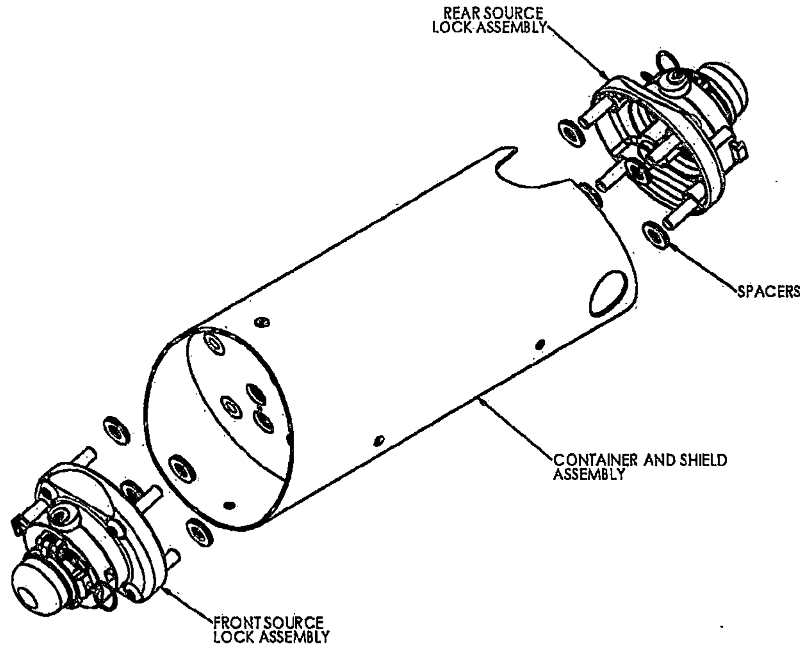


FIGURE 2.2: MODEL 880SC SOURCE CHANGER SCHEMATIC

The primary containment system of the package is the completely seal welded source capsule assembly. The capsule assembly, tested to the ANSI/ISO class 4 or 7MPa pressure test requirements, is manufactured at atmospheric pressure and ambient temperature and therefore does not need to be adjusted for the test.

The secondary containment system, the transport package source lock assemblies and shield assembly, are open to the atmosphere and therefore in constant equilibrium with changing operating pressures.

The structural materials used in the construction of the Model 880SC transport package retain their key mechanical and physical properties between -40°C (-40°F) and +38°C (+100°F). Therefore, the temperature of the test specimens did not need to be adjusted for the tests performed in test plan 206.

Section 3 Regulatory Compliance

The Model 880SC transport package complies with the normal transport package test requirements of 10 CFR 71.71 and IAEA TS-R-1 based on the successful completion of the tests and analysis described in this report.

The pass criteria for a successful normal transport test or analysis is identified 10 CFR part 71.43 paragraph (f). This paragraph states:

> "There should be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.
>
> IAEA TS-R-1 paragraph 646 stipulates the same criteria except that it also requires that the loss of shielding integrity not result in more than a 20% increase in the radiation level at any external surface of the package."

Free Drop Height Adjustment

The free drop test heights specified in 10 CFR Part 71 are adjusted higher to allow for the Model 880SC transport packages built heavier than the test specimen but less than the maximum package weight. The actual test specimens weigh less than the maximum weight specified on the top level assembly drawing. This is primarily due to the absence of the optional jacket.

Table 3.1 shows the adjusted free drop height based on the actual test specimen weight compared to the maximum transport package weight. The adjusted heights provide impact energy equal to or greater than the maximum transport package weight if dropped at the 10 CFR Part 71 specified drop height. The adjusted drop height is determined by multiplying the worst case weight ratio by the required drop test height (4 feet). The worst case weight ratio is calculated by dividing the maximum allowable weight by the actual test specimen weight.

Table 3.1. Test Specimen 1.2 Meter Free Drop Height Adjustment

Test Specimen	Actual Test Specimen Weight (Lbs)	Maximum Transport Package Weight (Lbs)	1.2 Meter (4-foot) Adjusted Height		
			(Meters)	(Feet)	(Inches)
TP206(A)	44.80	52	1.42	4.7	56
TP206(B)	44.85	52	1.42	4.7	56
TP206(C)	44.80	52	1.42	4.7	56

Section 4 Test Results

4.1 Water Spray Test

Per Test Plan 206 the water spray test was not performed:

> "The ***water spray test*** per 10 CFR 71.71 (c) (6) and IAEA TS-R-1 Section VII, paragraph 721 of the package <u>will not be performed</u> as the Model 880SC transport package is constructed of waterproof materials throughout. Water spray will not degrade the structural integrity of the Model 880SC transport package."

4.2 Compression Test

Per Test Plan 206 the compression test was not performed:

The ***compression or stacking test*** per 10 CFR 71.71 (c) (9) and IAEA TS-R-1 Section VII, paragraph 723 will not be performed because the maximum weight of the 880SC transport package without the jacket is 46 lbs. and was tested as part of the 880 Transport packeage:

> "Test Plan and Report 100 (Section 2.12) documents that Test Specimens P01 and P02 were subjected simultaneously to a compressive load of 459 lbs (209 kg) for a period of 24 hours. This exceeds five times the maximum transport package weight of 46 lbs for the heaviest version of the Model 880 (without the optional jacket). The actual compressive weight of 459 lbs (209 kg) is greater than 13 kPa (2 lb/in2) multiplied by the vertically projected area of the transport package."

4.3 Penetration Test

4.3.1 Penetration Test Requirement

This test drops a vertically oriented, solid steel, cylindrical bar from a height of 1 m (40 in) onto the exposed surface of the package that is most vulnerable to puncture.

The bar has a diameter of 3.2 cm (1.25 in) with a hemispherical end and a mass of 6 kg (13 lbs). The long axis of the cylinder must be perpendicular to the package surface.

For the 880SC unit it was determined the lock and lock slide would be the most vulnerable areas. Two penetration tests were performed to determine compliance to this test. Test specimens TP206(A) (s/n: D11827) and TP206(B) (s/n: D11828) were used for this test.

4.3.2 Penetration Test Results – TP206(A)

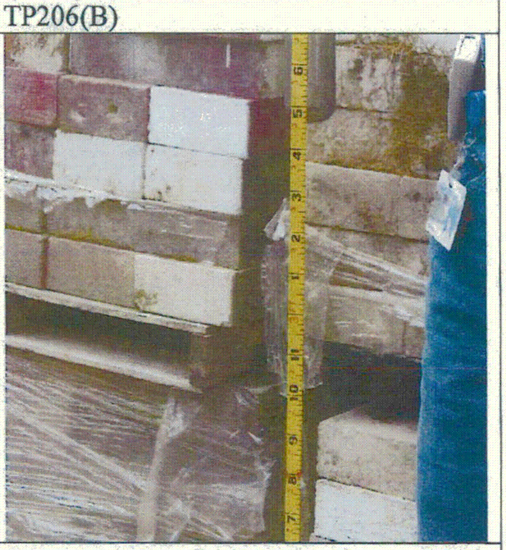
Figure 4.3.2A shows the penetration bar contacting the top of the lock, figure 4.3.2B shows the drop height of the bar, and figure 4.3.2C shows the damage caused by the dropped bar.

<table>
<tr><th colspan="2">Table 4.3.2: Penetration Bar Test Setup – TP206(A)</th></tr>
<tr><td>Changes to the planned penetration target.</td><td>None</td></tr>
<tr><td>Test Specimen Weight</td><td>44.80 Pounds</td></tr>
<tr><td>Actual Bar Drop Height</td><td>1.0 Meter (39.4 inches)</td></tr>
<tr><td>Temperature during test</td><td>61.2 °F/16.2 °C</td></tr>
<tr><td>Test Specimen</td><td>TP206(A)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Figure 4.3.2A: Penetration Bar Test Setup – TP206(A)</td><td>Figure 4.3.2B: Penetration Bar height – TP206(A)</td></tr>
</table>

Figure 4.3.2C: Damage from Penetration Bar Test – TP206(A)

4.3.3 Penetration Test Results – TP206(B)

Figure 4.3.3A shows the penetration bar contacting the top of the lock slide, figure 4.3.3B shows the drop height of the bar, and figure 4.3.3C shows the damage caused by the dropped bar.

Table 4.3.3: Penetration Bar Test Setup – TP206(B)	
Changes to the planned penetration target.	None
Test Specimen Weight	44.85 Pounds
Actual Bar Drop Height	1.0 Meter (39.4 inches)
Temperature during test	62.3 °F/16.8 °C
Test Specimen	TP206(B)
	
Figure 4.3.3A: Penetration Bar Test Setup – TP206(B)	**Figure 4.3.3B: Penetration Bar height – TP206(B)**

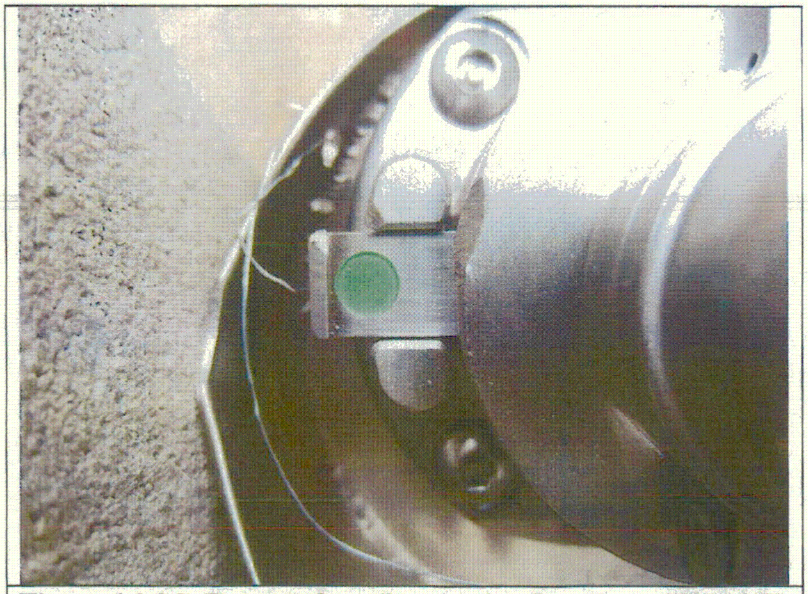


Figure 4.3.3C: Damage from Penetration Bar Test – TP206(C)

4.3.4 Penetration Test Assessment

The penetration test was executed in accordance with Test plan 206, 10 CFR 71.71, and IAEA TS-R-1. An evaluation of the specimen relative to the requirements of 10 CFR 71 and IAEA TS-R-1 confirms the package meets the test requirement. The damage was not sufficient enough to prevent further testing. So, testing continued on to the 1.2 meter free drop test.

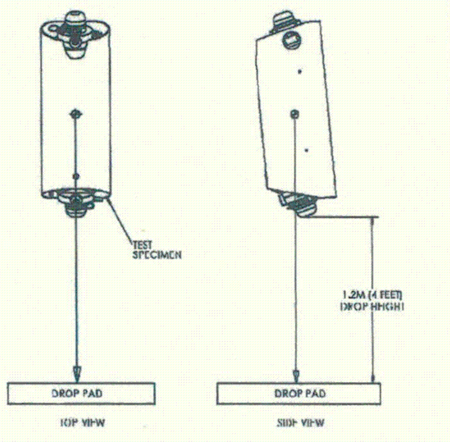
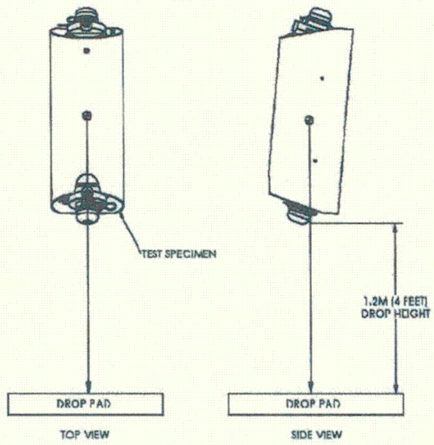
4.4 1.2 Meter Free Drop Test

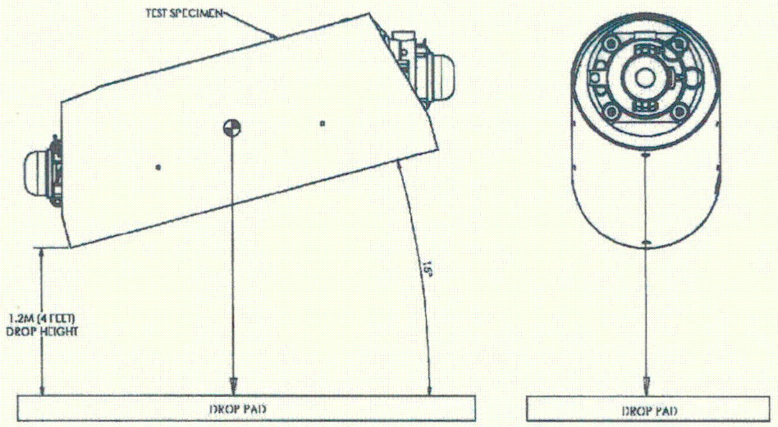
4.4.1 1.2 Meter Free Drop Test Requirement

The 1.2 meter free drop test subjects the test specimen to a free drop of at least 1.2 meters (4 feet) onto a rigid, essentially unyielding surface. The orientation of the test specimen during the drop shall be the most unfavourable relative to the failure modes identified in Test Plan 206.

4.4.2 1.2 Meter Free Drop Test Orientation

Table 4.4.2 Free Drop Test Orientation Review

	
TP206(A) Front Surface Drop	**TP206(B) Rear Surface Drop**



TP206(C) Shallow Angle Drop

4.4.3 1.2 Meter Free Drop Test Results

4.4.3.1 1.2 Meter Free Drop Test – TP206(A) Results

Table 4.4.3.1A. TP206(A) Four Foot Drop Test Setup	
Drop Orientation	Test Plan 206 Figure 8.6.2.1
Test Specimen Weight	44.80 pounds
Actual Drop Height	56 Inches
Temperature during test	17.4°C (63.4°F)

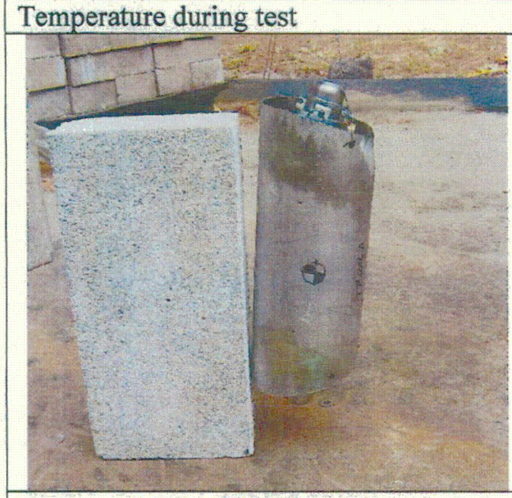



Figure 4.4.3.1A TP206(A) Orientation	**Figure 4.4.3.1B TP206(A) Drop Height**

Table 4.4.3.1B: TP206(A) Four Foot Drop Test Damage Assessment	

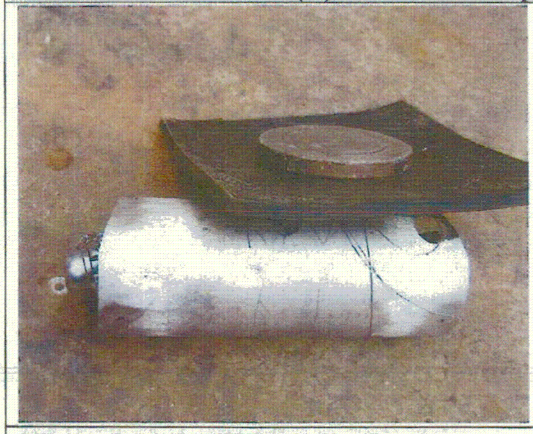
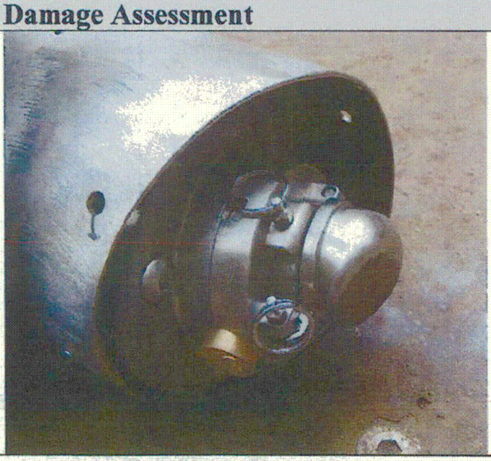

	

Figure 4.4.3.1C TP206(A) after drop	**Figure 4.4.3.1D TP206 Close Up**
Damage: 1. As expected there was some minor damage to the cap. 2. The spring plunger was damaged. 3. The cap remained closed. 4. The lock slide assembly was fully functional.	

4.4.3.2 1.2 Meter Free Drop Test – TP206(B) Results

Table 4.4.3.2A. TP206(B) Four Foot Drop Test Setup	
Drop Orientation	Test Plan 206 Figure 8.6.3.1
Test Specimen Weight	44.85 pounds
Actual Drop Height	56 Inches
Temperature during test	17.7°C (63.9°F)
	
Figure 4.4.3.2A TP206(B) Orientation	**Figure 4.4.3.2B TP206(B) Drop Height**

Table 4.4.3.2B: TP206(B) Four Foot Drop Test Damage Assessment	

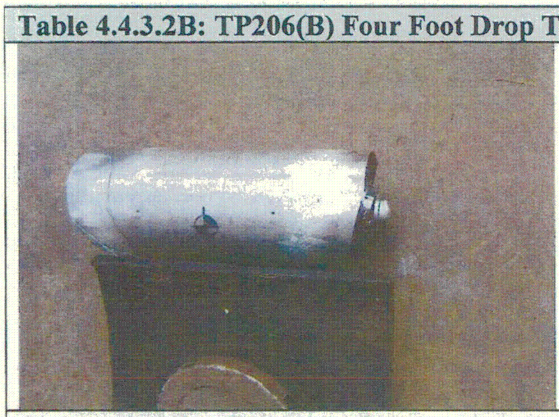
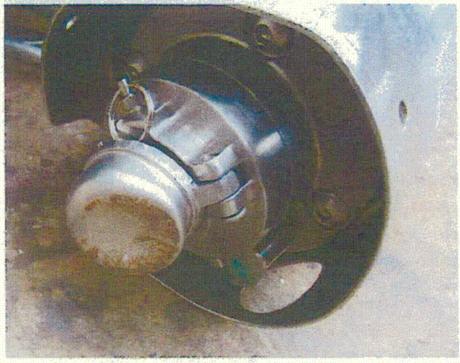

	

Figure 4.4.3.2C TP206(A) after drop	**Figure 4.4.3.2D TP206 Close Up**
Damage: **1. As expected there was some minor damage to the cap.** **2. The spring plunger was damaged.** **3. The cap was open.** **4. Source was secure.** **5. The lock slide assembly was fully functional.**	

4.4.3.3 1.2 Meter Free Drop Test – TP206(C) Results

Table 4.4.3.3A. TP206(C) Four Foot Drop Test Setup	
Drop Orientation	Test Plan 206 Figure 8.6.4.1
Test Specimen Weight	44.80 pounds
Actual Drop Height	56 Inches
Temperature during test	17.5°C (63.5°F)
	
Figure 4.4.3.3A TP206(C) Orientation	**Figure 4.4.3.3B TP206(C) Drop Height**

Table 4.4.3.3B: TP206(C) Four Foot Drop Test Damage Assessment	

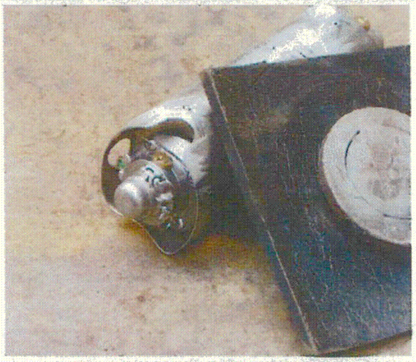



Figure 4.4.3.2C TP206(C) after drop	**Figure 4.4.3.2D TP206(C) Close Up**
Damage: **1. Shell slightly bent on both ends** **2. The lock slide assembly was fully functional.**	

4.4.4 Radiation Profile Inspection

Tables 4.4.4.1A, 4.4.4.1B and 4.4.4.1C show the surface and one-meter radiation profile measurements taken on the three test specimen (TP206(A) thru TP206(C)). All measurements are factored for a maximum package capacity of 150 curies of Iridium-192. All units were tested with source model A424-9 / source serial number 99334B. Each unit was tested first with the source in the "Front" position and then in the "Rear" position. The opposing end was loaded with the shipping plug. Comparing the measurements of the pre-tested specimen with the tested specimens proves there is no significant change in the radiation levels on the package as a result of the normal conditions of transport testing.

In some cases the dose rates after testing varied more than 25% from the original survey readings. In most cases, the dose rates involved were very low, typically < 2 mR/hr. In these cases, a variance slightly more than 0.5 mR/hr in a post test profile is sufficient to produce a dose rate change of 25% from the initial pre-test profile readings.

A review of the effect of human error introduced by obtaining manual survey measurements for dose rate surveys has demonstrated that this manual process can produce a ±25% difference in measurements due to human variability alone. Factoring in the human error and comparing the results of the pre and post test survey readings and the fact that all post test surveys within the maximum allowed readings on the surface and at 1 meter from the package, it is argued that there was no significant increase in the radiation dose rate readings from the test specimens after performance of the normal condition transport tests.

	Table 4.4.4.1A Maximum Radiation for TP206(A)				
Specimen	**Maximum "Surface" Measurements**				**% Difference**
	Before		**After**		
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**	
TP206(A) Front Loaded Source	125.9	Top	130.1	Top	3
	139.1	Right	147.3	Right	6
	119.1	Bottom	122.7	Bottom	2
	130.4	Left	132.9	Left	2
	154.1	Front	137.3	Front	-12
	116.6	Rear	117.1	Rear	1
TP206(A) Rear Loaded Source	125.1	Top	124.3	Top	-1
	134.7	Right	132.9	Right	-1
	140.2	Bottom	136.8	Bottom	-2
	138.0	Left	129.8	Left	-6
	97.9	Front	115.4	Front	16
	148.0	Rear	150.7	Rear	2
Specimen	**Maximum "1 Meter" Measurements**				**% Difference**
	Before		**After**		
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**	
TP206(A) Front Loaded Source	.9	Top	1.0	Top	11
	.9	Right	1.1	Right	20
	1.0	Bottom	1.0	Bottom	0
	1.0	Left	1.0	Left	0
	2.1	Front	2.0	Front	-5
	2.2	Rear	2.2	Rear	0
TP206(A) Rear Loaded Source	.9	Top	1.0	Top	11
	1.0	Right	1.0	Right	0
	1.0	Bottom	1.1	Bottom	10
	.9	Left	1.0	Left	11
	2.5	Front	2.9	Front	15
	1.9	Rear	2.3	Rear	19

	Table 4.4.4.1B Maximum Radiation for TP206(B)				
Specimen	**Maximum "Surface" Measurements**				**% Difference**
	Before		**After**		
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**	
TP206(B) Front Loaded Source	145.5	Top	142.8	Top	-2
	163.5	Right	156.5	Right	-4
	149.4	Bottom	148.7	Bottom	0
	145.9	Left	148.3	Left	2
	157.4	Front	170.3	Front	8
	104.0	Rear	109.7	Rear	5
TP206(B) Rear Loaded Source	138.2	Top	140.7	Top	2
	138.8	Right	138.6	Right	0
	163.0	Bottom	164.0	Bottom	1
	149.3	Left	148.9	Left	0
	96	Front	138.8	Front	*36*
	136.9	Rear	136.9	Rear	0
Specimen	**Maximum "1 Meter" Measurements**				**% Difference**
	Before		**After**		
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**	
TP206(B) Front Loaded Source	.9	Top	1.0	Top	11
	1.2	Right	1.0	Right	-18
	1.2	Bottom	1.2	Bottom	0
	1.1	Left	1.0	Left	-10
	2.2	Front	1.9	Front	-15
	2.4	Rear	2.1	Rear	-13
TP206(B) Rear Loaded Source	.8	Top	.9	Top	10
	1.0	Right	1.1	Right	10
	1.1	Bottom	1.1	Bottom	0
	1.0	Left	1.0	Left	0
	2.4	Front	2.0	Front	-18
	2.0	Rear	2.0	Rear	0

	Table 4.4.4.1C Maximum Radiation for TP206(C)				
Specimen	**Maximum "Surface" Measurements**				**% Difference**
	Before		**After**		
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**	
TP206(C) Front Loaded Source	126.3	Top	141.7	Top	11
	139.9	Right	141.6	Right	1
	130.3	Bottom	140.7	Bottom	8
	139.4	Left	139.9	Left	0
	131.0	Front	137.2	Front	5
	99.7	Rear	109.7	Rear	10
TP206(C) Rear Loaded Source	120.9	Top	124.7	Top	3
	147.8	Right	155.9	Right	5
	138.1	Bottom	143.0	Bottom	4
	135.2	Left	139.6	Left	3
	89.0	Front	94	Front	6
	143.4	Rear	158.5	Rear	10
Specimen	**Maximum "1 Meter" Measurements**				**% Difference**
	Before		**After**		
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**	
TP206(C) Front Loaded Source	.9	Top	.9	Top	0
	1.1	Right	1.0	Right	10
	1.0	Bottom	1.0	Bottom	0
	1.0	Left	.9	Left	-11
	1.9	Front	2.3	Front	19
	1.9	Rear	2.4	Rear	***23***
TP206(C) Rear Loaded Source	1.0	Top	1.1	Top	10
	1.1	Right	1.1	Right	0
	1.1	Bottom	1.2	Bottom	9
	1.1	Left	1.1	Left	0
	1.7	Front	2.3	Front	***30***
	2.5	Rear	2.6	Rear	4

4.4.5 1.2 Meter Free Drop Test Assessment

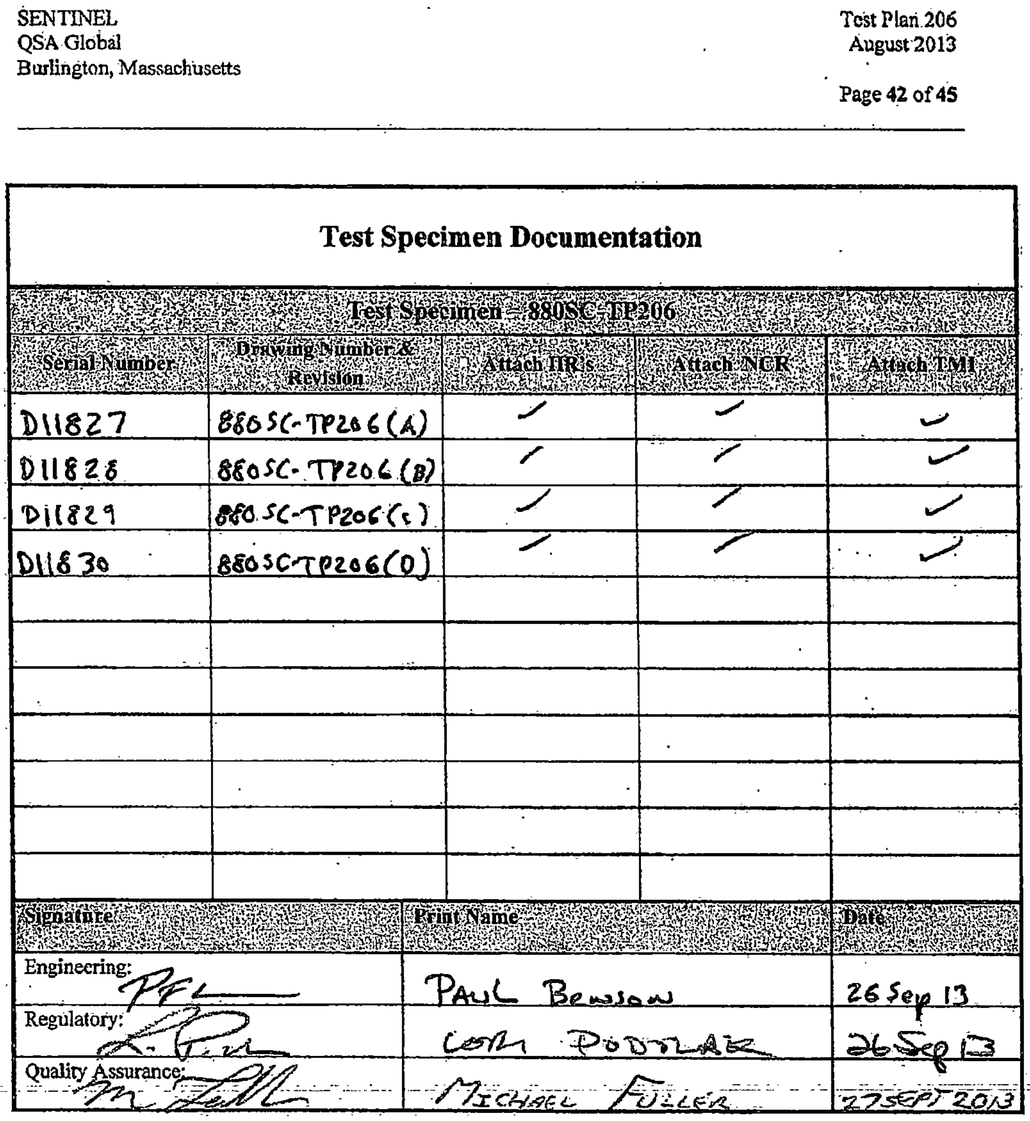
The 1.2 meter free drop test was performed in accordance with test plan 206, 10 CFR 71, IAEA TS-R-1.

After the 1.2 meter free drop test, all test specimens continued to successfully meet the normal transport requirements of 10 CFR 71 and IAEA TS-R-1. As a result of the testing, there was no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.

Section 5 Post Test Assessment

The test results confirm the Model 880SC transport package complies with the normal transport test requirements of 10 CFR part 71 and IAEA TS-R-1. The test resulted in no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels and no substantial reduction in the effectiveness of the packaging.

Appendix A: Test Specimen Documentation



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QSA Global
Burlington, Massachusetts

Test Plan 206
August 2013

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Test Specimen Documentation

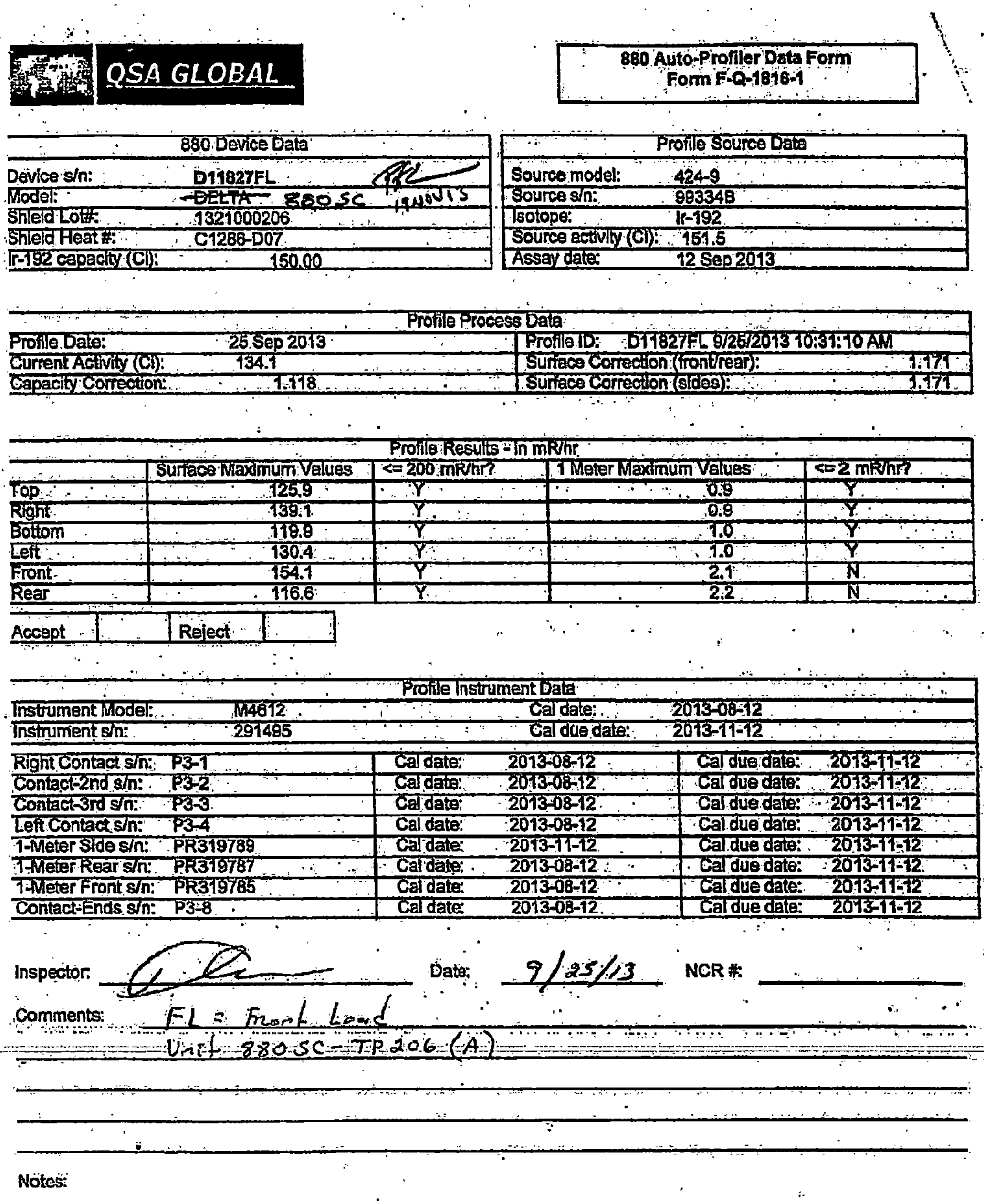
Test Specimen – 880SC-TP206

Serial Number	Drawing Number & Revision	Attach IIR's	Attach NCR	Attach TMI
D11827	880SC-TP206(A)	✓	✓	✓
D11828	880SC-TP206(B)	✓	✓	✓
D11829	880SC-TP206(C)	✓	✓	✓
D11830	880SC-TP206(D)	✓	✓	✓

Signature	Print Name	Date
Engineering:	PAUL BENSON	26 Sep 13
Regulatory:	LORI PODOLAK	26 Sep 13
Quality Assurance:	MICHAEL FULLER	27SEPT2013

Appendix B: Radiation Profile Results

TP206(A) (s/n: D11827) – Front Load (FL) Radiation Profile Inspection
Pre NCT Test Profile Results



QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11827FL
Model:	~~DELTA~~ 880 SC 11NOV13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D07
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	25 Sep 2013	Profile ID:	D11827FL 9/25/2013 10:31:10 AM
Current Activity (Ci):	134.1	Surface Correction (front/rear):	1.171
Capacity Correction:	1.118	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	125.9	Y	0.9	Y
Right	139.1	Y	0.9	Y
Bottom	119.9	Y	1.0	Y
Left	130.4	Y	1.0	Y
Front	154.1	Y	2.1	N
Rear	116.6	Y	2.2	N

Accept ☐ Reject ☐

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9/25/13 NCR #:

Comments: FL = Front Load
Unit 880SC-TP206 (A)

Notes:

TP206(A) (s/n: D11827) – Front Load (FL) Radiation Profile Inspection

Post NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data		
Device s/n:	D11827FL	
Model:	~~DELTA~~ 880SC	17 NOV 13
Shield Lot#:	1321000206	
Shield Heat #:	C1286-D07	
Ir-192 capacity (Ci):	150.00	

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	30 Sep 2013	Profile ID:	D11827FL 9/30/2013 10:50:49 AM
Current Activity (Ci):	128.0	Surface Correction (front/rear):	1.171
Capacity Correction:	1.172	Surface Correction (sides):	1.171

Profile Results - In mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	130.1	Y	1.0	Y
Right	147.3	Y	1.1	Y
Bottom	122.7	Y	1.0	Y
Left	132.9	Y	1.0	Y
Front	137.3	Y	2.0	Y
Rear	117.1	Y	2.2	N

Accept		Reject	

Profile Instrument Data

Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9/30/13 NCR #:

Comments: FL = Front Load
Unit 880SC-TP206 A
Post Drop Test unit

Notes:

TP206(A) (s/n: D11827) – Rear Load (RL) Radiation Profile Inspection
Pre NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data			Profile Source Data	
Device s/n:	D11827RL		Source model:	424-9
Model:	~~DELTA~~ 880SC	19 NOV 13	Source s/n:	99334B
Shield Lot#:	1321000206		Isotope:	Ir-192
Shield Heat #:	C1286-D07		Source activity (Ci):	161.5
Ir-192 capacity (Ci):	150.00		Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	25 Sep 2013	Profile ID:	D11827RL 9/25/2013 11:04:36 AM
Current Activity (Ci):	134.1	Surface Correction (front/rear):	1.171
Capacity Correction:	1.118	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	125.1	Y	0.9	Y
Right	134.7	Y	1.0	Y
Bottom	140.2	Y	1.0	Y
Left	138.0	Y	0.9	Y
Front	97.9	Y	2.5	N
Rear	148.0	Y	1.9	Y

Accept ☐ Reject ☐

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319769	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: ____________ Date: 9/25/13 NCR #: ____________

Comments: RL = Rear Load
unit 880SC-TP206(A)

Notes:

TP206(A) (s/n: D11827) – Rear Load (RL) Radiation Profile Inspection

Post NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11827RL
Model:	~~DELTA~~ 880SC 19NOV13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D07
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.6
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	30 Sep 2013	Profile ID:	D11827RL 9/30/2013 11:32:26 AM
Current Activity (Ci):	128.0	Surface Correction (front/rear):	1.171
Capacity Correction:	1.172	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	124.3	Y	1.0	Y
Right	132.9	Y	1.0	Y
Bottom	136.8	Y	1.1	Y
Left	129.8	Y	1.0	Y
Front	115.4	Y	2.9	N
Rear	150.7	Y	2.3	N

Accept		Reject	

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: ______ Date: 9/30/13 NCR #: ______

Comments: RL = Rear Load
unit 880SC-TP206 A
Post Drop Test unit

Notes:

TP206(B) (s/n: D11828) – Front Load (FL) Radiation Profile Inspection

Pre NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11828FL
Model:	~~DELTA~~ 880 SC 15 Nov 13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D09
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	25 Sep 2013	Profile ID:	D11828FL 9/25/2013 12:09:27 PM
Current Activity (Ci):	134.1	Surface Correction (front/rear):	1.171
Capacity Correction:	1.118	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	145.5	Y	0.9	Y
Right	163.5	Y	1.2	Y
Bottom	149.4	Y	1.2	Y
Left	145.9	Y	1.1	Y
Front	157.4	Y	2.2	N
Rear	104.0	Y	2.4	N

Accept		Reject	

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: ______ Date: 9/25/13 NCR #: ______

Comments: FL = Front Load
unit 880SC-TP206 (B)

Notes:

TP206(B) (s/n: D11828) – Front Load (FL) Radiation Profile Inspection

Post NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1818-1

880 Device Data		Profile Source Data	
Device s/n:	D11828FL	Source model:	424-9
Model:	~~DELTA~~ 880 SC 18 NOV 13	Source s/n:	99334B
Shield Lot#:	13210000206	Isotope:	Ir-192
Shield Heat #:	C1286-D09	Source activity (Ci):	151.5
Ir-192 capacity (Ci):	150.00	Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	30 Sep 2013	Profile ID:	D11828FL 9/30/2013 12:54:33 PM
Current Activity (Ci):	128.0	Surface Correction (front/rear):	1.171
Capacity Correction:	1.172	Surface Correction (sides):	1.171

Profile Results - In mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	142.8	Y	1.0	Y
Right	156.5	Y	1.0	Y
Bottom	148.7	Y	1.2	Y
Left	148.3	Y	1.0	Y
Front	170.3	Y	1.9	Y
Rear	109.7	Y	2.1	N

Accept ☐ Reject ☐

Profile Instrument Data

Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: ____________ Date: 9/30/13 NCR #: ____________

Comments: FL = Front Load
Unit 880SC - TP206 B
Post Drop Test unit

Notes:

TP206(B) (s/n: D11828) – Rear Load (RL) Radiation Profile Inspection

Pre NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11828RL
Model:	~~DELTA~~ 880 SC 15Nov13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D09
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	25 Sep 2013	Profile ID:	D11828RL 9/25/2013 2:32:03 PM
Current Activity (Ci):	134.1	Surface Correction (front/rear):	1.171
Capacity Correction:	1.118	Surface Correction (sides):	1.171

Profile Results - In mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	138.2	Y	0.8	Y
Right	138.8	Y	1.0	Y
Bottom	163.0	Y	1.1	Y
Left	149.3	Y	1.0	Y
Front	96.0	Y	2.4	N
Rear	136.9	Y	2.0	Y

Accept		Reject	

Profile Instrument Data

Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291496	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: ______ Date: 9/25/13 NCR #: ______

Comments: RL = Rear Load
Unit 880SC-TP206 (B)

Notes:

TP206(B) (s/n: D11828) – Rear Load (RL) Radiation Profile Inspection

Post NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data		
Device s/n:	D11828RL	
Model:	~~DELTA~~ 880SC	13 NOV 13
Shield Lot#:	1321000206	
Shield Heat #:	C1286-D09	
Ir-192 capacity (Ci):	150.00	

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	30 Sep 2013	Profile ID:	D11828RL 9/30/2013 1:37:03 PM
Current Activity (Ci):	128.0	Surface Correction (front/rear):	1.171
Capacity Correction:	1.172	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	140.7	Y	0.9	Y
Right	138.6	Y	1.1	Y
Bottom	164.0	Y	1.1	Y
Left	148.9	Y	1.0	Y
Front	138.8	Y	2.0	N
Rear	136.9	Y	2.0	Y

Accept		Reject	

Profile Instrument Data					
Instrument Model:	M4612			Cal date:	2013-08-12
Instrument s/n:	291495			Cal due date:	2013-11-12
Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: ____________ Date: 9/30/13 NCR #: ____________

Comments: RL = Rear Load
unit 880SC - TP206 B
Post Drop Test unit

Notes:

TP206(C) (s/n: D11829) – Front Load (FL) Radiation Profile Inspection

Pre NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11829FL
Model:	~~DELTA~~ 880SC 19NOV 13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D11
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	25 Sep 2013	Profile ID:	D11829FL 9/25/2013 3:06:19 PM
Current Activity (Ci):	134.1	Surface Correction (front/rear):	1.171
Capacity Correction:	1.118	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	126.3	Y	0.9	Y
Right	139.9	Y	1.1	Y
Bottom	130.3	Y	1.0	Y
Left	139.4	Y	1.0	Y
Front	131.0	Y	1.9	Y
Rear	99.7	Y	1.9	Y

Accept ☐ Reject ☐

Profile Instrument Data

Instrument Model:	M4612		Cal date:	2013-08-12	
Instrument s/n:	291495		Cal due date:	2013-11-12	
Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9/25/13 NCR #:

Comments: FL = Front Load
Unit 880SC-TP206 (C)

Notes:

TP206(C) (s/n: D11829) – Front Load (FL) Radiation Profile Inspection

Post NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11829FL
Model:	~~DELTA~~ 880SC 19 NOV 13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D11
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.6
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	30 Sep 2013	Profile ID:	D11829FL 9/30/2013 2:49:48 PM
Current Activity (Ci):	128.0	Surface Correction (front/rear):	1.171
Capacity Correction:	1.172	Surface Correction (sides):	1.171

Profile Results - In mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	141.7	Y	0.9	Y
Right	141.6	Y	1.0	Y
Bottom	140.7	Y	1.0	Y
Left	139.9	Y	0.9	Y
Front	137.2	Y	2.3	N
Rear	109.7	Y	2.4	N

Accept	☐	Reject	☐

Profile Instrument Data

Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9/30/13 NCR #:

Comments: FL = Front Load
Unit 880SC - TP 206 C
Post Drop Test unit

Notes:

TP206(C) (s/n: D11829) – Rear Load (RL) Radiation Profile Inspection
Pre NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data		
Device s/n:	D11829RL	
Model:	~~DELTA~~ 880 SC	19NOV13
Shield Lot#:	1321000206	
Shield Heat #:	C1286-D11	
Ir-192 capacity (Ci):	150.00	

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	25 Sep 2013	Profile ID:	D11829RL 9/25/2013 3:37:19 PM
Current Activity (Ci):	134.1	Surface Correction (front/rear):	1.171
Capacity Correction:	1.118	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	120.9	Y	1.0	Y
Right	147.8	Y	1.1	Y
Bottom	138.1	Y	1.1	Y
Left	135.2	Y	1.1	Y
Front	89.0	Y	1.7	Y
Rear	143.4	Y	2.5	N

Accept ☐ Reject ☐

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

nspector: ______ Date: 9/25/13 NCR #: ______

Comments: FL = Front Load
unit 880SC-TP206 (C)

Notes:

TP206(C) (s/n: D11829) – Rear Load (RL) Radiation Profile Inspection

Post NCT Test Profile Results

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11829RL
Model:	~~DELTA~~ 880 SC 8 Oct 13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D11
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.6
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	30 Sep 2013	Profile ID:	D11829RL 9/30/2013 3:29:40 PM
Current Activity (Ci):	128.0	Surface Correction (front/rear):	1.171
Capacity Correction:	1.172	Surface Correction (sides):	1.171

Profile Results - in mR/hr				
	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	124.7	Y	1.1	Y
Right	155.9	Y	1.1	Y
Bottom	143.0	Y	1.2	Y
Left	139.6	Y	1.1	Y
Front	94.0	Y	2.3	N
Rear	158.5	Y	2.6	N

Accept		Reject	

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9/30/13 NCR #:

Comments: RL = Rear Load
Unit 880 SC - TP 206C
Post Drop Test Unit

Notes:

Appendix C: Test Data Worksheets

Drop & Puncture Test Equipment List

Test: Penetration 1 - NCT

Description * Mark NA when not used.	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Test Specimen, Drawing No.	880SC-TP206(A) D11827	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Penetration Bar	T10129	
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	27 Sep 13
Verified by:	Matt Potenza	27 SEP 13

Drop & Puncture Test Checklist

Test: Penetration 1 - NCT

Test Location: 40 North Drop Pad

Step	**Data**	**Measuring Instrument**
1. Record test specimen serial number: D11827	880 SC-TP206(A)	
2. Record the test specimen weight:	44.80 lbs.	E4L110566B
3. Record the ambient temperature (°C):	61.2 °F	ENG-20 (T-198776)
4. Record set-up orientation figure:	Fig. 8.5.2.1	
5. Verify set-up orientation and drop height. 40"		
6. Photograph set-up in at least two perpendicular planes. ✓		
7. Begin video recording of the test so that impact is recorded. ✓		
8. Release the test specimen. ✓		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved. ✓		
10. Record the damage to the test specimen on a separate sheet and attach. ✓		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering: MAP	Matt Potenza	27 SEP 13
Regulatory Affairs:	Michael Fuller	20 NOV 2013
Quality Assurance:	John Hieber	11 NOV 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(A) / D11827

Test: Penetration 1 - NCT

Test Date: 27 Sep 13

Test Time: 10:30 AM

Describe drop orientation and drop height:

Figure 8.5.2.1 of test plan. Target impact on lock. 40" from lock.

Describe impact (location, rotation, etc.):

Impact on lock. Source remained in locked position

Describe on-site inspection (damage, broken parts, etc.):

Damage to lock area where key is inserted

On-site test assessment:

TBD. will test to see if lock is functional

Engineering: 27 Sep 13 Regulatory: 20 Nov 2013 QA: 16 Oct 13

Describe any post-test disassembly and inspection:

Replaced lock. Key could not be inserted
Lock slide functional. Lock was replaced AFTER 1.2 meter drop.

Describe any change in source position:

No change in source position

Describe results of radiography:

N/A. Performed 1.2 meter drop prior to radiography

Completed by:

Date: 30 OCT 13

Drop & Puncture Test Equipment List

Test: Penetration 2 - NCT

Description *** Mark NA when not used.**	**Enter the Model and Serial Number**	**Attach Inspection Report or Calibration Certificate**
Test Specimen, Drawing No.	880SC-TP206(B) D11828	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Penetration Bar	T10129	
Signature	**Print Name**	**Date**
Completed by: PFR	Paul Benson	27 Sep 13
Verified by:	Matt Potenza	27 SEP 13

Drop & Puncture Test Checklist

Test: Penetration 2 - NCT

Test Location: 40 North - Drop Pad

Step	**Data**	**Measuring Instrument**
1. Record test specimen serial number:	880SC-TP206(B) D11828	
2. Record the test specimen weight:	44.85 lbs	E4L110566B
3. Record the ambient temperature (°C):	62.3°F	ENG-20 (T-198776)
4. Record set-up orientation figure:	Fig. 8.5.3.1	
5. Verify set-up orientation and drop height. 40"		
6. Photograph set-up in at least two perpendicular planes. ✓		
7. Begin video recording of the test so that impact is recorded. ✓		
8. Release the test specimen. ✓		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved. ✓		
10. Record the damage to the test specimen on a separate sheet and attach. ✓		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach. ✓		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering: MAP	Matt Potenza	27 SEP 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	John Hiebor	11 NOV 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(B) / D11828	Test: Penetration 2 - NCT
Test Date: 27 Sep 13	Test Time: 10:40 AM

Describe drop orientation and drop height:
Figure 8.5.3.1 of test plan. Target impact on the lock slide. 40" from lock slide.

Describe impact (location, rotation, etc.): Penetration bar made direct impact on the lock slide

Describe on-site inspection (damage, broken parts, etc.):
Small dent on the lock slide & shell.

On-site test assessment:
Lock slide assembly was fully functional.

Engineering: 27Sep13 Regulatory: 20 NOV 2013 QA: 16 oct 13

Describe any post-test disassembly and inspection: None

Describe any change in source position: No change in source position

Describe results of radiography:
N/A. Performed 1.2 meter drop prior to radiography

Completed by: Date: 30 OCT 13

Drop & Puncture Test Equipment List

Test: 1.2 Meter Drop 1 - NCT		
Description *** Mark NA when not used.**	**Enter the Model and Serial Number**	**Attach Inspection Report or Calibration Certificate**
Test Specimen, Drawing No.	880SC-TP206(A) D11827	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	27 Sep 13
Verified by:	Matt Potenza	07 SEP 13

Drop & Puncture Test Checklist

Test: 1.2 Meter Drop 1 - NCT

Test Location: 40 North Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number: D11827	880SC-TP206(A)	
2. Record the test specimen weight:	44.80 Lbs	EL/L110566B
3. Record the ambient temperature (°C):	63.4°F	ENG-20
4. Record set-up orientation figure:	Fig 8.6.2.1	
5. Verify set-up orientation and drop height. 4' 8"		
6. Photograph set-up in at least two perpendicular planes. ✓		
7. Begin video recording of the test so that impact is recorded. ✓		
8. Release the test specimen. ✓		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved. ✓		
10. Record the damage to the test specimen on a separate sheet and attach. ✓		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	Print Name	Date
Engineering:	Matt Potenza Paul Benson	27 SEP 13 27 Sep 13
Regulatory Affairs:	Michael Fuller	20 NOV 2013
Quality Assurance:	John [illegible]	16 ~~Sept~~ Oct 13

RA 16oct13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(A)/D11827	Test: 1.2 Meter Drop 1 - NCT
Test Date: 27 Sep 13	Test Time: 11:15 AM

Describe drop orientation and drop height:

Figure 8.6.2.1 of test Plan.
Height/weight adjusted to 4'-8"

Describe impact (location, rotation, etc.):

Direct impact on cap.

Describe on-site inspection (damage, broken parts, etc.):

Cap damaged. Spring plunger damaged.

On-site test assessment:

Other than cap & spring plunger there was no other visual damage

Engineering: 27 Sep 13 Regulatory: 20 NOV 2013 QA: 16 Oct 13

Describe any post-test disassembly and inspection:

Backed off spring plunger & cap opened. Lock slide assembly was fully functional. Replaced lock.

Describe any change in source position: No change in source position

Describe results of radiography:

See Test Plan 206 - Report #1. Section 4.4.4

Completed by:	Date: 20 NOV 13

Drop & Puncture Test Equipment List

Test: 1.2 Meter Drop 2 - NCT

Description *** Mark NA when not used.**	**Enter the Model and Serial Number**	**Attach Inspection Report or Calibration Certificate**
Test Specimen, Drawing No.	880SC-TP206(B) D11828	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		

Signature	**Print Name**	**Date**
Completed by:	Paul Benson	27 Sep 13
Verified by:	Matt Potenza	27 SEP 13

Drop & Puncture Test Checklist

Test: 1.2 Meter Drop 2 - NCT

Test Location: 40 North Drop Pad

Step	**Data**	**Measuring Instrument**
1. Record test specimen serial number: D11828	880SC-TP206(B)	
2. Record the test specimen weight:	44.85 lbs	E4L110566B
3. Record the ambient temperature (°C):	63.9°F	ENG-20 (T-198776)
4. Record set-up orientation figure:	Fig 8.6.3.1	
5. Verify set-up orientation and drop height.	4' - 8"	
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen. ✓		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved. ✓		
10. Record the damage to the test specimen on a separate sheet and attach. ✓		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering:	Matt Potenza	27 SEP 13
Regulatory Affairs:	Michael Fuller	20 NOV 2013
Quality Assurance:	Jon Hicken	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(B)/D11828	Test: 1.2 Meter Drop 2 - NCT
Test Date: 27 Sep 13	Test Time: 11:34

Describe drop orientation and drop height:
Figure 8.6.3.1 of test Plan.
Height/weight adjusted to 4'-8"

Describe impact (location, rotation, etc.):
Direct impact on Cap

Describe on-site inspection (damage, broken parts, etc.):
Cap opened. ~~Rim damaged~~ Spring plunger damaged.

On-site test assessment:
Cap can no longer be closed. Lock slide assembly fully functional

Engineering: 27 Sep 13 Regulatory: 20 NOV 2012 QA: 16 Oct 13

Describe any post-test disassembly and inspection:
None

Describe any change in source position:
No change in source location.

Describe results of radiography:
See Test Plan 206 - Report #1. Section 4.4.4

Completed by:	Date: 20 NOV 13

Drop & Puncture Test Equipment List

Test: 1.2 Meter Drop 3 - NCT

Description *** Mark NA when not used.**	**Enter the Model and Serial Number**	**Attach Inspection Report or Calibration Certificate**
Test Specimen, Drawing No.	880SC-TP206(C) D11829	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
15° Angle Fixture	T10835	

Signature	**Print Name**	**Date**
Completed by:	Paul Benson	27 Sep 13
Verified by:	Matt Potenza	27 SEP 13

Drop & Puncture Test Checklist

Test: 1.2 Meter Drop 3 - NCT

Test Location: 40 North - Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number: D11829	880SC-TP206(c)	
2. Record the test specimen weight:	44.80 lbs	E4L110566B
3. Record the ambient temperature (°C):	63.5°F	ENG-20 (T-198776)
4. Record set-up orientation figure:	Fig 8.6.4.1	
5. Verify set-up orientation and drop height. ~~1.2 M~~ 4' 8"		
6. Photograph set-up in at least two perpendicular planes. ✓		
7. Begin video recording of the test so that impact is recorded. ✓		
8. Release the test specimen. ✓		
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved. ✓		
10. Record the damage to the test specimen on a separate sheet and attach. ✓		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	Print Name	Date
Engineering:	Matt Potenza	27 SEP 13
Regulatory Affairs:	Michael Fuller	20 NOV 2013
Quality Assurance:	John Hieber	11 NOV 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: D11829

Test: 1.2 meter Drop 3 - NCT

Test Date: 27 Sep 13

Test Time: 12:30

Describe drop orientation and drop height:
Figure 8.6.4.1 of test plan. "Slap down".
1.2 meter drop. adjusted to 4' 8" for weight

Describe impact (location, rotation, etc.):
Impact on left side of shell. Shell bent slightly. on impact. Right side shell also bent slightly.

Describe on-site inspection (damage, broken parts, etc.):
No visual damage other than shell.

On-site test assessment:
Minor damage to shell.
Lock slide operational

Engineering: 27 Sep 13 Regulatory: 20 NOV 2013 QA: 16 Oct 13

Describe any post-test disassembly and inspection:
Very minor damage to spring plunger.
Still operational. Lock slide operational

Describe any change in source position: No change in source position

Describe results of radiography:
See Test Plan 206 - Report #. Section 4.4.4

Completed by:

Date: 20 Nov 13

2.12.17 Test Plan 206 Report #2 minus Appendices D & E (Nov 2013)

QSA GLOBAL	Document Number **F-E-1808-2** **Test Report Cover Sheet**	Revision 0

TEST REPORT #2
FOR TEST PLAN 206

Model 880SC Transport Package

Hypothetical Accident Conditions (HAC) Transport Test Results

Revision: 0

Originator		Date: 22 OCT 13

APPROVALS		
Engineering	S. Gemini	Date: 23 OCT 2013
Regulatory		Date: 21 NOV 2013
Quality Assurance		Date: 21 Nov 2013

TEST PLAN 206 – REPORT #2

MODEL 880SC TRANSPORT PACKAGE

HYPOTHETICAL ACCIDENT CONDITIONS (HAC) TRANSPORT TEST RESULTS

As of

October, 2013

Contents

Test Plan No. 206

Section 1 Introduction

This report documents the hypothetical accident conditions (HAC) test results of Test Plan 206 performed on the Model 880SC transport package. The results confirm the Model 880SC transport package, identified in Section 2 passes all the hypothetical accident conditions transport test requirements specified in Test Plan 206, the Code of Federal Regulations, 10 CFR Part 71, revised as of January 26, 2004 and criteria stated in the IAEA Regulations for the Safe Transport of Radioactive Material, No. TS-R-1 1996 Edition (as amended 2003).

In order to determine the cumulative effect on the Model 880SC transport package, the HAC test evaluation is based on the sequential application of the tests specified in the order indicated in 10 CFR Part 71. Alternatively, if the test sequence had been performed in reverse order to the sequence identified in 10 CFR Part 71, with the Puncture test performed before the 30-foot free drop, an assessment is included to evaluate the effect the reverse order tests would have on the HAC test results. See section *5.3* for the reverse order assessment.

The thermal test portion of the HAC test sequence is not performed based on the condition of the test specimens after the 30-foot free drop and Puncture tests. See section *5.4* for this assessment.

The following is the pass criteria for a Type B(U) transport package after being subjected to the HAC test sequence:

- There shall be no loss or dispersal of radioactive material from the package.
- There shall be no external radiation dose rate exceeding 10-mSv/h (1-rem/h) at 1 m (40 in) from the external surface of the package.

The following HAC tests were not covered in the test plan and therefore not conducted.

- The ***crush test*** was not performed because is not required since the Model 880SC transport package weighs 52 lbs which is less than the 1100 lbs. minimum weight limit for the test.
- The ***immersion – fissile material test*** is not required since the Model 880SC package does not transport fissile material.
- The ***immersion – all packages test*** was not performed and is instead assessed since the materials of construction used in the Model 880SC transport package are impervious to water and are not structurally affected when immersed in water of at least 15 meters (50 feet).

Section 2 Construction and Condition of Test Specimens

2.1 Test Specimen Construction

The test specimens were constructed in accordance with QSA Global engineering drawings and Quality Assurance Program. The drawings and manufacturing documents accurately depict the intended design at the time of testing along with methods for building and verifying the finished product. There were no deviations and/or changes to the test specimen before testing.

The four test specimens built for this test are the Model 880SC. **Figures 2.1** and **2.2** shows test specimens, specimen numbers are TP206(A) through TP206(D). TP206(D) was assembled as a spare. This unit was not required for the HAC testing. Shipping labels and nameplates were not attached for testing.

Figures 2.1 and **2.2** shows the major assemblies and common components of the Model 880SC transport package. The nomenclature used in **Figures 2.1** and **2.2** are referenced throughout this report.

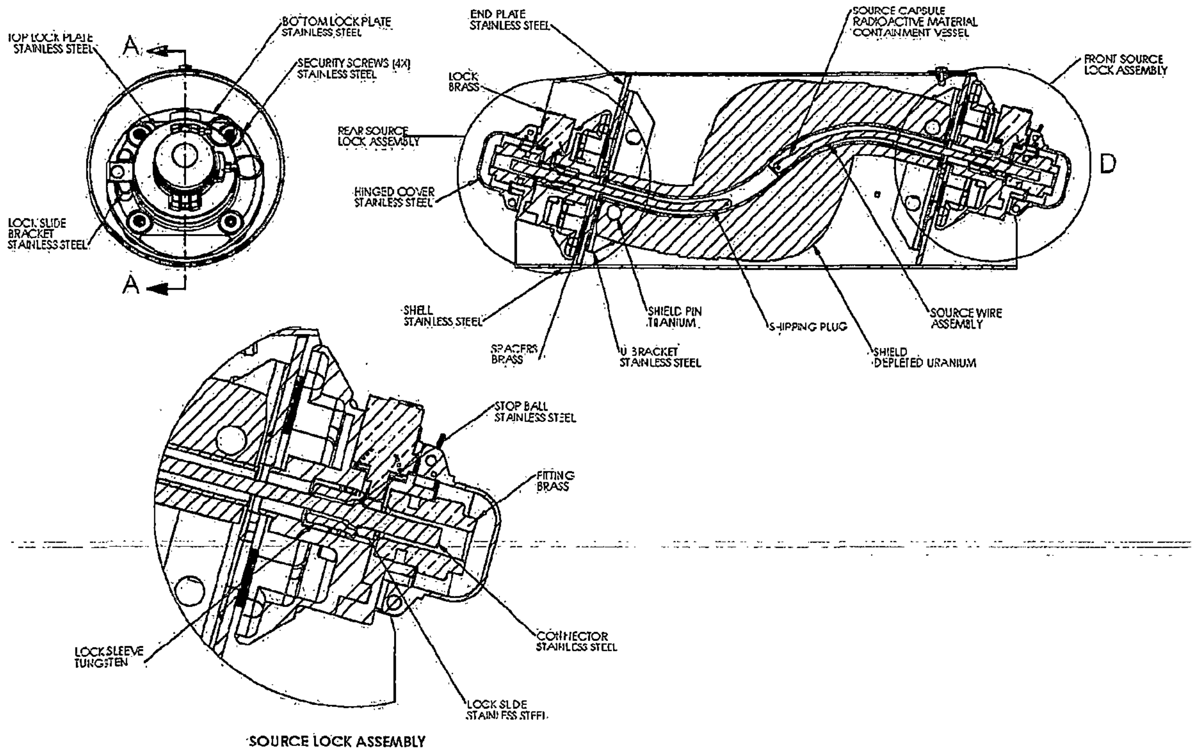


FIGURE 2.1: MODEL 880SC SOURCE CHANGER TRANSPORT PACKAGE
(without optional Jacket)

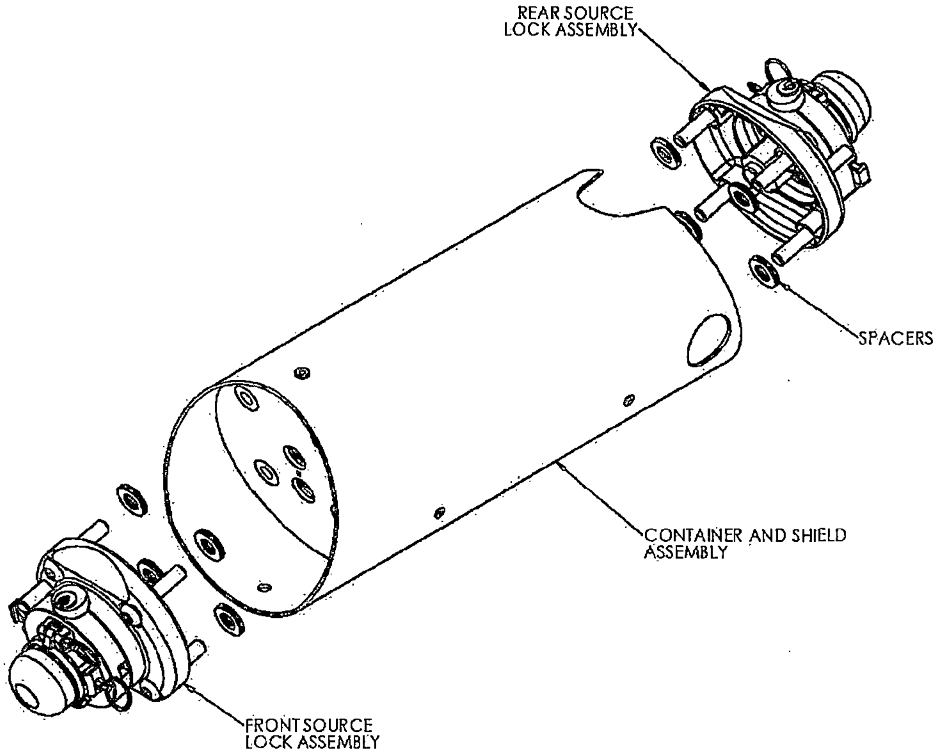


FIGURE 2.2: MODEL 880SC SOURCE CHANGER SCHEMATIC
(without optional Jacket)

The primary containment system of the package is the completely seal welded source capsule assembly. The secondary containment system, the transport package source lock assemblies and shield assembly, are open to the atmosphere and therefore in constant equilibrium with changing operating pressures.

The structural materials used in the construction of the Model 880SC transport package retain their key mechanical and physical properties between -40°C (-40°F) and +38°C (+100°F). Therefore, the temperature of the test specimens did not need to be adjusted for the tests performed in test plan 206.

2.2 Test Specimen Modification

The test specimens used for the HAC were first subject to the NCT testing. Test Plan 206 - Report #1 describes damage that was caused during the testing. The penetration test on TP206(A) caused damage to the lock, specifically the key hole. This Lock was replaced prior to HAC testing.

Section 3 Failure Modes and Test Orientations

3.1 Test Failure Modes

Each of the test orientations (Tables 3.2.1 and 3.2.2) targets a specific area on the package in an attempt to damage the package enough to cause an elevation in radiation measurements. The possible failures considered under the required test conditions potentially leading to elevated radiation measurements on and around the transport package include the following:

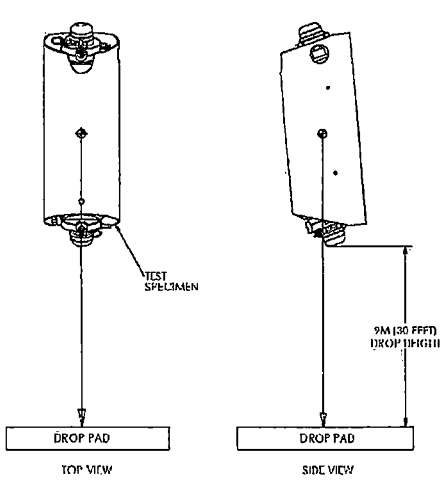
1. Fracture of the shield allowing a direct beam of radiation to transmit to the exterior of the package.
2. Extreme displacement of the shield within the package enough to position the source in a much less shielded location.
3. Any release or loss of control of the source from its shielded position within the package.

3.2 Test Orientations

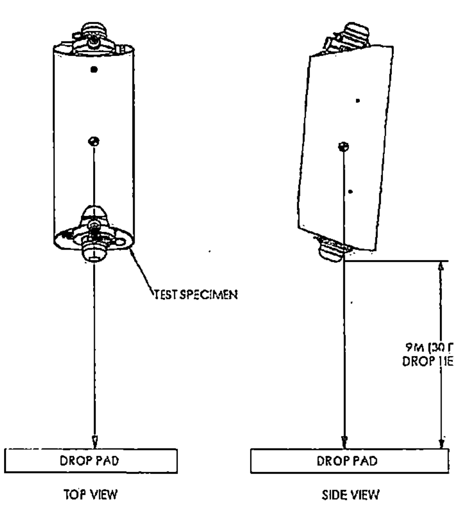
Table 3.2.1 shows the planned test orientation used for each test specimen in the 30-foot free drop test. These orientations attempt to exploit the failure modes discussed in section 3.1.

Table 3.2.2 shows the planned test orientation used for each test specimen in the Puncture drop test. These orientations attempt to exploit the failure modes discussed in section 3.1.

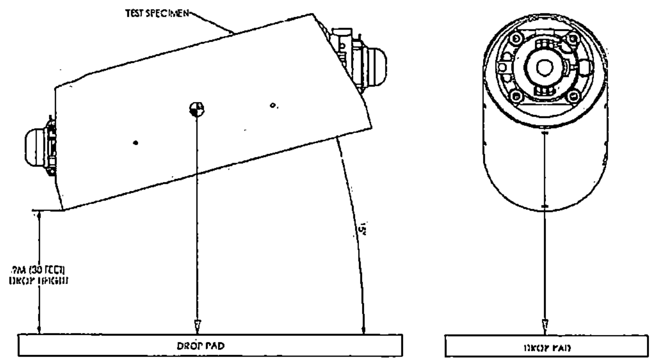
Table 3.2.1: 30-Foot (9 Meter) Free Drop Test Orientation Review



Test Specimen: TP206(A)
Front Surface Drop

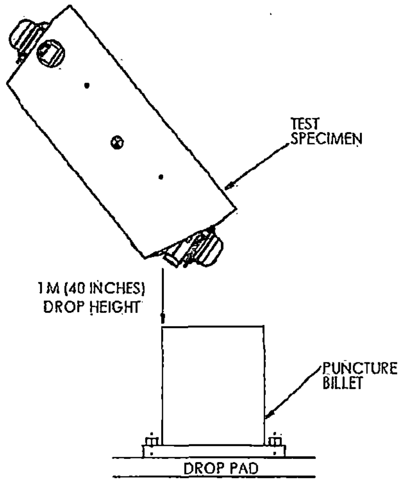


Test Specimen: TP206(B)
Rear Surface Drop

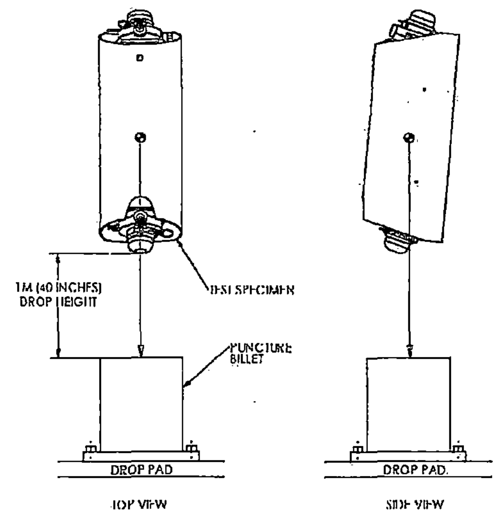


Test Specimen: TP206(C)
Shallow Angle Drop

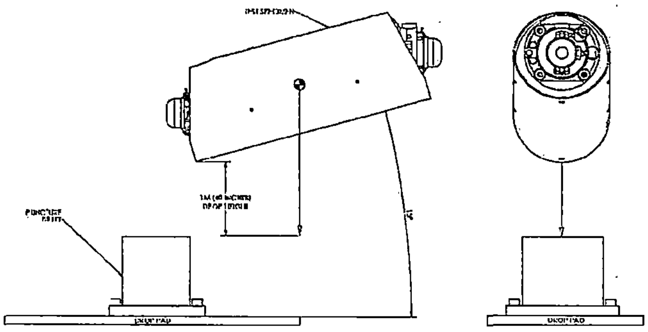
Table 3.2.2: Puncture Drop Test Orientation Review



Test Specimen: TP206(A)
Front Surface Puncture Drop



Test Specimen: TP206(B)
Rear Surface Puncture Drop



Test Specimen: TP206(C)
Shallow Angle Puncture Drop

3.3 Free Drop Height Adjustment

The drop test heights specified in 10 CFR Part 71 are adjusted higher in all the 30-foot (9 Meter) drop and 40-inch (1 Meter) Puncture tests. The adjusted drop height allows for future Model 880SC transport packages built heavier than the actual test specimens specifically for the additional weight of the jacket, but less than the maximum allowable weight specified for the transport package configuration to comply with 10 CFR Part 71.

The adjusted drop height is calculated for both the 30-foot (9 Meter) drop and 40-inch (1 Meter) Puncture tests. The adjusted drop height is determined by multiplying the worst case weight ratio by the required drop test height, 30 feet or 40 inches. The worst case weight ratio is calculated by dividing the maximum allowable weight by the actual test specimen weight. The actual weight is significantly lower given the absence of the jacket.

The maximum allowable transport package weight in the Model 880SC is 52 lbs. Table 3.3.1 shows the adjusted height for each specimen for the 30-foot (9 Meter) drop. Table 3.3.2 shows the adjusted height for each specimen for the 40-inch (1 Meter) Puncture drop.

The impact energy produced by the adjusted height in all drop tests is equal to or greater than the impact energy produced by the transport package built to its maximum weight and dropped at the required drop height specified in 10 CFR Part 71.

Table 3.3.1 Test Specimen 30-Foot (9 Meter) Free Drop Height Adjustment

Test Specimen	**Actual Test Specimen Weight (Lbs)**	**Maximum Transport Package Weight (Lbs)**	**30-Foot (9 Meter) Adjusted Height**		
			(Meters)	**(Feet)**	**(Feet - Inches)**
TP206(A)	44.80	52	10.6	34.82	34' 10"
TP206(B)	44.85	52	10.6	34.82	34' 10"
TP206(C)	44.80	52	10.6	34.82	34' 10"

Table 3.3.2 Test Specimen 40-inch (1 Meter) Puncture Drop Height Adjustment

Test Specimen	**Actual Test Specimen Weight (Lbs)**	**Maximum Transport Package Weight (Lbs)**	**40-inch (1 Meter) Adjusted Height**		
			(Meters)	**(Feet)**	**(Inches)**
TP206(A)	44.80	52	1.18	3.875	46.5
TP206(B)	44.85	52	1.18	3.875	46.5
TP206(C)	44.80	52	1.18	3.875	46.5

Section 4 Test Results

4.1 Test Specimen TP206(A) Test Results

For the 30-Foot (9 Meter) test, Specimen TP206(A) was dropped from 34 feet 10 inches while oriented in its near vertical position (along the center of gravity) and with the front source lock assembly facing down toward the location of impact. The source assembly was loaded in the front source lock assembly and the shipping plug was in the rear source lock assembly. TP206(A) rotated slightly during the drop but hit the drop plate on the upper part of the source lock assembly. This impact created a shearing action on the top two bolts of the source lock assembly.

Examination of the test specimen just after the 30-Foot drop showed the top two screws of the lock source assembly had sheared off. The bottom two screws were intact. The top of the source lock assembly moved away slightly from the end plate by approximately .125". The bottom of the source lock assembly was in contact with the end plate. The end plate was slightly bent but fully intact. The source remained locked and secure. There was damage to the cap and lock. The cap was in the open position.

For the Puncture drop, test specimen TP206(A) orientation was changed from Test Plan 206. Since the top two screws were sheared / broken off during the 30-Foot drop the orientation was changed in an attempt to completely shear off the source lock assembly or try to dislodge or shear off the remaining two screws. The specimen was dropped from 46.5 inches above the puncture bar onto the side front lock source assembly. The specimen impacted per revised plan.

No additional damage was evident. The source remained locked and secure. Due to the angle of the drop the cap closed during impact.

During the post-test examination it was determined the lock needed to be replaced. The lock had sustained damage during the 30 foot drop and the key could not be inserted. To replace the lock the entire source lock assembly needed to be removed from the front plate. The "gap" created by the missing top two screws were measured prior to dis-assembly. Once the lock was replaced the source lock assembly was fully functional. The source lock assembly was then installed back onto the end plate using the original two bottom screws. These screws were bent but functional. The "gap" between the source lock assembly and the end plate was then measured to assure it was the same as prior to dis-assembly. The cap was "jammed" in the closed position and needed to be pried open.

Two sets of radiation profiles were taken on the package after testing. One with the source loaded in the front of the Model 880SC and one with the source loaded in the rear of the Model 880SC. Both inspections show dose levels were well below the limit of 1 R/hr at a meter from the surface of the package. See Table 5.2.1 for radiation profile data.

Table 4.1.1: 30-Foot (9 Meter) Drop Test Setup – TP206(A)	
Changes to the planned drop orientation.	None
Test Specimen Weight	44.80 pounds
Actual Drop Height	34 Feet 10 inches (10.62 Meters)
Temperature during test	68.9°F (20.5°C)
	
Figure 4.1.1.1: 30-Foot Drop – TP206(A) Orientation View #1	**Figure 4.1.1.2: 30-Foot Drop – TP206(A) Orientation View #2**

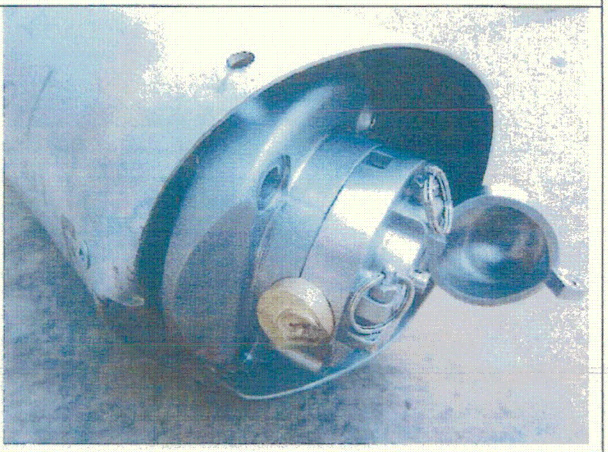
Table 4.1.2: 30-Foot Drop Test Damage Report – TP206(A)	
- Top 2 bolts were missing - Minor damage to cap - Cap was open - Damage to top of lock	
	
Figure 4.1.2.1: TP206(A) immediately after 30-Foot Drop Test.	**Figure 4.1.2.2: Close-up view of TP206(A) after 30-Foot Drop Test.**

Table 4.1.3: Puncture Drop Test Setup – TP206(A)	
Changes to the planned drop orientation.	Adjustment to angle. Trying to shear of the entire source lock assembly.
Test Specimen Weight	44.80 pounds
Actual Drop Height	46.5 Inches (1.18 Meters)
Temperature during test	77.5°F (25.3°C)

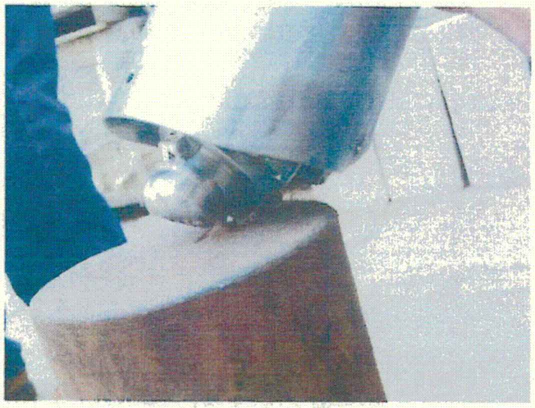



Figure 4.1.3.1: Puncture Drop – TP206(A) Orientation View #1 – Setting Angle	**Figure 4.1.3.2: Puncture Drop – TP206(A) Orientation View #2**

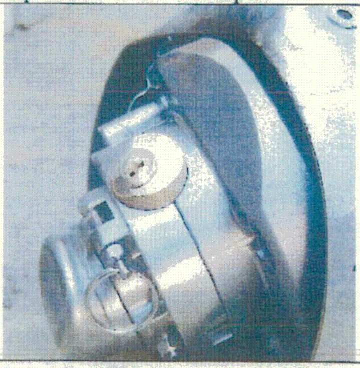
Table 4.1.4: Puncture Drop Test Damage Report – TP206(A)	
• There appeared to be no additional movement / displacement of the source lock assembly • There was minor additional damage to the lock and cap at the area of impact.	
	
Figure 4.1.4.1: TP206(A) immediately after the Puncture drop test.	**Figure 4.1.4.2: TP206(A) immediately after the Puncture drop test – close up.**

Table 4.1.5: Post Test Examination Photos – TP206(A)	

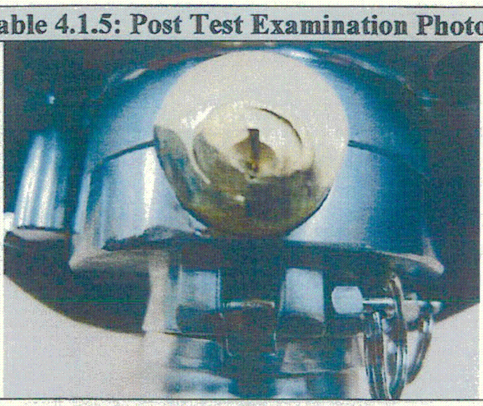
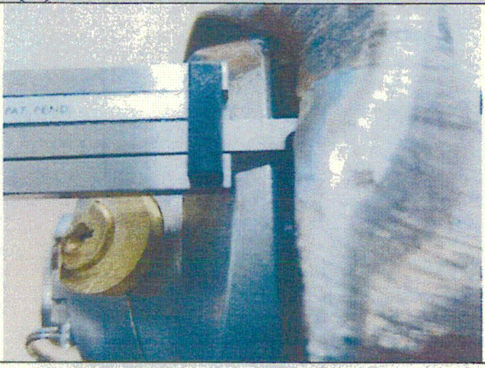

	

Figure 4.1.5.1: Close-Up	**Figure 4.1.5.2: Measuring distance from end plate to source lock assembly**

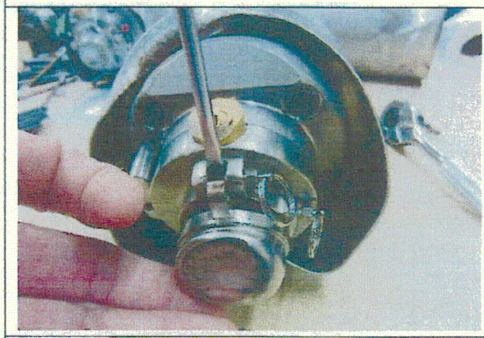
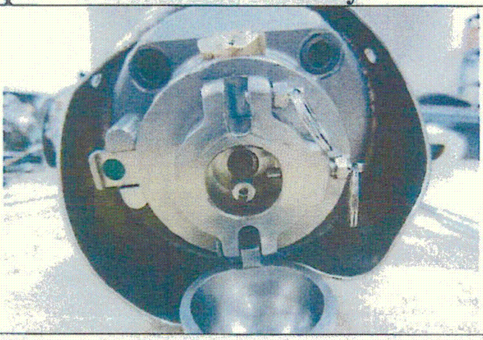

	

Figure 4.1.5.3: Opening cap.	**Figure 4.1.5.4: Source in locked and secured position.**

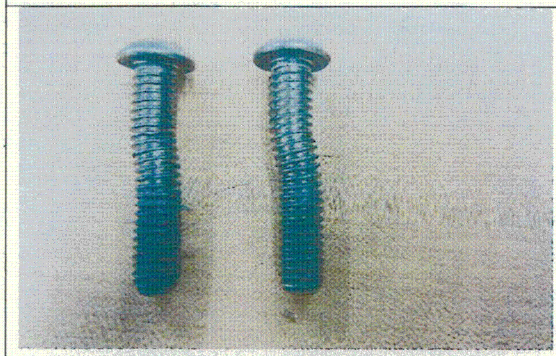
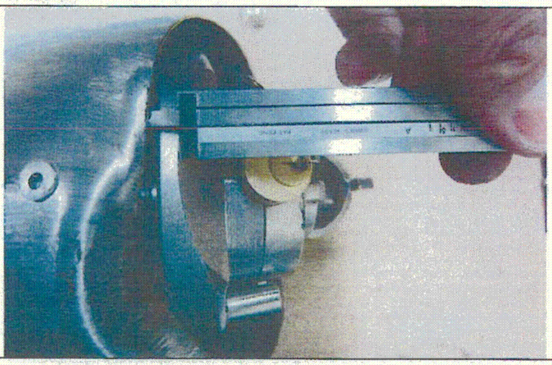

	

Figure 4.1.5.5: Bent "bottom" screws.	**Figure 4.1.5.6: Re-assembled unit with new lock.**

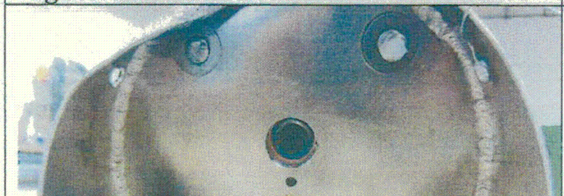



Figure 4.1.5.7: Shell bent but intact.	

4.2 Test Specimen TP206(B) Test Results

For the 30-Foot (9 Meter) test, Specimen TP206(B) was dropped from 34 feet 10 inches while oriented in its near vertical position (along the center of gravity) and with the rear source lock assembly facing down toward the location of impact. The source assembly was loaded in the rear source lock assembly and the shipping plug was in the front source lock assembly. The cap had sustained damage during the Normal Conditions of Transport Test (see Test Plan Report #1) and therefore the cap remained open during this test. TP206(B) did not rotate during the drop and impacted per plan.

Examination of the test specimen just after the 30-Foot drop showed there was only minor additional damage to the shell and cap. The cap remained attached to the assembly. The source remained locked and secure.

For the Puncture drop, test specimen TP206(B) orientation was not changed from Test Plan 206. The specimen was dropped from 46.5 inches above the puncture bar onto the rear lock source assembly. TP206(B) impacted per plan. The cap remained open for this drop.

Examination of the test specimen just after the Puncture drop showed the cap had broken off. The bottom lock plate also appeared to be slightly bent. The source remained locked and secure.

During the post-test examination the source was secure and in the locked position but the lock slide assembly could not be opened. Due to the damage to the bottom lock plate the lock slide would not move. Upon further inspection it was discovered that the lock slide was binding on the lock slide bracket. The lock slide bracket was removed and the lock slide assembly was fully functional.

Two sets of radiation profiles were taken on the package after testing. One with the source loaded in the front of the Model 880SC and one with the source loaded in the rear of the Model 880SC. Both inspections show dose levels were well below the limit of 1 R/hr at a meter from the surface of the package. See Table 5.2.1 for radiation profile data.

Table 4.2.1: 30-Foot (9 Meter) Drop Test Setup – TP206(B)

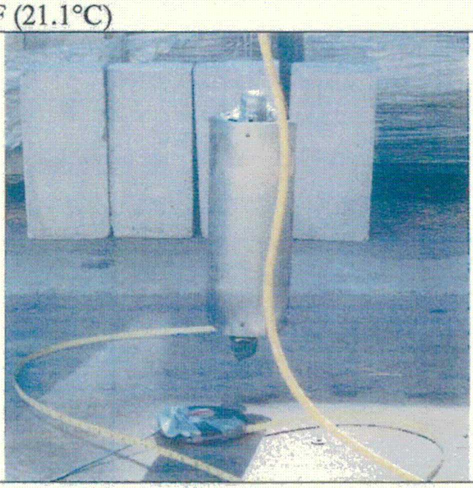
Changes to the planned drop orientation.	None
Test Specimen Weight	44.85 pounds
Actual Drop Height	34 Feet 10 inches (10.62 Meters)
Temperature during test	70°F (21.1°C)
	
Figure 4.2.1.1: 30-Foot Drop – TP206(B) Orientation View #1	**Figure 4.2.1.2: 30-Foot Drop – TP206(B) Orientation View #2**

Table 4.2.2: 30-Foot Drop Test Damage Report – TP206(B)

Minor damage to Shell. Cap remained attached.	
	
Figure 4.2.2.1: TP206(B) immediately after 30-Foot Drop Test.	**Figure 4.2.2.2: Close-up view of TP206(B) after 30-Foot Drop Test.**

Table 4.2.3: Puncture Drop Test Setup – TP206(B)	
Changes to the planned drop orientation.	None
Test Specimen Weight	44.85 pounds
Actual Drop Height	46.5 Inches (1.18 Meters)
Temperature during test	77.2°F (25.1°C)
	
Figure 4.2.3.1: Puncture Drop – TP206(B) Orientation View #1	**Figure 4.2.3.2: Puncture Drop – TP206(B) Orientation View #2**

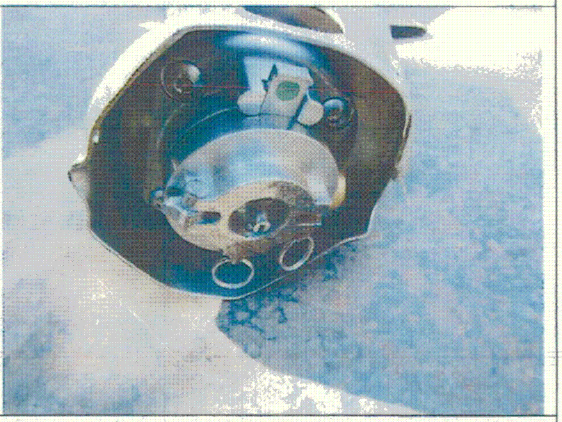
Table 4.2.4: Puncture Drop Test Damage Report – TP206(B)	
• Cap broke off. • Bottom lock plate was slightly bent • Minor damage to shell.	
	
Figure 4.2.4.1: TP206(B) immediately after the Puncture drop test.	**Figure 4.2.4.2: TP206(B) immediately after the Puncture drop test – close up.**

Table 4.2.5: Post Test Examination Photos – TP206(B)	

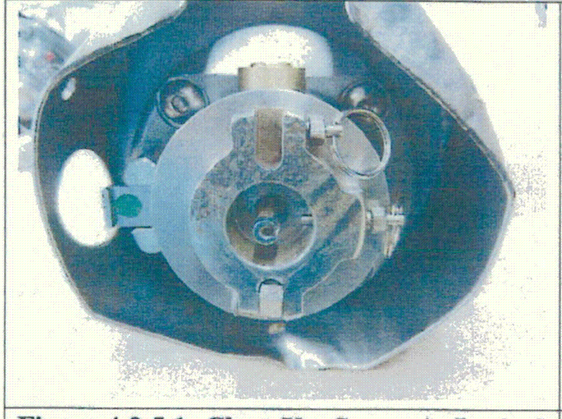
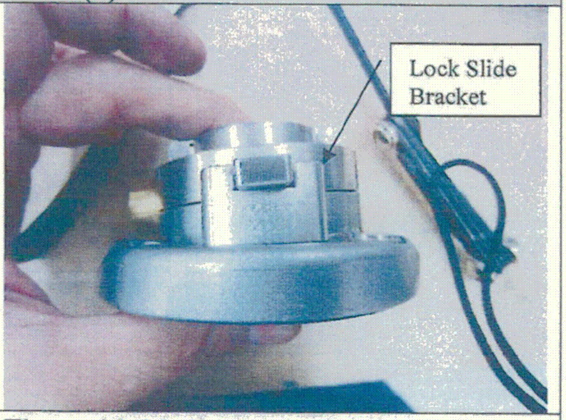

	

Figure 4.2.5.1: Close-Up. Source in Locked and secured position.	**Figure 4.2.5.2: Damage to bottom lock plate.**

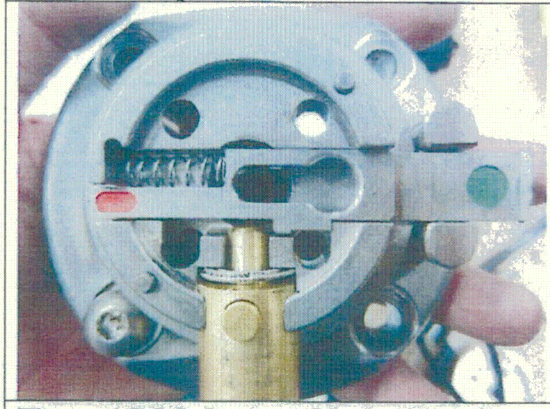
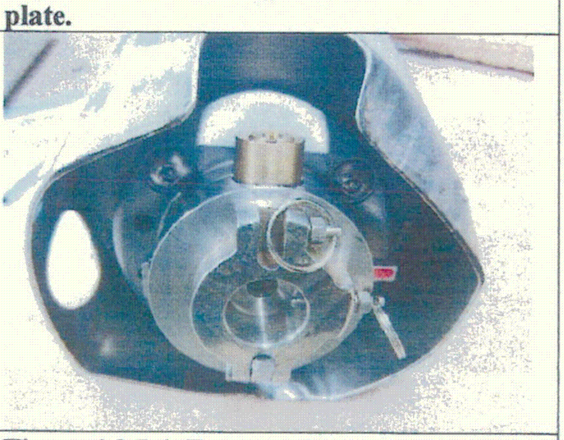

	

Figure 4.2.5.3: Lock and lock slide still operational.	**Figure 4.2.5.4: Re-assembled with lock slide bracket removed.**

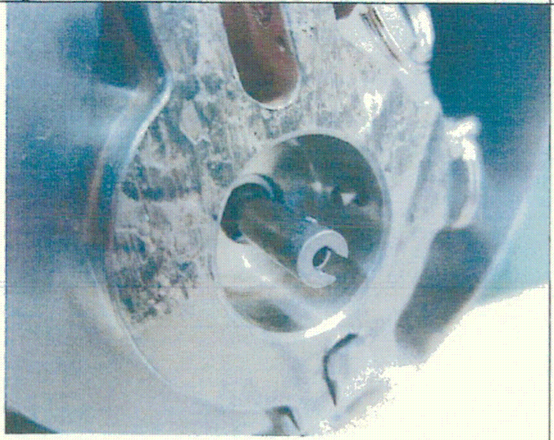



Figure 4.2.5.5: Close up of connector – no damage.	

4.3 Test Specimen TP206(C) Test Results

For the 30-Foot (9 Meter) test, Specimen TP206(C) was dropped from 34 feet 10 inches while oriented in the "slap down, 15° orientation. TP206(C) did not rotate during the drop and impacted per plan. The source assembly was loaded in the front source lock assembly and the shipping plug was in the rear source lock assembly.

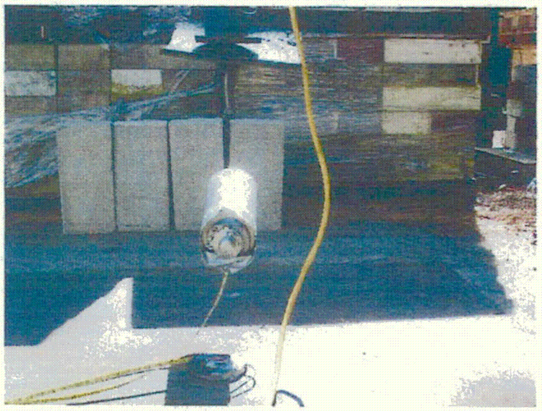
Examination of the test specimen just after the 30-Foot drop showed there was only minor additional damage to the shell and rear cap. The rear cap opened but remained attached to the assembly. The source remained locked and secure.

For the Puncture drop, test specimen TP206(C) the orientation was not changed from Test Plan 206. The specimen was dropped from 46.5 inches above the puncture bar onto the bottom side of the rear source lock assembly. TP206(C) impacted per plan.

Examination of the test specimen just after the Puncture drop showed minor damage to the rear cap. The rear cap was bent but remained attached to the assembly. The front source lock assembly Cap was damaged but remained attached.

During the post-test examination the source was secure and in the locked position. Both source lock assemblies were functional.

Two sets of radiation profiles were taken on the package after testing. One with the source loaded in the front of the Model 880SC and one with the source loaded in the rear of the Model 880SC. Both inspections show dose levels were well below the limit of 1 R/hr at a meter from the surface of the package. See Table 5.2.1 for radiation profile data.

<table>
<tr><th colspan="2">Table 4.3.1: 30-Foot (9 Meter) Drop Test Setup – TP206(C)</th></tr>
<tr><td>Changes to the planned drop orientation.</td><td>None</td></tr>
<tr><td>Test Specimen Weight</td><td>44.80 pounds</td></tr>
<tr><td>Actual Drop Height</td><td>34 Feet 10 inches (10.62 Meters)</td></tr>
<tr><td>Temperature during test</td><td>71.4°F (21.9°C)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Figure 4.3.1.1: 30-Foot Drop – TP206(C) Orientation View #1</td><td>Figure 4.3.1.2: 30-Foot Drop – TP206(C) Orientation View #2</td></tr>
</table>

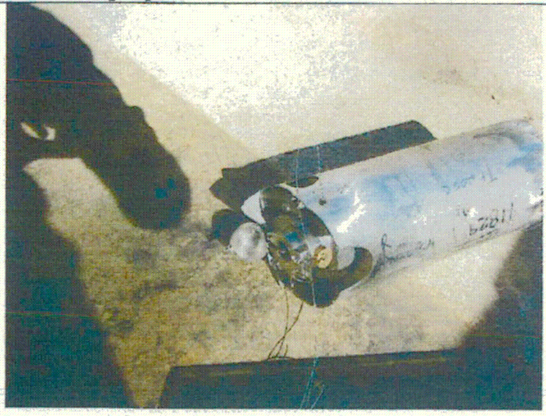
<table>
<tr><th colspan="2">Table 4.3.2: 30-Foot Drop Test Damage Report – TP206(C)</th></tr>
<tr><td colspan="2">Minor damage to shell.
Cap opened but remained attached.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Figure 4.3.2.1: TP206(C) immediately after 30-Foot Drop Test. Rear view.</td><td>Figure 4.3.2.2: TP206(C) after 30-Foot Drop Test. Front view.</td></tr>
</table>

Table 4.3.3: Puncture Drop Test Setup – TP206(C)

Changes to the planned drop orientation.	None
Test Specimen Weight	44.80 pounds
Actual Drop Height	46.5 Inches (1.18 Meters)
Temperature during test	77.4°F (25.2°C)
	
Figure 4.3.3.1: Puncture Drop – TP206(C) Orientation View #1	**Figure 4.3.3.2: Puncture Drop – TP206(C) Orientation View #2**

Table 4.3.4: Puncture Drop Test Damage Report – TP206(C)

- Cap opened and slightly damaged.
- Visible signs of impact but no major damage.
- Minor damage to shell.
- Opposite cap was crushed.

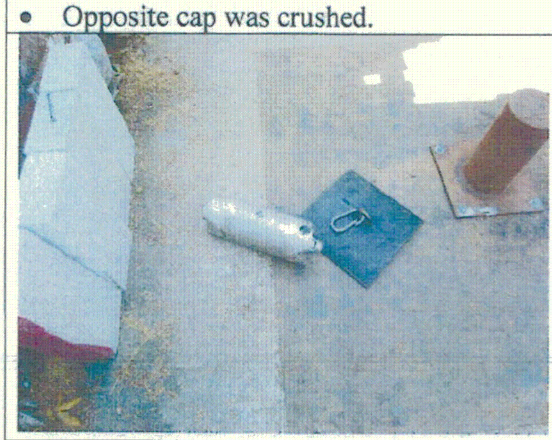
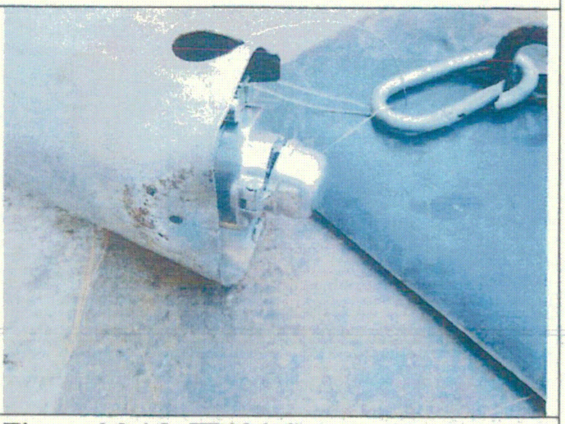
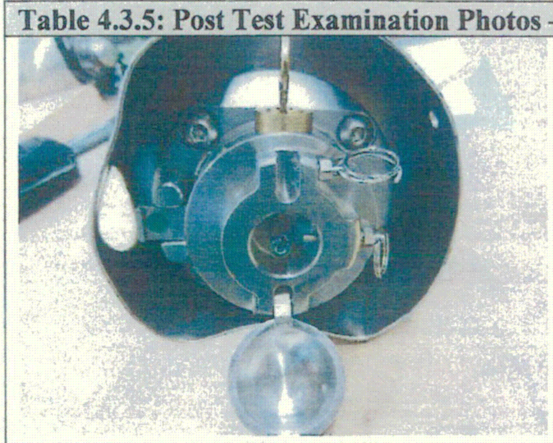
	

Figure 4.3.4.1: TP206(C) immediately after the Puncture drop test.	**Figure 4.3.4.2: TP206(C) immediately after the Puncture drop test – close up.**

<table>
<tr><th colspan="2">Table 4.3.5: Post Test Examination Photos – TP206(C)</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Figure 4.3.5.1: Close-Up. Source in locked and secured position.</td><td>Figure 4.3.5.2: Damage to opposite end - cap.</td></tr>
</table>

Section 5 Test Assessments

5.1 30-Foot Free Drop & Puncture Test Assessment

All 30-foot free drop and Puncture tests were performed in accordance with test plan 206, 10 CFR 71, IAEA TS-R-1.

Based on the condition and position of the post Puncture test specimens, and their contents, the Model 880SC specimens tested will pass the thermal test. All Model 880SC components deemed important to safety are constructed with materials that will retain their structural integrity when exposed to temperatures at 800C for an hour.

The Model 880SC transport package satisfies the HAC test requirements of Test Plan 206, the Code of Federal Regulations, 10 CFR Part 71 and criteria stated in the IAEA Regulations for the Safe Transport of Radioactive Material, No. TS-R-1.

After the 30-foot free drop and Puncture tests, all test specimens continued to successfully meet the hypothetical accident conditions transport requirements of 10 CFR 71 and IAEA TS-R-1. After the test, there was:

- No loss or dispersal of radioactive material or contents.
- No external radiation dose rate exceeding 10-mSv/h (1-rem/h) at 1 m (40 in) from the external surface of the package.
- No escape of other radioactive material exceeding a total amount A_2 in 1 week.

5.2 Radiation Profile Inspection

Tables 5.2.1 shows the one-meter radiation profile measurements taken on the three test specimen (TP206(A) thru TP206(C)). All measurements are factored for a maximum package capacity of 150 curies of Iridium-192. All units were tested with source model A424-9 / source serial number 99334B. Each unit was tested first with the source in the "Front" position and then in the "Rear" position. The opposing end was loaded with the shipping plug.

Table 5.2.1 Maximum 1-Meter Radiation				
	Front Load		**Rear Load**	
	Dose mR/hr	**Location**	**Dose mR/hr**	**Location**
TP206(A)	1.1	Top	0.9	Top
	1.1	Right	1.1	Right
	1.0	Bottom	1.1	Bottom
	1.1	Left	1.0	Left
	2.0	Front	1.5	Front
	1.6	Rear	2.3	Rear
TP206(B)	1.0	Top	1.1	Top
	1.1	Right	1.1	Right
	1.2	Bottom	1.1	Bottom
	1.0	Left	1.0	Left
	1.6	Front	1.2	Front
	2.0	Rear	2.6	Rear
TP206(C)	0.9	Top	1.1	Top
	1.2	Right	1.1	Right
	1.2	Bottom	0.9	Bottom
	1.1	Left	1.0	Left
	1.3	Front	1.3	Front
	2.0	Rear	1.8	Rear

5.3 Reverse Sequence 30-Foot Free Drop & Puncture Assessment

If we were to reverse the test sequence and perform the Puncture test before the 30-foot free drop, the Model 880SC transport package would continue to meet the HAC requirements of 10 CFR Part 71. The test results indicate there is no evidence the puncture billet is capable of affecting the source security of the package. It has been shown that the cap and the bottom lock plate absorb the majority of the impact with little or no effect to the source lock assembly operation and specifically the locking of the source.

This allows the Model 880SC transport package to successfully meet the hypothetical accident conditions transport test requirements of IAEA TS-R-1.

5.4 Thermal Test Assessment

Review of the damage to all test specimens after the drop tests suggest the fire test would have no effect on the radiation measurements taken after the drop tests. The reasons for this can be justified based on the condition of the test specimen after the drop tests and the properties of the materials used to secure and shield the source within the specimen. See 5.4.2 for further assessment for TP206(A) .

5.4.1 Condition of Test Specimens before Thermal Test

- The internal structure for supporting the shield is intact and fully functional.
- The source assembly is intact, undamaged and secure in the shielded position.
- The source lock assembly continues to secure the source assemblies to the package in their shielded position.

5.4.2 Additional Thermal Analysis for 880SC-TP206(A)

Significant oxidation of the depleted uranium does not occur if there is insufficient flow of oxygen available to the shield. Two major contribution factors to limiting this oxidation are the oxygen inhibitive nature of charred polyurethane foam and the packages' ability to contain the foam once charred. This has been demonstrated by thermal testing conducted by QSA Global Inc. in support of previous Type B package submissions described in the following paragraphs.

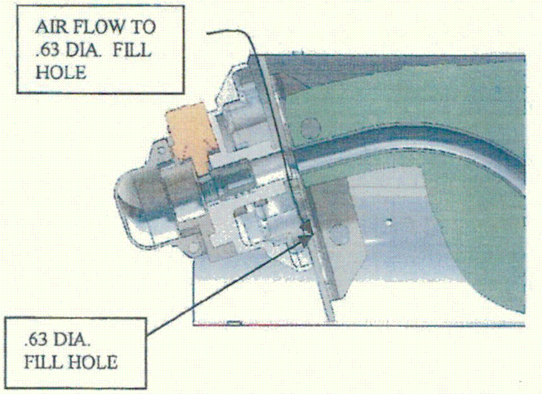
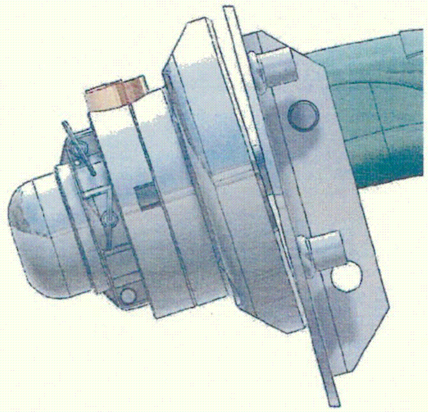
Under Test Plan 74 (Section 2.12), the Model 660 Series, Specimen D was tested successfully through normal and accidental conditions. Before thermal testing, the unit showed gaps in the outer containment (shell to endplate interface) up to ½ wide and 1 inch long (.5 in²). Pyrolized foam was contained within the unit. Although the shield oxidized slightly on the end nearest the largest gap, the unit passed final profile at 0.0047 R/hr at one meter.

Under Test Plan 72-S2 (Section 2.12), in support of Certificate of Compliance number USA/9035/B(U) for the Model 680-OP Series, camera s/n B198 was subjected to thermal testing. Before testing, the unit was intact and essentially undamaged with no gaps between mating surfaces. After the 30 foot and puncture drop tests, ¾ inch long by 1/16 in wide gaps were present on both sides of the unit at the side plate / shell interface. Thermocouple readings showed temperatures of up to 1000°C on the unit and over 900°C within the depleted uranium shield. The foam was completely pyrolized but was contained within the unit. No oxidation of the shield occurred and the unit passed final profile at 0.330 R/hr at 1 meter.

Under Test Plan 80 Report (Section 2.12), in support of Certificate of Compliance number USA/9269/B(U) for the Model 650L, test specimen TP80(B) was subject to thermal testing. The drop test (30 foot and Puncture) caused the outer shell to split completely open and the inner shell to crack, creating a 3 inch long by ½ inch wide gap (1.5 in²). Subsequent thermal testing caused pyrolization of all the foam and vaporization in the area of the gap. Some minor oxidation of the shield was also noted. Thermocouples recorded temperatures in the shield of over 900°C and close to 1000°C at the shell. Although the shield oxidized slightly in the area of the gap, the unit passed final profile at 0.028 R/hr at one meter.

Specimen number TP206(A) sustained damage during the 30 foot drop test. The two top screws holding the source lock assembly sheared off from the end plate. The two remaining screws on the bottom were intact and securely held the source lock assembly. The top of the "bottom lock plate" moved away slightly (approx. .125") from the end plate. This gap created the potential for oxygen flow to the polyurethane foam via the .63 inch diameter foam fill hole located behind the lock plate.

As demonstrated in previous thermal testing, minor air gaps in the containment surrounding the shield are insufficient to allow oxidation of the depleted uranium shield during the thermal test.

Graphical representation of "gap" created on Specimen TP206(A)	
	
CROSS-SECTION OF TP206(A) SHOWING GAP	**VIEW OF "GAP" – SHELL HIDDEN**

5.4.3 Material Properties at Elevated Temperatures

- The melting temperature for all materials (stainless steel, depleted uranium and tungsten) of the structure, source lock assembly and source assembly is above the thermal test temperature of 800°C.
- The thermal expansion for all materials of the structure is less than the design clearance allowed for assembly.
- The stainless steel components of the structure and source assemblies have about 30% of their room temperature strength at 800°C, respectively.

The load condition for the thermal test is for the structure to support the static weight of the shield in suspension. The dynamic impact nature of the drop tests subjects the structure to a force over 100 times the static weight of the shield. This suggests the strength of the materials used in the structure would need to decrease by two orders of magnitude or to about 1% of their strength at room temperature. The 30-minute thermal test is not long enough for significant creep deformation to occur in the structure.

Section 6 Final Test Assessment

The Model 880SC transport package did not lose or disperse radioactive material and did not have external radiation dose rates exceeding 10-mSv/h (1-rem/h) at 1 m (40 in) from the external surface of the package after being subjected to the HAC test sequence identified in 10 CFR Part 71.

6.1 Production Unit Assessment

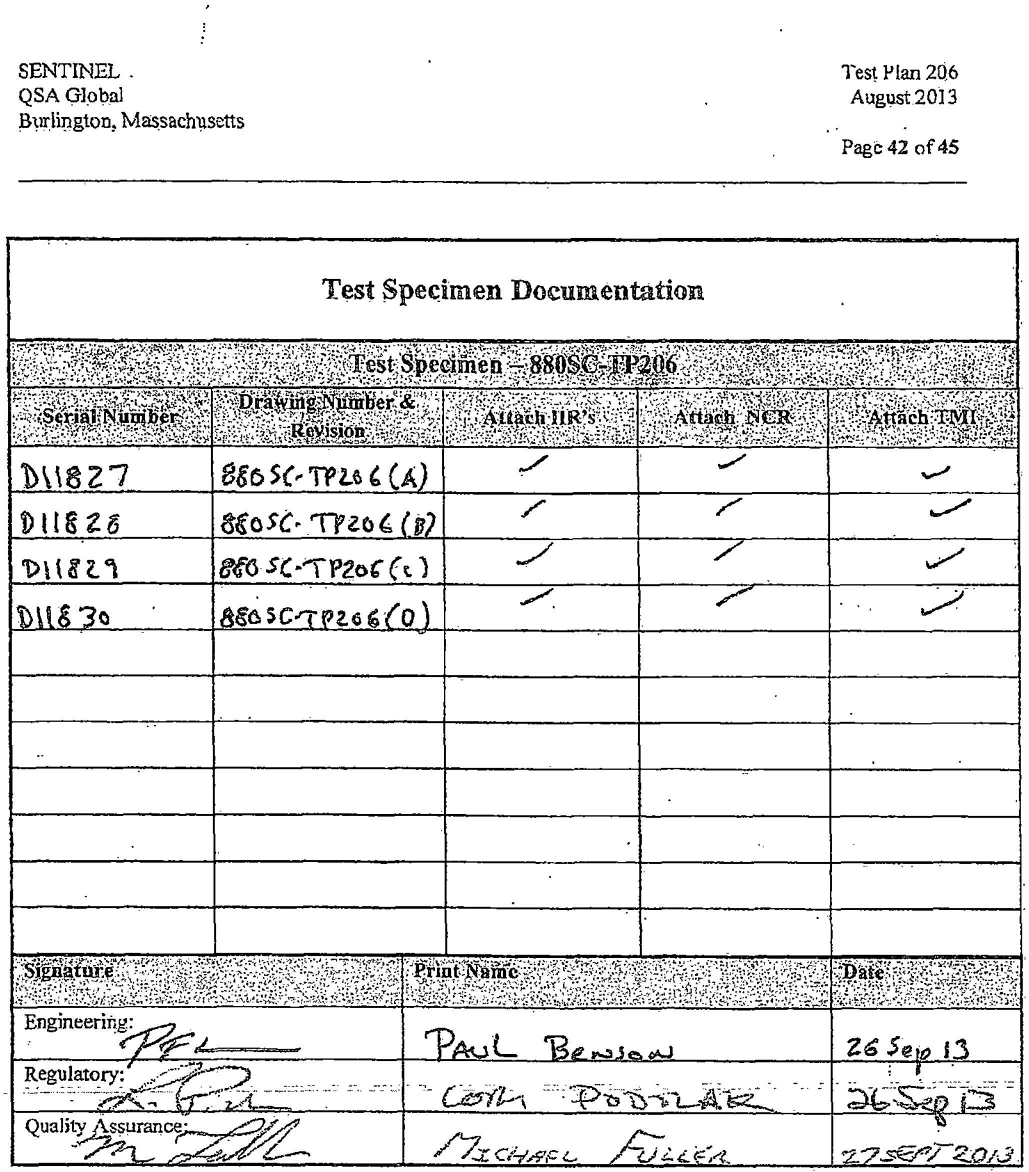
The actual production units of the Model 880SC transport package will include a feature presenting a slight variation compared to the tested specimen. This variation and the possible effect on HAC testing is listed in Table 6.1 below.

Table 6.1 Production Unit Feature/Change Assessment	
Feature/Change	**Net Effect on Transport Package**
Thickness of the bottom lock plate. An increase of .10" will be added to the plate.	Add a maximum of .25 lbs. Eliminates the need for spacers between source lock assembly and end plate.

The production feature listed in table 6.1 adds less than .25 pounds to the package and will not cause the package to exceed the maximum allowable weight for any configuration.

The results and assessments in this report confirm the Model 880SC transport package meets the hypothetical accident conditions test requirements of test plan 206, 10 CFR Part 71, and IAEA TS-R-1.

Appendix A: Test Specimen Documentation



SENTINEL
QSA Global
Burlington, Massachusetts

Test Plan 206
August 2013

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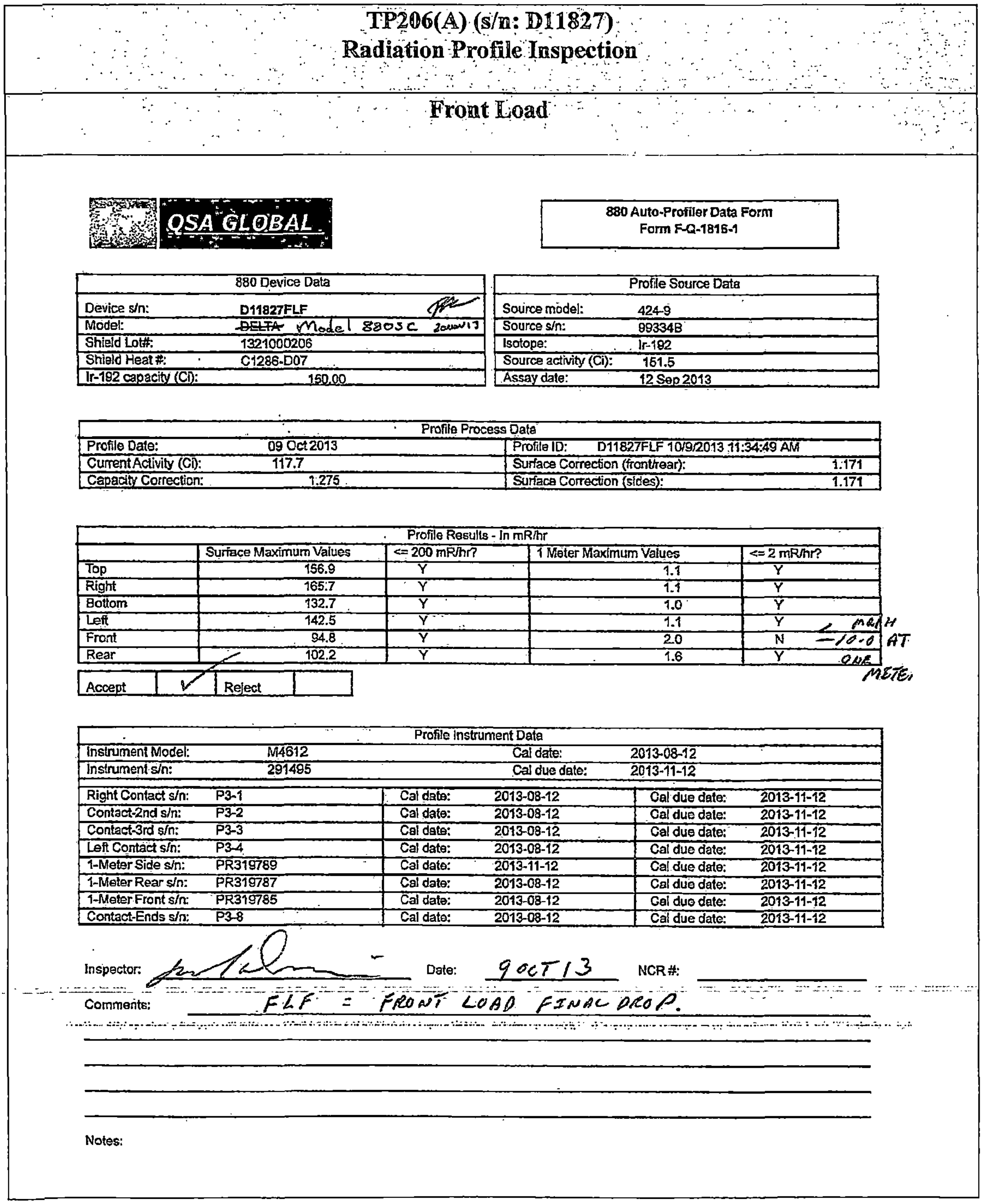
Test Specimen Documentation

Test Specimen – 880SC-TP206				
Serial Number	Drawing Number & Revision	Attach IIR's	Attach NCR	Attach TMI
D11827	880SC-TP206(A)	✓	✓	✓
D11828	880SC-TP206(B)	✓	✓	✓
D11829	880SC-TP206(C)	✓	✓	✓
D11830	880SC-TP206(D)	✓	✓	✓

Signature	Print Name	Date
Engineering:	Paul Benson	26 Sep 13
Regulatory:	Colin Podzlak	26 Sep 13
Quality Assurance:	Michael Fuller	27 SEPT 2013

Appendix B: Radiation Profile Results



TP206(A) (s/n: D11827)
Radiation Profile Inspection

Front Load

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11827FLF
Model:	~~DELTA~~ Model 8805C 20Nov13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D07
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	09 Oct 2013	Profile ID:	D11827FLF 10/9/2013 11:34:49 AM
Current Activity (Ci):	117.7	Surface Correction (front/rear):	1.171
Capacity Correction:	1.275	Surface Correction (sides):	1.171

Profile Results - In mR/hr				
	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	156.9	Y	1.1	Y
Right	165.7	Y	1.1	Y
Bottom	132.7	Y	1.0	Y
Left	142.5	Y	1.1	Y
Front	94.8	Y	2.0	N
Rear	102.2	Y	1.6	Y

≤ mR/H
10.0 AT
ONE
METER

Accept	✓	Reject	

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9 OCT 13 NCR #:

Comments: FLF = FRONT LOAD FINAL DROP.

Notes:

TP206(A) (s/n: D11827)
Radiation Profile Inspection

Rear Load

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	**D11827RLF**
Model:	~~DELTA~~ Model 880SC 20NOV13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D07
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	09 Oct 2013	Profile ID:	D11827RLF 10/9/2013 12:14:30 PM
Current Activity (Ci):	117.7	Surface Correction (front/rear):	1.171
Capacity Correction:	1.275	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	128.9	Y	0.9	Y
Right	133.4	Y	1.1	Y
Bottom	149.1	Y	1.1	Y
Left	142.9	Y	1.0	Y
Front	69.6	Y	1.5	Y
Rear	129.8	Y	2.3	N

mR/H ≤ 10.0 AT ONE METER

Accept	✓	Reject	

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9 OCT 13 NCR #:

Comments: RLF = REAR LOAD FINAL DROP

Notes:

TP206(B) (s/n: D11828)
Radiation Profile Inspection

Front Load

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11828FLF
Model:	~~DELTA~~ Model 6865C 20 Nov 13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D09
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	09 Oct 2013	Profile ID:	D11828FLF 10/9/2013 12:55:49 PM
Current Activity (Ci):	117.7	Surface Correction (front/rear):	1.171
Capacity Correction:	1.275	Surface Correction (sides):	1.171

Profile Results - in mR/hr				
	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	156.3	Y	1.0	Y
Right	164.4	Y	1.1	Y
Bottom	146.9	Y	1.2	Y
Left	150.5	Y	1.0	Y
Front	178.4	Y	1.6	Y
Rear	92.5	Y	2.0	N ≤10.0 mR/H AT ONE METER

Accept	✓	Reject	

Profile Instrument Data					
Instrument Model:	M4612	Cal date:	2013-08-12		
Instrument s/n:	291495	Cal due date:	2013-11-12		
Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319765	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9 OCT 13 NCR #:

Comments: FLF = FRONT LOAD FINAL DROP.

Notes:

TP206(B) (s/n: D11828)
Radiation Profile Inspection

Rear Load

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	D11828 RLF
Model:	~~DELTA~~ Model 880SC 20NOV13
Shield Lot#:	1321000206
Shield Heat #:	C1286-D09
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	09 Oct 2013	Profile ID:	D11828 10/9/2013 1:28:42 PM
Current Activity (Ci):	117.7	Surface Correction (front/rear):	1.171
Capacity Correction:	1.275	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	196.4	Y	1.1	Y
Right	181.9	Y	1.1	Y
Bottom	157.9	Y	1.1	Y
Left	162.5	Y	1.0	Y
Front	173.9	Y	1.2	Y
Rear	99.1	Y	2.6	N

mR/H ≤ 10.0 AT ONE METER

Accept	✓	Reject	

Profile Instrument Data			
Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 9 OCT 13 NCR #:

Comments: RLF = REAR LOAD FINAL DROP

Notes:

TP206(C) (s/n: D11829)
Radiation Profile Inspection

Front Load

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data		
Device s/n:	D11829FLF	
Model:	~~DELTA~~ Model 880SC	26 NOV 13
Shield Lot#:	1321000206	
Shield Heat #:	C1286-D11	
Ir-192 capacity (Ci):	150.00	

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	09 Oct 2013	Profile ID:	D11829FLF 10/9/2013 2:40:04 PM
Current Activity (Ci):	117.7	Surface Correction (front/rear):	1.171
Capacity Correction:	1.275	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	128.0	Y	1.1	Y
Right	147.5	Y	1.1	Y
Bottom	136.8	Y	0.9	Y
Left	138.2	Y	1.0	Y
Front	129.7	Y	1.3	Y
Rear	103.6	Y	1.8	Y

Accept	✓	Reject	

Profile Instrument Data

Instrument Model:	M4612	Cal date:	2013-08-12		
Instrument s/n:	291495	Cal due date:	2013-11-12		
Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 10 OCT 13 NCR #:

Comments: FLF = FRONT LOAD FINAL DROP

Notes:

TP206(C) (s/n: D11829)
Radiation Profile Inspection

Rear Load

QSA GLOBAL

880 Auto-Profiler Data Form
Form F-Q-1816-1

880 Device Data	
Device s/n:	**D11829RLF**
Model:	~~DELTA~~ Model 880 SC R 20 NOV 13
Shield Lot#:	1321000208
Shield Heat #:	C1286-D11
Ir-192 capacity (Ci):	150.00

Profile Source Data	
Source model:	424-9
Source s/n:	99334B
Isotope:	Ir-192
Source activity (Ci):	151.5
Assay date:	12 Sep 2013

Profile Process Data			
Profile Date:	10 Oct 2013	Profile ID:	D11829RLF 10/10/2013 7:53:44 AM
Current Activity (Ci):	116.6	Surface Correction (front/rear):	1.171
Capacity Correction:	1.287	Surface Correction (sides):	1.171

Profile Results - in mR/hr

	Surface Maximum Values	<= 200 mR/hr?	1 Meter Maximum Values	<= 2 mR/hr?
Top	127.6	Y	0.9	Y
Right	153.5	Y	1.2	Y
Bottom	150.6	Y	1.2	Y
Left	136.0	Y	1.1	Y
Front	95.8	Y	1.3	Y
Rear	149.5	Y	2.0	N ≤ 10. mR/hR AT ONE METER.

Accept	✓	Reject	

Profile Instrument Data

Instrument Model:	M4612	Cal date:	2013-08-12
Instrument s/n:	291495	Cal due date:	2013-11-12

Right Contact s/n:	P3-1	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-2nd s/n:	P3-2	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-3rd s/n:	P3-3	Cal date:	2013-08-12	Cal due date:	2013-11-12
Left Contact s/n:	P3-4	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Side s/n:	PR319789	Cal date:	2013-11-12	Cal due date:	2013-11-12
1-Meter Rear s/n:	PR319787	Cal date:	2013-08-12	Cal due date:	2013-11-12
1-Meter Front s/n:	PR319785	Cal date:	2013-08-12	Cal due date:	2013-11-12
Contact-Ends s/n:	P3-8	Cal date:	2013-08-12	Cal due date:	2013-11-12

Inspector: Date: 10 OCT 13 NCR #:

Comments: RLF = REAR LOAD FINAL DROP

Notes:

Appendix C: Test Data Worksheets

Drop & Puncture Test Equipment List

Test: 9 M Drop 1 - HAC

Description * Mark NA when not used.	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Test Specimen, Drawing No.	TP206(A) D11827	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	N/A
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	02 OCT 13
Verified by: MAP	Matt Potenza	02 OCT 13

Drop & Puncture Test Checklist

Test: 9 M Drop 1 - HAC

Test Location: 40 North Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number:	D11827	
2. Record the test specimen weight:	44.80 lbs	E4L110566B
3. Record the ambient temperature (°C):	20.5	ENG-20
4. Record set-up orientation figure:	Fig 8.72.1.	
5. Verify set-up orientation and drop height.	34 FT 10 IN	~~34 FT 10 IN~~
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen.	✓	
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.	✓	
10. Record the damage to the test specimen on a separate sheet and attach.	✓	
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	Print Name	Date
Engineering: NAP	Paul Benson	2 OCT 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	Jan Hicks	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(A)/D11827	Test: 9 Meter Drop 1-HAC
Test Date: 2 OCT 13	Test Time: 10:45AM

Describe drop orientation and drop height:
Fig. 8.7.2.1 of Test Plan

Describe impact (location, rotation, etc.):
Slight rotation onto upper edge of lock plate.

Describe on-site inspection (damage, broken parts, etc.):
Source lock assy tilted away from endplate. Two mounting screws broken/missing. Lock was damaged.

On-site test assessment: Source remains in shield & safe position. but moved away from sweet spot. This impact orientation was as damaging if not more damaging than the intended impact. Therefore the test was not repeated

Engineering: 02 OCT 13 Regulatory: 20 NOV 2013 QA: 11NOV13

Describe any post-test disassembly and inspection: NONE
The Puncture test was performed after the 9M drop.

Describe any change in source position:
Slight change due to broken screws.

Describe results of radiography:
N/A

Radiography performed after the Puncture test

Completed by:	Date: 20 OCT 13

Drop & Puncture Test Equipment List

Test: 9M Drop 2 - HAC

Description * Mark NA when not used.	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Test Specimen, Drawing No.	TP206 (B) D1182	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	N/A
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		

Signature	Print Name	Date
Completed by:	Paul Benson	02 OCT 13
Verified by: MAP	Matt Potenza	02 OCT 13

Drop & Puncture Test Checklist

Test: 9 M Drop 2 - HAC

Test Location: 40 North Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number:	D11827	
2. Record the test specimen weight:	44.85	E4L110566B
3. Record the ambient temperature (°C):	21.1	ENG-20
4. Record set-up orientation figure:	FIG 8.7.3.1	
5. Verify set-up orientation and drop height.	34 FT 10 IN	
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen.	✓	
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.	✓	
10. Record the damage to the test specimen on a separate sheet and attach.	✓	
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	Print Name	Date
Engineering: MAP	Paul Benson	02 OCT 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	John Nielsen	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(B)/D11828	Test: 9 M Drop 2 - HAC
Test Date: 2 OCT 13	Test Time: 10:20 AM

Describe drop orientation and drop height:
Fig. 8.7.3.1 of Test Plan

Describe impact (location, rotation, etc.):
Impact as planned. No rotation observed. Dust cap not engaged before drop. Impact target on source connector - no damage.

Describe on-site inspection (damage, broken parts, etc.):
Impact point on dust cover mounting face. Bent body flange. Lifting eye dented body.

On-site test assessment:
Source remained secure in shielded position.

Engineering: 02 OCT 13 Regulatory: 20 NOV 2013 QA: 11 NOV 13

Describe any post-test disassembly and inspection: NONE
The Puncture test was performed after the 9M drop.

Describe any change in source position:
NONE

Describe results of radiography:
N/A
Radiography performed after the Puncture test.

Completed by: Date: 30 OCT 13

Drop & Puncture Test Equipment List

Test: 9M Drop 3 - HAC

Description * Mark NA when not used.	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Test Specimen, Drawing No.	TP206(C) D11829	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	N/A	N/A
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	02 OCT 13
Verified by: MAP	Matt Potenza	02 OCT 13

Drop & Puncture Test Checklist

Test: 9M Drop 3 - HAC

Test Location: 40 North Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number:	D11829	
2. Record the test specimen weight:	44.80 lbs	E4L110566B
3. Record the ambient temperature (°C):	21.9	ENG-20
4. Record set-up orientation figure:	FIG 8.7.4.1	
5. Verify set-up orientation and drop height.	34 FT 10 IN.	
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen.	✓	
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.	✓	
10. Record the damage to the test specimen on a separate sheet and attach.		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	Print Name	Date
Engineering: MAP	Paul Benson	02 OCT 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	John Hickson	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206 (C)/D11829	Test: 9M Drop 3 - HAC
Test Date: 2 OCT 13	Test Time: 10:30 AM

Describe drop orientation and drop height:

Figure 8.7.4.1 of Test Plan

Describe impact (location, rotation, etc.):

IMPACT LOCATION AS PLANNED
NO ROTATION OBSERVED

Describe on-site inspection (damage, broken parts, etc.):

IMPACT PRINT ON BOTTOM

On-site test assessment:

SOURCE REMAINED SECURED AND SHIELDED.

Engineering: 02 OCT 13 Regulatory: 20 NOV 2013 QA: 16 Oct 13

Describe any post-test disassembly and inspection:

NONE

Describe any change in source position:

NONE

Describe results of radiography:

See Table 5.2.1 & Appendix B of Test Plan 206 - Report #2

Completed by: Date: 14 OCT 13

Drop & Puncture Test Equipment List

Test: Puncture 1 - HAC

Description * Mark NA when not used.	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Test Specimen, Drawing No.	TP206(A) D11827	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	T10119	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	2 oct 13
Verified by: MAP	Matt Potenza	2 oct 13

Drop & Puncture Test Checklist

Test: Puncture 1 - HAC

Test Location: 4/0 North Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number:	D11827	
2. Record the test specimen weight:	44.80	E4L110566B
3. Record the ambient temperature (°C):	25.3	ENG-20
4. Record set-up orientation figure:	Slight Adjustment to Angle To Attempt to Pry off Two Remaining screws!	
5. Verify set-up orientation and drop height.	46.5 IN	
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen.	✓	
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.	✓	
10. Record the damage to the test specimen on a separate sheet and attach.		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering:	Paul Bonson	2 OCT 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	John Hixbe	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(A)/D11827

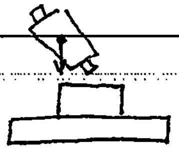
Test: Puncture 1- HAC

Test Date: 2 OCT 13

Test Time: 2:20 PM

Describe drop orientation and drop height:

Figure 8.8.2.1 of test plan.
Orientation changes to attempt to pry off two remaining bolts.



Describe impact (location, rotation, etc.):

Impact hit on lock plate at an angle with center of gravity off the target surface.

Describe on-site inspection (damage, broken parts, etc.):

Only minor dents. Lock plate & source wire remains intact.

On-site test assessment:

Source remained in its secure & shielded position.

Engineering: 02OCT13 Regulatory: 20 NOV 2013 QA: 11 NOV 13

Describe any post-test disassembly and inspection:

Removed source lock assy from shell & replaced the lock. The lock was damaged during the 9m drop & needed to be replaced for profiling. Re-assembled using bent screws → Opened the cap which was "jammed" shut.

Describe any change in source position:

Slight change due to 30' drop.

Describe results of radiography:

See Table 5.2.1

See Appendix B of Test Plan 206 Report #2

- Max. 1 meter reading was 2.3 mR/hr.

Completed by:

Date: 11 NOV 13

Drop & Puncture Test Equipment List

Test: Puncture 2 - HAC

Description *** Mark NA when not used.**	**Enter the Model and Serial Number**	**Attach Inspection Report or Calibration Certificate**
Test Specimen, Drawing No.	TP206(B) D11828	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	T10619	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	02 OCT 13
Verified by: MAP	Matt Potenza	02 OCT 13

Drop & Puncture Test Checklist

Test: Puncture 2 - HAC

Test Location: 40 North Drop Pad

Step	Data	Measuring Instrument
1. Record test specimen serial number:	D11828	
2. Record the test specimen weight:	44.85	E4L110566B
3. Record the ambient temperature (°C):	25.1	ENG-20
4. Record set-up orientation figure:	Per test plan	
5. Verify set-up orientation and drop height.	46.5 inches.	
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen.	✓	
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.	✓	
10. Record the damage to the test specimen on a separate sheet and attach.		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	Print Name	Date
Engineering: MAP	Paul Benson ~~02 OCT 13~~	02 OCT 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	John Hielse	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(B) / D11828	Test: Puncture 2 - HAC
Test Date: 2 OCT 13	Test Time: 2:40 PM

Describe drop orientation and drop height:
Figure 8.8.3.1 of Test Plan

Describe impact (location, rotation, etc.):
IMPACT ON DUST CAP (NOT LATCHED).

Describe on-site inspection (damage, broken parts, etc.):
DUST CAP REMOVED UPON IMPACT
MINOR DENTS ON BODY

On-site test assessment:
SOURCE REMAINS SECURED AND IN ITS FULLY SHIELDED POSITION.

Engineering: 02 OCT 13 Regulatory: 20 NOV 2013 QA: 16 Oct 13

Describe any post-test disassembly and inspection:
Lock slide was jammed on lock slide bracket. Source lock assy was removed from shell & lock slide bracket was removed. Source lock assy was then re-assembled to shell.

Describe any change in source position:
NONE

Describe results of radiography:
See Table 5.2.1 & Appendix B of Test Plan 206 - Report #2
Max 1 meter reading was 2.6 mR/hr

Completed by:	Date: 14 OCT 13

Drop & Puncture Test Equipment List

Test: Puncture 3 - HAC

Description * Mark NA when not used.	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Test Specimen, Drawing No.	TP206 (C) D11829	
Drop Surface, Drawing No.	T10740	
* Puncture Billet, Drawing No.	T10119	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificates.		
Signature	**Print Name**	**Date**
Completed by:	Paul Benson	02 OCT 13
Verified by: MAP	Matt Potenza	02 OCT 13

Drop & Puncture Test Checklist

Test: Puncture 3 - HAC

Test Location: 40 North Drop Pad

Step	**Data**	**Measuring Instrument**
1. Record test specimen serial number:	TP206(C) D11829	
2. Record the test specimen weight:	414.80 lbs	E4L110566B
3. Record the ambient temperature (°C):	25.2	ENG-20
4. Record set-up orientation figure:	PER PLAN	
5. Verify set-up orientation and drop height.	46.5 IN	
6. Photograph set-up in at least two perpendicular planes.	✓	
7. Begin video recording of the test so that impact is recorded.	✓	
8. Release the test specimen.	✓	
9. Stop the video recorder. Ensure the point of impact and orientation specified in the plan has been achieved.	✓	
10. Record the damage to the test specimen on a separate sheet and attach.		
11. Engineering, Regulatory Affairs and Quality Assurance make a preliminary assessment relative to 10 CFR 71. Record the assessment on a separate sheet and attach.		

Test witnessed by (Signature)	**Print Name**	**Date**
Engineering: MAP	Paul Benson	02 OCT 13
Regulatory Affairs:	MICHAEL FULLER	20 NOV 2013
Quality Assurance:	John Hebner	16 oct 13

Drop & Puncture Test Data Sheet

Test Unit Model/Serial No.: 880SC-TP206(C)/D11829	Test: Puncture 3- HAC
Test Date: 2 OCT 13	Test Time: 3:05 PM

Describe drop orientation and drop height:
Figure 8.8.4.1 of test Plan

Describe impact (location, rotation, etc.):
Impact per plan

Describe on-site inspection (damage, broken parts, etc.):
Dust cover unlatched.
Opposite Dust cover crushed inward.

On-site test assessment:
Source remains secured and in its shielded Position.

Engineering: 2 OCT 13 Regulatory: 20 NOV 2013 QA: 16 Oct 13

Describe any post-test disassembly and inspection:
NONE

Describe any change in source position:
NONE

Describe results of radiography:
See Table 5.2.1 & Appendix B of Test Plan 206 - Report #2
- Max 1 meter reading was 2.0 mR/hr

Completed by:	Date: 14 OCT 13

Section 3 - THERMAL EVALUATION

3.1 Description of Thermal Design

The Model 880 Series transport packages are completely passive thermal devices having no mechanical cooling system or relief valves. The exterior surface finish of the package is light silvery stainless steel having an absorptivity of about 0.44, or a reflectivity of 0.56. Cooling of the package is through free convection and radiation. There are no specific cooling or insulating design features. Pressure relief of the container weldment is only necessary during the thermal test and is provided by the holes in both the rear and front end plates which will vent to atmosphere.

3.1.1 Design Features

The Model 880 Series transport packages are described in Section 1. The thin walls of the steel weldment exhibit almost no thermal gradient. During a fire test, the exterior steel weldment will very quickly heat to a uniform temperature, eliminating stresses induced by thermal differentials within the material. Further, the steel weldment will move and flex easily, thus relieving any thermal expansion stress without rupture.

The containers use depleted uranium shielding. The depleted uranium is fully enclosed in the welded steel structure and endplates which are attached by screws. This construction prevents oxidation by severely limiting oxygen from reaching the depleted uranium shield.

3.1.2 Decay Heat of Contents

The maximum activity for this package is 150 Ci of Ir-192. Accounting for source absorption, this equals a maximum content activity of 345 Ci of Ir-192. The corresponding decay heat generation rate for the content activity is approximately 3 Watts (See Table 1.2.B).

3.1.3 Summary Tables of Temperatures

Table 3.1.A: Summary Table of Temperatures

Temperature Condition	Model 880 Series Package	Comments
Insolation (38°C in full sun)	65.4°C (149.6°F)	Section 3.4.1.1
Decay Heating (38°C in shade)	47°C (117°F)	Section 3.4.1.2
Fire Test During & Maximum Post-Fire Test	800°C (1,472°F)	

3.1.4 Summary Tables of Maximum Pressures

All package components are vented to atmosphere. As such, no pressure will build up in these components under either Normal or Hypothetical Accident conditions. Normal operating conditions will generate negligible pressure differential within the package. The package has the ability to withstand elevated atmospheric pressure because all components, except the special form source, are open to the atmosphere.

Any pressure generated within the special form source is significantly below that which would be generated during the Hypothetical Accident Conditions thermal test, which is shown in Sections 2.7.4.3 and 3.4.1.4 to result in no loss of structural integrity or containment.

Table 3.1.B: Summary Table of Maximum Pressures

Package Configuration	Void Volume in^3	Normal Conditions 88°C (190°F) Pressure Developed	Fire Conditions 800°C (1,472°F) Pressure Developed	Comments
880 Series	0	0 psig	0 psig	

3.2 Material Properties and Component Specifications

3.2.1 Material Properties

Table 3.2.A lists the relevant thermal properties of the important materials in the transport package. The sources referred to in the last column are listed below the table.

Table 3.2.A: Thermal Properties of Principal Transport Package Materials

Material	Density (lb/in^3)	Melting/Combustion Temperature	Thermal Expansion[1]	Source
Depleted Uranium	0.68	1,130°C (2,066°F)	8μin/in°F	Reference #1, p. 6-11 and Reference #2
Steel (nominal)	0.28	1,510°C (2,750°F)	6.3μin/in°F	Reference #1, p. 6-7 and 6-11
Stainless Steel-Type 304L	0.29	1,400-1,450°C (2,550-2,640°F)	9.9μin/in°F	Reference #1, p. 6-11
Tungsten	0.70	3,370°C (6,098°F)	2.4μin/in°F	Reference #1, p. 6-51
Titanium	0.16	1,500 – 1,700°C (2,732 – 3,092°F)	11μm/m°K	Reference #4

[1] Note that the thermal expansions of the materials in this table are temperature dependent.

Resource references:

1. Eugene A. Avallone and Theodore Baumeister III, *Mark's Standard Handbook for Mechanical Engineers, Tenth Edition,* New York: McGraw-Hill, 1996.

2. Lowenstein, Paul. *Industrial Uses of Depleted Uranium.* American Society for Metals. Metals Handbook, Volume 3, Ninth Edition.

3. Metals Handbook. American Society for Metals, 8th Edition.

4. ASM Material Properties Handbook Titanium Alloys, ed. Rodney Boyer, Gerhard Welsch, E.W. Collings, 1994.

3.2.2 Component Specifications

All components are specified and described on the descriptive drawings included in Appendix 1.3.

3.3 General Considerations

3.3.1 Evaluation by Analysis

Evaluations by analysis are described in the section they apply to in this Safety Analysis Report or when applicable in the Test Plans contained in Appendix 2.12.

3.3.2 Evaluation by Test

Evaluations by direct testing are documented in the Test Plans contained in Appendix 2.12 or are described in the section they apply to in this Safety Analysis Report.

3.4 Thermal Evaluation Under Normal Conditions of Transport

3.4.1 Heat and Cold

3.4.1.1 Insolation and Decay Heat

This analysis determines the maximum surface temperature produced by solar heating of the transport package surface in accordance with 10 CFR 71.71(c)(1) and Table XI of IAEA TS-R-1.

The following design analysis calculates the steady state surface temperature of a cylindrical package subjected to insolation and self-heat. The analysis is based on recognized heat transfer theory and specifically, that the total heat input due to the self-heat of the radioactive contents and the insolation energy absorbed must balance the heat loss due to convection and emitted radiation from the package surface.

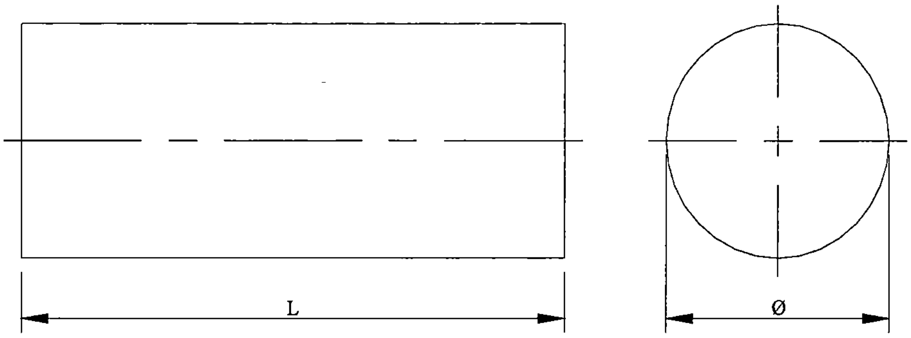


Figure 3.4.A: Model of Cylindrical Package for Heat Analysis

The package is evaluated in the orientation shown in Figure 3.4a, which also defines the overall package dimensions. In order to assure conservatism, the following assumptions are made:

a. Basic Input Parameters:

Max Content Activity, A = 345 Ci of Ir-192 (150 Ci x 2.3 for self absorption)
The surface finish of the package is light silvery grade 304 stainless steel

Length of Package, L = 0.33 m
Diameter of Package, $\phi = 0.127$ m
Stefan-Boltzmann constant, $\sigma = 5.669 \times 10^{-8}$ W/m^2K^4
By Kirchhoff's Law Emissivity, ε = Absorptivity, $\alpha = 0.44$
(Ref: Heat Transmission, 3rd Edition - M^{c}Adams)
Ambient Temperature, $T_A = 311°K$
Area of cylinder ends, $A_{CE} = 0.025$ m^2
Total Area of curved surfaces, $A_{CS} = 0.132$ m^2
Decay Heat Input $Q_{DT} = 3$ W

The transport package is assumed to undergo free radiative heat transfer from the top and sides.

b. The transport package is assumed to undergo free convective heat transfer from the top, sides and bottom.

c. To maximize the temperature of the stainless steel cylinder surface temperature, the inside transport package faces are considered perfectly insulated so there is no conduction into the transport package. In use, the inside transport package will act as a heat sink during daylight hours and a heat source during the night, but this will be ignored for this calculation.

d. The transport package is approximated as a right cylinder with dimensions, 5 inches (0.13 m) in diameter and 13 inches (0.33m) long (approximation of the solid length of the cylinder).

e. The surfaces of the transport package are assumed to be solid. The faces are considered to be sufficiently thin so that no temperature gradients exist in the faces.

f. The worst case decay heat load (3 Watts) is added to the solar heat input load.

The following heat calculations are based on the steady-state equilibrium relationship between the heat gained by the package and the heat lost.

Heat Input, Q_{IN} = Heat Output, Q_{OUT} in the steady-state.
Q_{IN} = Solar Heat Input + Decay Heat
Q_{OUT} = Heat loss by Radiation and Convection
Q_{IE} = Heat input due to insolation falling on ends
Q_{IC} = Heat input due to insolation on curved surfaces,

Solar Heat Input = $\alpha(Q_{IE} + Q_{IC})$, where α is the absorptivity

The solar heat input is the combined solar heating of the top horizontal surface and the vertical side surface. The insolation data, provided in 10 CFR 71.71(c)(1), is found in Table 3.4.A.

Table 3.4.A: Insolation Data

Surface	Insolation for a 12 hour period ($g\text{-}cal/cm^2$ or W/m^2)
Horizontal base	None
Other horizontal flat surfaces	800
Non-horizontal flat surfaces	200
Curved surfaces	400

Practically all solid materials used in engineering are opaque to thermal radiation (even glass is only transparent to a fairly narrow range of wavelengths), and thermal radiation is in fact either reflected or absorbed within a very shallow depth of matter. Thus for solids it is possible to neglect transmissivity and write:

$$\text{reflectivity, } \rho + \text{absorptivity, } \alpha \quad = \quad 1$$

i.e., the sum of the radiation reflected and absorbed by the material is equal to the total incident energy. Since the reflected energy does not contribute to the heat energy contained within the system, or package, it is not necessary to consider it in the analysis. However, the absorptivity of the material is the fraction of the total incident energy entering the system, which in this case is the heat input due to insolation.

Heat input due to insolation falling on ends, $Q_{IE} = 200\ W/m^2 \times A_{CE} = 5\ W$
Heat input due to insolation on curved surfaces, $Q_{IC} = 400\ W/m^2 \times A_{CS} = 52.8\ W$

In the case of a cylindrical package standing on the ground, the top surface can radiate freely to the surroundings assumed to be effectively at ambient temperature. For the vertical surface, the upper 90° of azimuth can radiate freely to the surrounding air in the same way as the top surfaces. However, some radiation emitted in the lower 90° will be intercepted by the ground and vice versa. Owing to the complex nature of radiation interchange, and allowing for this asymmetrical characteristic, a geometrical factor g is assumed in the following analysis.

For curved surfaces, $g_c = 0.5$
For vertical surfaces, $g_s = 0.5$

Radiation heat transfer from curved surfaces,

$$Q_{RC} = g_c \sigma \varepsilon A_{CS}\{T_W^4 - T_A^4\} = 1.54\times10^{-9}\{T_W^4 - T_A^4\}$$

Radiation heat transfer from end surface,

$$Q_{RE} = g_s \sigma \varepsilon A_{CE}\{T_W^4 - T_A^4\} = 3.12\times10^{-10}\{T_W^4 - T_A^4\}$$

Heat transfer by convection is complex as it represents a dynamic process involving fluid flow. Newton introduced a quantity known as the "heat transfer coefficient" represented by the symbol, h. From Newton's Law of cooling due to heat loss by convection:

$$Q_C = hA[T_W-T_A]$$

Consider the curved surface of the cylinder:

Cylindrical Surface Convection, $Q_{CC} = H_C A_{CS}[T_W-T_A]$

Where the free convection coefficient, $H_C = 1.32\{(1/\phi)^{1/4}(T_W-T_A)^{1/4}\}$ (Ref 1)

Therefore, $Q_{CC} = 0.27(T_W-T_A)^{5/4}$

Considering the vertical surfaces of the cylinder:

Vertical End Surface Convection, $Q_{CE} = H_S A_{CE}\{T_W-T_A\}$

Where the free convection coefficient, $H_S = 1.42\{(1/\phi)^{1/4}(T_W-T_A)^{1/4}\}$ (Ref. 1)

Therefore, $Q_{CE} = 0.06\ (T_W-T_A)^{1.25}$

Total Heat Input, $Q_{IN} = \alpha(Q_{IE} + Q_{IC}) + Q_{DT} = 28.4$ W

Total Heat Output, $Q_{OUT} = (Q_{RC} + Q_{RE}) + (Q_{CC} + Q_{CE})$

$$28.4\text{ W} = 1.86\times10^{-9}\{T_W^4 - (311)^4\} + 3.34\times10^{-1}(T_W - (311))^{1.25}$$

Iteration of this relationship yields a maximum wall temperature (T_W) of 65.4°C (149.7°F). This temperature would constitute the most onerous Normal Transport thermal condition. Based on the package materials of construction, this temperature will not be sufficient to adversely affect the package containment or shielding integrity since the melting temperatures of all safety critical components are well above this temperature. It is therefore concluded that the Model 880 Series transport package will maintain its structural integrity and shielding effectiveness under the normal transport heat condition.

3.4.1.2 Still Air (shaded) Decay Heating

This analysis calculates the maximum surface temperature of the Model 880 Series Transport package in the shade (i.e., no insolation effects), assuming an ambient temperature of 38°C (100°F), per 10 CFR 71.43(g).

The same assumptions from Section 3.4.1.1 are used. The following heat calculations are based on the steady-state equilibrium relationship between the heat gained by the package and the heat lost.

Heat Input, Q_{IN} = Heat Output, Q_{OUT} and Q_{IN} = Decay Heat = 3 Watts

$$Q_{OUT} = \text{Heat loss by Convection}$$

Heat transfer by convection is complex as it represents a dynamic process involving fluid flow. Newton introduced a quantity known as the "heat transfer coefficient" represented by the symbol, h. From Newton's Law of cooling due to heat loss by convection:

$$Q_C = hA[T_W - T_A] \text{ (W)}$$

Considering the curved surface of the cylinder:

Cylindrical Surface Convection, $Q_{CC} = H_C A_{CS}[T_W - T_A]$

Where the free convection coefficient, $H_C = 1.32\{(1/\phi)^{1/4}(T_W - T_A)^{1/4}\}$
(Ref. 1 Section 3.4.1.2)

Therefore, $Q_{CC} = 0.27\ (T_W - T_A)^{1.25}$

Considering the vertical surfaces of the cylinder:

Vertical End Surface Convection, $Q_{CE} = H_S A_{CE}\{T_W - T_A\}$

Where the free convection coefficient, $H_S = 1.42\{(1/\phi)^{1/4}(T_W - T_A)^{1/4}\}$
(Ref. 1 Section 3.4.1.2)

Therefore, $Q_{CE} = 0.06\times(T_W - T_A)^{1.25}$

Total Heat Input, $Q_{IN} = Q_{DT} = 3$ W

Total Heat Output, $Q_{OUT} = (Q_{CC} + Q_{CE}) = 3.34\times10^{-1}(T_W - T_A)^{1.25}$

Since Heat Input, Q_{IN} = Heat Output, Q_{OUT}, in the steady state.

$$3\text{ W} = 3.34\times10^{-1}(T_W - T_A)^{1.25}$$

Solving for T_W, $T_W = T_A + [3/(3.34\times10^{-1})]^{0.8} = 320°\text{K}$

Therefore, a maximum wall temperature (T_W) of 47°C (117°F), which is less than the maximum 50°C (122°F) allowed by 10 CFR 71.43(g).

3.4.1.3 Cold Effected Materials

An ambient air temperature of –40 F in still air and shade has no effect on the safety of the package. The safety materials: stainless steel, titanium, tungsten and depleted uranium retain their mechanical properties at this temperature. Thus, it is concluded that the Model 880 transport package will withstand the normal transport cold condition.

3.4.1.4 Model 880 Series Series Type B(U) Source Capsule Thermal Analysis

This analysis demonstrates that the pressure inside the Model 880 Series source capsule, when subjected to the Hypothetical Accident Conditions of Transport thermal test, does not exceed the pressure which corresponds to the minimum yield strength at the thermal test temperature.

The source capsules used in the 880 Series are all special form tested and approved. The thermal test for special form capsules involves heating the capsules at 800°C for at least 10 minutes and allowing the capsules to cool afterwards. Test capsules are tested for leak tightness after this test and must pass intact in order to achieve special form status.

Special form capsules are also brought up to the 800°C temperature and allowed to cool prior to integrity testing. The special form capsules serve as the primary containment for the radioactive material and they demonstrate their ability to retain integrity at 800°C. Therefore it is concluded that the container and contents meet the requirements of this section.

3.4.2 Temperatures Resulting in Maximum Thermal Stresses

The temperature and pressure variations described in Sections 3.4.1 and 3.4.3 will not adversely affect the transport package during normal transport since the melting temperatures of all safety critical components are well above these temperatures and the package will experience no pressures sufficient to cause package failure. It its therefore concluded that the Model 880 Series transport packages will maintain their structural integrity and shielding effectiveness under the normal transport thermal stress conditions.

3.4.3 Maximum Normal Operating Pressure

All 880 Series components are vented to the atmosphere. As such, pressure will not build up in the packages during Normal Transport conditions. Containers will exhibit a pressure differential of 0 psi as they are vented to the atmosphere with no means for creating a pressure differential. No other contributing gas sources are present.

3.5 Thermal Evaluation Under Hypothetical Accident Conditions

3.5.1 Initial Conditions

The thermal test was not performed. Rather, an assessment was performed to demonstrate that the thermal test would not create sufficient additional damage to the package that would cause it to fail final profile criteria.

Consideration of the principle materials of manufacture and their melting points indicates that they would not fail and shielding integrity would not be significantly degraded. (See Table 2.2.A)

Damage to the outer containment, increasing the potential for oxygen ingress to the shield, by a build up of pressure within the assembly through the pyrolization of the foam, or expansion of a trapped volume of air is not possible. The package is vented to atmosphere through both the front and rear end plates. These vents will relieve any internal generation or expansion of gases created by the elevated temperatures.

Damage incurred during the drop testing (4 foot, 30 foot and puncture) was minimal, consisting of insignificant deformation of the shell, lock mounting block and dust cover, slight bowing of the end plates and loss of two lock plate bolts. None of the damage increased, or created any new, significant pathways for the ingress of oxygen. Oxygen ingress has been shown empirically to be the primary contributing factor in the oxidation of depleted uranium shields during thermal testing (see Section 2.7.4.5.b).

3.5.2 Fire Test Conditions

Without the possibility of gross oxidation, and subsequent destruction of the shield, thermal failure is then predicated on mechanical degradation of the packages' support structure. The Model 880 is predominately of welded stainless steel construction. A similar type of construction was analyzed for the Model 865 (Certificate of Compliance number 9165). The thermal analysis for the Model 865 is part of the documentation referenced for that package under the USNRC Certificate of Compliance USA/9165/B(U). It showed that the thermal gradients that occur during temperature ramp-up (especially within the first 3 minutes) do not create undue stresses on the structure of the device (~4-5% strain).

In addition, the effect of structural yielding under self-weight at temperature caused by the degradation of mechanical properties of the materials of construction was insignificant. Areas examined were:

a. Tear-out of the shield support pin from the support bracket with the device in a vertical position (see Section 2.7.4.5.c(1)).
b. Cracking of the depleted uranium (DU) around the titanium support pin due to differential expansion (see Section 2.7.4.5.c(2)).
c. De-attachment of the rear lock assembly due to failure of the three- (3) remaining security screws (see Section 2.7.4.5.c(3)).

Based on the previous empirical data and analyses, we conclude that oxidation of the shield will not occur, the structural integrity of the package will remain intact and the containment of the source will not be affected. As such, the Model 880 would pass the thermal test without exceeding the final profile criteria.

3.5.3 Maximum Temperatures and Pressure

See Sections 3.1.3 and 3.1.4. All 880 Series components are vented to the atmosphere. The packages are vented to atmosphere through both the front and rear end plates. These vents will relieve any internal generation or expansion of gases created by the elevated temperatures. As such, pressure will not build up in the packages during Hypothetical Accident Transport conditions. Containers will exhibit a pressure differential of 0 psi as they are vented to the atmosphere with no means for creating a pressure differential. No other contributing gas sources are present.

3.5.4 Temperatures Resulting in Maximum Thermal Stresses

The temperature and pressure variations described in Sections 3.4.1 and 3.4.3 will not adversely affect the transport package during normal transport since the melting temperatures of all safety critical components are well above these temperatures and the package will experience no pressures sufficient to cause package failure. It is therefore concluded that the Model 880 Series transport package will maintain its structural integrity and shielding effectiveness under the hypothetical accident condition transport thermal stress conditions.

3.5.5 Fuel/Cladding Temperatures for Spent Nuclear Fuel

Not applicable. This package is not used for transport of spent nuclear fuel.

3.5.6 Accident Conditions for Fissile Material Packages for Air Transport

Not applicable. This package is not used for transport of Type B quantities of fissile material.

3.6 Appendix

Not Applicable.

Section 4 – CONTAINMENT

4.1 Description of the Containment System

The containment system consists of the Model 880 Series transport package and the radioactive source capsule. This source capsule shall be qualified as Special Form radioactive material under 49 CFR 173 and IAEA TS-R-1.

4.1.1 Special Requirements for Damaged Spent Nuclear Fuel

Not applicable. This package is not used for the transport of spent nuclear fuel.

4.2 Containment Under Normal Conditions of Transport

As demonstrated in the Test Plan Reports and supported by assessments when applicable (Section 2.12), performance of the normal conditions of transport testing caused no breach of the source capsules contained in the package. The source capsules used in conjunction with the transport package have satisfied the requirements for the special form radioactive material as prescribed in 10 CFR 71.75, 49 CFR 173.469 and IAEA TS-R-1. There will be no release of radioactive material under the Normal Conditions of Transport.

The normal conditions of transport criteria listed in 10 CFR 71.71 will result in no loss of transport package containment as prescribed in 10 CFR 71.51(a)(1). This conclusion is based on information presented in Sections 2 and 3.

4.3 Containment Under Hypothetical Accident Condition

The hypothetical accident conditions outlined in 10 CFR 71.73 will result in no loss of transport package containment. This conclusion is based on information presented in Section 2.7 and Section 3.5 which show that the transport package meets the containment requirements of 10 CFR 71.51(a)(2).

4.4 Leakage Rate Tests for Type B Packages

The primary containment for the radioactive material in the Model 880 Series Transport Packages are the radioactive source capsules. All source capsules authorized for Type B transport in the Model 880 Series are certified as special form radioactive material under 10 CFR Part 71, 49 CFR Part 173 and IAEA TS-R-1. After manufacture, and again once every six months thereafter prior to transport, the source capsules are leak tested in accordance with ISO9978:1992(E) (or more recent editions) to ensure that containment of the source does not allow release of more than 0.005 μCi of radioactive material. These fabrication and periodic tests ensure that contamination release from the package does not exceed the regulatory limits.

Reference ISO9978:1992(E) – Radiation Protection – Sealed Radioactive Sources – Leakage Test Methods.

4.5 Appendix

Not applicable.

Section 5 - SHIELDING EVALUATION

5.1 Description of Shielding Design

5.1.1 Design Features

The principal shielding in the Model 880 Series transport package is the depleted uranium shield assembly. The shielding is cast as one piece and is essentially enclosed by stainless steel. Dimensional information for the individual shield containers is contained in the shield drawings (See Appendix 1.3).

5.1.2 Summary Table of Maximum Radiation Levels

Tables 5.1.A and 5.1.B include worst case radiation profile data obtained from the 880 Series packages that were tested to the Normal and Hypothetical Accident Conditions of Transport under Test Plans 108 and 186 (see Section 2.12). Tables 5.1.F and 5.1.G include worst case radiation profile data obtained from the 880SC packages that were tested to the Normal and Hypothetical Accident Conditions of Transport under Test Plans 206 (see Section 2.12).

Table 5.1.A: Model 880 Delta sn TP186A Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Ir-192 (Non-Exclusive Use) and Hypothetical Accident Transport Condition Testing[3]

Normal Conditions of Transport	Package Surface mSv/h (mrem/hr)[2]			1 Meter from Package Surface mSv/h (mrem/h)[2]		
Radiation	Top	Side	Bottom	Top	Side	Bottom
Gamma	1.68 (168)	1.83 (183)	0.98 (98)	0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
Neutron	NA	NA	NA	NA	NA	NA
Total	1.68 (168)	1.83 (183)	0.98 (98)	0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
10 CFR 71.47(a) or Paragraphs 530 and 531 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.1 (10)[1]	0.1 (10)[1]	0.1 (10)[1]
Hypothetical Accident Conditions						
Gamma				0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
Neutron				NA	NA	NA
Total				0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] Transport Index may not exceed 10.

[2] Based on the cylindrical geometry of this package, the "top" is considered to be the front as profiled, the "bottom" is considered to be the back as profiled and all other surfaces are considered part of the "side" of the package.

[3] Survey results after testing were obtained from the Model 880 Delta without the optional jacket. This produced dose rates which would be higher than the Model 880 Delta if it had the optional jacket attached.

Table 5.1.B: Model Delta sn TP186A Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Ir-192 (Exclusive Use)[1]

	Package (or Freight Container) Surface mSv/h (mrem/h)			2 Meters from Outer Vehicle Surface mSv/h (mrem/h)		
Normal Conditions of Transport	Top	Side	Bottom	Top	Side	Bottom
Gamma	1.68 (168)	1.83 (183)	0.98 (98)	0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
Neutron	NA	NA	NA	NA	NA	NA
Total	1.68 (168)	1.83 (183)	0.98 (98)	0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
10 CFR 71.47(b) or Paragraphy 572 of TS-R-1 Limit	10 (1000)^2	10 (1000)^2	10 (1000)^2	0.1 (10)	0.1 (10)	0.1 (10)
	Vehicle Surface mSv/h (mrem/h)			**Occupied Position mSv/h (mrem/hr)**		
Gamma	< 0.008 (0.8)	< 0.014 (1.4)	< 0.010 (0.1)	≤ 0.02 (2)^3		
Neutron	NA	NA	NA	NA		
Total	< 0.008 (0.8)	< 0.014 (1.4)	< 0.010 (0.1)	≤ 0.02 (2)^3		
10 CFR 71.47(b) or Paragraphy 572 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.02 (2)		
Hypothetical Accident Conditions				**1 Meter from Package Surface mSv/h (mrem/hr)**		
Gamma				0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
Neutron				NA	NA	NA
Total				0.008 (0.8)	0.014 (0.14)	0.010 (0.10)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] For packages transported by roadway, railway and sea.

[2] For packages in closed vehicles, otherwise, 2 (200).

[3] Confirmed at time of vehicle loading prior to shipment.

Tables 5.1.C and 5.1.D include radiation profile data used to demonstrate that the Model 880 Delta and 880 Elite package configurations will meet the external radiation level requirements for non-exclusive use transport when loaded to capacity for Se-75. Based on comparisons of radiation profiles for Ir-192 after hypothetical accident testing and relative photon energy outputs for Ir-192 and Se-75, it is assessed that radiation levels from Se-75 will be essentially unchanged after undergoing the hypothetical accident condition testing. By assessment, since the Model 880 Sigma shield has greater shielding than the Model 880 Elite shield, the Model 880 Sigma package configuration will also meet the external radiation level requirements for non-exclusive use when loaded to capacity for Se-75.

Table 5.1.E includes radiation profile data used to demonstrate that the Model 880 Elite package configuration will meet the external radiation level requirements for non-exclusive use transport when loaded to capacity for Ir-192.

Table 5.1.H includes radiation profile data used to demonstrate that the Model 880SC package configuration will meet the external radiation level requirements for non-exclusive use transport when loaded to capacity for Se-75. Based on comparisons of radiation profiles for Ir-192 after hypothetical accident testing and relative photon energy outputs for Ir-192 and Se-75, it is assessed that radiation levels from Se-75 will be essentially unchanged after undergoing the hypothetical accident condition testing.

Table 5.1.C: Model 880 Delta sn D2375 Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Se-75 (Non-Exclusive Use)[2]

	Package Surface mSv/h (mrem/h)			1 Meter from Package Surface mSv/h (mrem/h)		
Normal Conditions of Transport	Top	Side	Bottom	Top	Side	Bottom
Gamma	0.13 (13)	0.13 (13)	0.13 (13)	0.01 (1.0)	0.01 (1.0)	0.01 (1.0)
Neutron	NA	NA	NA	NA	NA	NA
Total	0.13 (13)	0.13 (13)	0.13 (13)	0.01 (1.0)	0.01 (1.0)	0.01 (1.0)
10 CFR 71.47(a) or Paragraphs 530 and 531 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.1 (10)[1]	0.1 (10)[1]	0.1 (10)[1]
Hypothetical Accident Conditions[3]						
Gamma				~0.01 (1.0)	~0.01 (1.0)	~0.01 (1.0)
Neutron				NA	NA	NA
Total				~0.01 (1.0)	~0.01 (1.0)	~0.01 (1.0)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] Transport Index may not exceed 10.

[2] Normal Condition values obtained by direct measurement corrected for capacity and detector geometry.

[3] Based on comparisons of radiation profiles for Ir-192 after hypothetical accident testing, it is assessed that radiation levels from Se-75 will be essentially unchanged after undergoing the hypothetical accident condition testing.

Table 5.1.D: Model 880 Elite sn E1060 Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Se-75 (Non-Exclusive Use)[2]

	Package Surface µSv/h (mrem/h)			1 Meter from Package Surface µSv/h (mrem/h)		
Normal Conditions of Transport	Top	Side	Bottom	Top	Side	Bottom
Gamma	0.13 (13)	0.13 (13)	0.13 (13)	0.01 (1.0)	0.01 (1.0)	0.01 (1.0)
Neutron	NA	NA	NA	NA	NA	NA
Total	0.13 (13)	0.13 (13)	0.13 (13)	0.01 (1.0)	0.01 (1.0)	0.01 (1.0)
10 CFR 71.47(a) or Paragraphs 530 and 531 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.1 (10)[1]	0.1 (10)[1]	0.1 (10)[1]
Hypothetical Accident Conditions[3]						
Gamma				~0.01 (1.0)	~0.01 (1.0)	~0.01 (1.0)
Neutron				NA	NA	NA
Total				~0.01 (1.0)	~0.01 (1.0)	~0.01 (1.0)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] Transport Index may not exceed 10.

[2] Normal Condition values obtained by direct measurement corrected for capacity and detector geometry.

[3] Based on comparisons of radiation profiles for Ir-192 after hypothetical accident testing, it is assessed that radiation levels from Se-75 will be essentially unchanged after undergoing the hypothetical accident condition testing.

Table 5.1.E: Model 880 Elite sn E1060 Summary Table of External Radiation Levels Extrapolated to Capacity of 50 Ci Ir-192 (Non-Exclusive Use)[2]

	Package Surface mSv/h (mrem/h)			1 Meter from Package Surface mSv/h (mrem/h)		
Normal Conditions of Transport	Top	Side	Bottom	Top	Side	Bottom
Gamma	1.35 (135)	1.64 (164)	1.43 (143)	0.008 (0.8)	0.017 (1.7)	0.009 (0.9)
Neutron	NA	NA	NA	NA	NA	NA
Total	1.35 (135)	1.64 (164)	1.43 (143)	0.008 (0.8)	0.017 (1.7)	0.009 (0.9)
10 CFR 71.47(a) or Paragraphs 530 and 531 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.1 (10)[1]	0.1 (10)[1]	0.1 (10)[1]
Hypothetical Accident Conditions[3]						
Gamma				0.008 (0.8)	0.017 (1.7)	0.009 (0.9)
Neutron				NA	NA	NA
Total				0.008 (0.8)	0.017 (1.7)	0.009 (0.9)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] Transport Index may not exceed 10.

[2] Normal Condition values obtained by direct measurement corrected for capacity and detector geometry.

[3] Based on comparisons of radiation profiles for the 880 Delta when loaded with Ir-192 after hypothetical accident testing, it is assessed that radiation levels from the 880 Elite for Ir-192 will be essentially unchanged after undergoing the hypothetical accident condition testing.

Table 5.1.F: Model 880SC sn TP206B Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Ir-192 (Non-Exclusive Use) and Hypothetical Accident Transport Condition Testing[3]

Normal Conditions of Transport	Package Surface mSv/h (mrem/hr)[2]			1 Meter from Package Surface mSv/h (mrem/h)[2]		
Radiation	Top	Side	Bottom	Top	Side	Bottom
Gamma	1.96 (196)	1.82 (182)	0.99 (99)	0.011 (1.1)	0.012 (1.2)	0.026 (2.6)
Neutron	NA	NA	NA	NA	NA	NA
Total	1.96 (196)	1.82 (182)	0.99 (99)	0.011 (1.1)	0.012 (1.2)	0.026 (2.6)
10 CFR 71.47(a) or Paragraphs 530 and 531 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.1 (10)[1]	0.1 (10)[1]	0.1 (10)[1]
Hypothetical Accident Conditions						
Gamma				0.011 (1.1)	0.012 (1.2)	0.026 (2.6)
Neutron				NA	NA	NA
Total				0.011 (1.1)	0.012 (1.2)	0.026 (2.6)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] Transport Index may not exceed 10.

[2] Based on the cylindrical geometry of this package, the "top" is considered to be the front as profiled, the "bottom" is considered to be the back as profiled and all other surfaces are considered part of the "side" of the package.

[3] Survey results after testing were obtained from the Model 880SC without the optional jacket. This produced dose rates which would be higher than the Model 880SC if it had the optional jacket attached.

Table 5.1.G: Model 880SC sn TP206B Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Ir-192 (Exclusive Use)[1]

	Package (or Freight Container) Surface mSv/h (mrem/h)			2 Meters from Outer Vehicle Surface mSv/h (mrem/h)		
Normal Conditions of Transport	Top	Side	Bottom	Top	Side	Bottom
Gamma	1.96 (196)	1.82 (182)	0.99 (99)	<0.011 (1.1)	<0.012 (1.2)	<0.026 (2.6)
Neutron	NA	NA	NA	NA	NA	NA
Total	1.96 (196)	1.82 (182)	0.99 (99)	<0.011 (1.1)	<0.012 (1.2)	<0.026 (2.6)
10 CFR 71.47(b) or Paragraphs 572 of TS-R-1 Limit	10 (1000)[2]	10 (1000)[2]	10 (1000)[2]	0.1 (10)	0.1 (10)	0.1 (10)
	Vehicle Surface mSv/h (mrem/h)			**Occupied Position mSv/h (mrem/hr)**		
Gamma	< 0.011 (1.1)	< 0.012 (1.2)	< 0.026 (2.6)	≤ 0.02 (2)[3]		
Neutron	NA	NA	NA	NA		
Total	< 0.011 (1.1)	< 0.012 (1.2)	< 0.026 (2.6)	≤ 0.02 (2)[3]		
10 CFR 71.47(b) or Paragraph 572 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.02 (2)		
Hypothetical Accident Conditions				**1 Meter from Package Surface mSv/h (mrem/hr)**		
Gamma				0.011 (1.1)	0.012 (1.2)	0.026 (2.6)
Neutron				NA	NA	NA
Total				0.011 (1.1)	0.012 (1.2)	0.026 (2.6)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] For packages transported by roadway, railway and sea.

[2] For packages in closed vehicles, otherwise, 2 (200).

[3] Confirmed at time of vehicle loading prior to shipment.

Table 5.1.H: Model 880SC Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Se-75 (Non-Exclusive Use)[2]

	Package Surface mSv/h (mrem/h)			1 Meter from Package Surface mSv/h (mrem/h)		
Normal Conditions of Transport	Top	Side	Bottom	Top	Side	Bottom
Gamma	<1.96 (196)	<1.82 (182)	<0.99 (99)	<0.011 (1.1)	<0.012 (1.2)	<0.026 (2.6)
Neutron	NA	NA	NA	NA	NA	NA
Total	<1.96 (196)	<1.82 (182)	<0.99 (99)	<0.011 (1.1)	<0.012 (1.2)	<0.026 (2.6)
10 CFR 71.47(a) or Paragraphs 530 and 531 of TS-R-1 Limit	2 (200)	2 (200)	2 (200)	0.1 (10)[1]	0.1 (10)[1]	0.1 (10)[1]
Hypothetical Accident Conditions[3]						
Gamma				<0.011 (1.1)	<0.012 (1.2)	<0.026 (2.6)
Neutron				NA	NA	NA
Total				<0.011 (1.1)	<0.012 (1.2)	<0.026 (2.6)
10 CFR 71.51(a)(2) or Paragraph 656(b)(ii)(I) of TS-R-1 Limit				10 (1000)	10 (1000)	10 (1000)

[1] Transport Index may not exceed 10.

[2] Normal Condition values obtained by direct measurement corrected for capacity and detector geometry.

[3] Based on comparisons of radiation profiles for Ir-192 after hypothetical accident testing, it is assessed that radiation levels from Se-75 will be essentially unchanged after undergoing the hypothetical accident condition testing.

5.2 Source Specification

5.2.1 Gamma Source

The gamma sources allowed for transport in the Model 880 Series transport package are specified in Sections 1.2.2 and 2.10.

5.2.2 Neutron Source

Not applicable. The Model 880 Series transport packages are not used for the transportation of neutron emitting sources.

5.3 Shielding Model

5.3.1 Configuration of Source and Shielding

A shielding model was not used as the primary justification for these packages. Shielding justification was based on direct measurement and a comparison of relative photon energy output per Ci between Ir-192 and Se-75 to justify Se-75 capacities in some cases. Since the 880 Delta and 880SC testing results showed that an insignificant change had occurred in the radiation profiles, all isotopes in all other versions of the Model 880 Series packages were considered acceptable.

5.3.2 Material Properties

Not applicable. A shielding model was not used as the primary justification for these packages. Shielding justification was based on direct measurement using Ir-192 and Se-75 and comparison of relative photon shielding effectiveness between Ir-192 and Se-75. Additional package configurations were justified based on test results of the Model 880 Delta and 880SC style packages.

5.4 Shielding Evaluation

5.4.1 Methods

Shielding justification was based on direct measurement and assessment. Radiation profiles have not been performed for the Model 880 Sigma, however, the shield design is identical to the Model 880 Delta. This design is capable of producing shields that can adequately shield 150 Ci of Ir-192 to within the regulatory dose limits. Due to variances in the shield manufacturing process, some shields are produced with a slightly lower shielding capacity. Shields which demonstrate a capacity of 130 Ci of Ir-192, based on device profiles prior to final acceptance and shipment, are distributed as Model 880 Sigma devices.

All packages are profiled prior to final acceptance and shipment. This profile takes into account the maximum capacity and detector geometry. Any package not meeting the required dose rates is rejected.

If the optional jacket is used, it will further reduce surface dose rates on some areas of the package. As such, the use of the jacket will have no detrimental impact on dose rates.

5.4.2 Input and Output Data

Radiation measurements included in this Section were adjusted to the maximum activity capacity for the package (e.g., activity correction factor) and the surface measurements were also adjusted to correct for off-set of the survey meter probe from the true surface of the package.

Activity correction factors (CF_A) were obtained by using the following relationship:

$$CF_A = \frac{Maximum Package Activity Capacity\ (A_C)}{Actual\ \mathrm{Pr}\,ofile Activity\ (A_P)}$$

$$For Example,\ if\ A_P = 135\,Ci\ and\ A_C = 150\,Ci,\ then$$

$$CF_A = \frac{150\,Ci}{135\,Ci} = 1.1$$

Therefore all original surface and 1 meter profile measurements would be multiplied by a factor of 1.1 for a package profiled using 135 Ci and a package capacity of 150 Ci.

Radiation measurements at the surface of the container were also adjusted to compensate for the off-set of the survey meter probe from the true surface of the package.

Surface correction factors (SCF) were obtained by using the following relationship:

$$SCF = \sqrt{\frac{d_2^2}{d_1^2}}\ where\ d_1\ and\ d_2\ are\ \mathrm{determined}\ as\ shown\ in\ Figure\ 5.4.A.$$

$$For Example,\ if\ d_1 = 9\,inches\ and\ d_2 = 10\,inches,\ then$$

$$SCF = \sqrt{\frac{(10\,inches)^2}{(9\,inches)^2}} = 1.11$$

Subsequent evaluation of the SCF revealed that the use of the inverse square law introduces an error when the material of the shield contains a heavy element such as tungsten, uranium or lead. When heavy shields are involved there is a build-up of Compton-scattered photons and X-rays which causes scattered radiation to emanate from everywhere within the shield and not just from the source in the center. Under these circumstances, the inverse square law relationship between dose rate and distance overestimates the actual dose rate on the surface of the device.

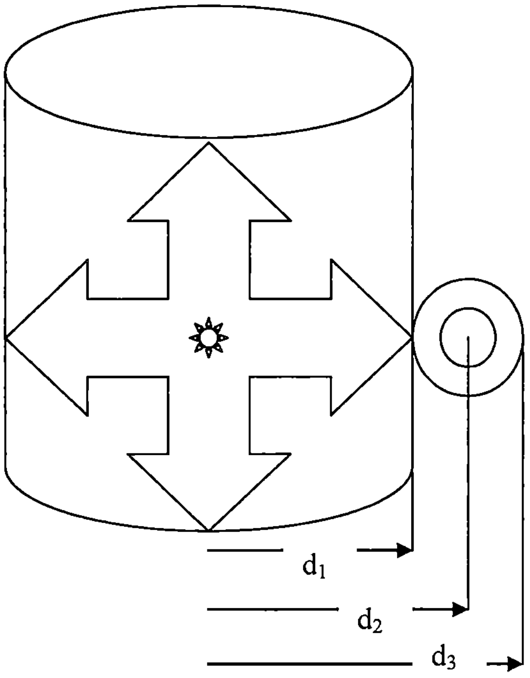
Experimental measurement using TLDs have demonstrated that the SCF for devices using heavy element shielding varies more accurately as follows:

$$SCF = \sqrt{\frac{d_3}{d_1}} \text{ where } d_1 \text{ and } d_3 \text{ are determined as shown in Figure 5.a.}$$

$$For\,Example,\ if\ d_1 = 9\,inches\ and\ d_3 = 10\,inches,\ then$$

$$SCF = \sqrt{\frac{(10\,inches)}{(9\,inches)}} = 1.05$$

Therefore in the example shown, all original surface profile measurements located along the side of the package shown in Figure 5.4.A would also be multiplied by a factor to account for surface correction of the detector to the package surface. Different SCF's would be calculated for the any dimension of the container where the minimum distance from the center of the activity to the center of the radiation probe is different.



d_1 = distance from activity center to surface of container.

d_2 = distance from activity center to surface of container plus radius of the survey meter probe.

d_3 = distance from activity center to back of the probe.

Figure 5.4.A. - Sample Surface Correction Factor Distance Criteria

The radiation profile data showed no increase in radiation dose after testing beyond normal measurement variations. All test specimens met the regulatory requirements.

5.4.3 Flux-to-Dose-Rate Conversion

Not applicable. Flux rates were not used to convert to dose rates in any shielding evaluations.

5.4.4 External Radiation Levels

Radiation surveys for all 880 Series configurations showed maximum surface and 1 meter radiation levels from the transport packages within regulatory limits. Radiation surveys of 880 Series transport packages after undergoing normal and accident condition transport testing were also well within the regulatory limits.

5.5 Appendix

Not Applicable.

Section 6 - CRITICALITY EVALUATION

All parts of this section are not applicable. The Model 880 Series transport packages are not used for shipment of Type B quantities of fissile material.

Section 7 – Package Operations

Operation of the Model 880 Series transport packages must be in accordance with the operating instructions supplied with the transport package, per 10 CFR 71.87 and 71.89.

7.1 Package Loading

7.1.1 Preparation for Loading

The Model 880 Series transport packages must be loaded and closed in accordance with procedures that, at a minimum, include the requirements specified in this section. Shipment of Type B quantities of radioactive material are authorized for sources specified in Section 7.1.1.1. Maintenance and inspection of these packages is in accordance with the requirements specified in Section 7.1.1.2.

7.1.1.1 Authorized Package Contents

The Model 880 Series transport packages are designed for use with a special form source capsules as approved under a U.S. Department of Transportation special form certification. The approved isotopes and maximum package activity limits is shown in Table 7.1.A. Details of encapsulation as well as chemical and physical form of the radioactive material will comply with specifications approved under U.S. Department of Transportation or other Competent Authority special form certifications.

Table 7.1.A: Isotopes Permitted in the Model 880 Series

Model	Nuclide	Form[1]	Maximum Capacity[2]	Maximum DU Weight	Maximum Weight Without Jacket	Maximum Weight With Jacket (Version 1)	Maximum Weight With Jacket (Version 2)
880 Delta	Ir-192	Special Form	150 Ci	34.4 lbs (15.6 kg)	46 lbs (21 kg)	52 lbs (24 kg)	55 lbs (25 kg)
	Se-75	Special Form	150 Ci				
880 Sigma	Ir-192	Special Form	130 Ci	34.4 lbs (15.6 kg)	46 lbs (21 kg)	52 lbs (24 kg)	55 lbs (25 kg)
	Se-75	Special Form	150 Ci				
880 Elite	Ir-192	Special Form	50 Ci	25 lbs (11 kg)	37 lbs (17 kg)	42 lbs (19 kg)	45 lbs (20 kg)
	Se-75	Special Form	150 Ci				
880SC	Ir-192	Special Form	150 Ci	34.4 lbs (15.6 kg)	46 lbs (21 kg)	52 lbs (24 kg)	NA
	Se-75	Special Form	150 Ci				

[1] Special Form is defined in 10 CFR 71, 49 CFR 173, and IAEA TS-R-1.

[2] Maximum Capacity Activity for Ir-192 is defined as output Curies as required in ANSI N432 and 10 CFR 34.20 and in line with TS-R-1 and Rulemaking by the USNRC and the USDOT published in the Federal Register on 26 January 2004

7.1.1.2 Packaging Maintenance and Inspection Prior to Loading

a. Ensure all markings are legible.

b. Inspect the container for signs of significant degradation. Ensure all welds are intact, the container is free of heavy rust and cracks/damage to the steel housing which breaches the container. If there is any evidence of bent or cracked welds contact QSA Global, Inc. prior to shipping.

c. Assure all bolts and fasteners (hardware) required for assembly of the package and as specified on the drawings referenced on the Type B transport certificate are fit for use. Without removing the hardware by disassembly from the device, examine the visible external surfaces of the bolts/fasteners for any signs of fatigue cracking.

Note: A visual examination of the bolt/fastener thread condition is performed after removal from the exposure device as part of the Quarterly and Annual Maintenance inspections required for radiography devices under 10 CFR 34.31 or equivalent Agreement State regulations.

The bolts/fasteners must be replaced if they are no longer fit for use (e.g., threads stripped, unable to fully thread, signs of cracking, etc). Ensure the front port is properly secured. Ensure seal wire(s) are properly installed. Ensure any replacement hardware meets all applicable specifications listed on the drawings referenced on the Type B transport certificate.

d. If the container fails any of the inspections in steps 7.1.1.2.a-c, remove the container from use until it can be brought into compliance with the Type B certificate.

7.1.2 Loading of Contents

NOTE: ***These loading operations apply to "dry" loading only. None of the shield configurations for the Model 880 Series package are approved for wet loading.***

7.1.2.1 Prior to transportation, ensure the package and its contents meet the following requirements:

a. The contents are authorized for use in the package.

b. The package condition has been inspected in accordance with Section 7.1.1.2.

c. Ensure that the source is secured into place in the storage position after loading the 880 package in accordance with the applicable licensing provisions for the user's facility related to radioactive material handling.

7.1.3 Preparation for Transport

7.1.3.1 Ensure that all conditions of the certificate of compliance are met.

7.1.3.2 Perform a contamination wipe of the outside surface of the package and ensure removable contamination does not exceed 0.0001 μCi when averaged over a wipe area of 300 cm^2.

7.1.3.3 Survey all exterior surfaces of the package to assure that the radiation level does not exceed 200 mR/hr at the surface. Measure the radiation level at one meter from all exterior surfaces to assure that the radiation level is less than 10 mR/hr.

7.1.3.4 Ship the container according to the procedure for transporting radioactive material as established in 10 CFR 71.5 and 49 CFR 171-178.

NOTE: The US Department of Transportation, in 49 CFR 173.22(c), requires each shipper of Type B quantities of radioactive material to provide prior notification to the consignee of the dates of shipment and expected arrival.

7.2 Package Unloading

7.2.1 Receipt of Package from Carrier

7.2.1.1 The consignee of a transport package of radioactive material must make arrangements to receive the transport package when it is delivered. If the transport package is to be picked up at the carrier's terminal, 10 CFR 20.1906 requires that this be done expeditiously upon notification of its arrival.

7.2.1.2 Upon receipt of a transport package of radioactive material:

a. Survey the transport package with a survey meter as soon as possible, preferably at the time of pick-up and no more than three hours after it was received during normal working hours. Radiation levels should not exceed 200 mR/hr at the surface of the transport package, nor 10 mR/hr at a distance of 1 meter from the surface.

b. Record the actual radiation levels on the receiving report.

c. If the radiation levels exceed these limits, secure the container in a Restricted Area and notify the appropriate personnel in accordance with 10 CFR 20 or applicable Agreement State regulations.

d. Inspect the outer container for physical damage or leaking. If the package is damaged or leaking or it is suspected that the package may have leaked or been damaged, restrict access to the package. As soon as possible, contact the Radiation Safety Office to perform a full assessment of the package condition and take necessary follow-up actions.

e. Record the radioisotope, activity, model number, and serial number of the source and the transport package model number and serial number.

7.2.2 Receipt of Contents

7.2.2.1 Unload the package must be in accordance with the instructions supplied with the package per 10 CFR 71.89.

7.2.2.2 Unloading of the package must also be in accordance with applicable licensing provisions for the user's facility related to radioactive material handling.

7.3 Preparation of Empty Package for Transport

In the following instructions, an *empty* transport package refers to a Model 880 Series transport package without an active source contained within the shielded container. To ship an empty transport package:

7.3.1. For the 880 Delta, 880 Sigma or 880 Elite packages, perform the following procedure to confirm that there are no unauthorized sources within the container:

7.3.1.1 Remove the authorized source assembly from the package in accordance with the instructions supplied with the package per 10 CFR 71.89.

7.3.1.2 After removing the source and disconnecting the source assembly, attach the jumper (dummy connector without a serial number) to the male connector of the drive cable.

7.3.1.3 Retract the jumper into the package and disconnect the controls.

7.3.1.4 Insert the shipping cover, rotate the selector ring to the lock position, depress the plunger lock and remove the key.

7.3.1.5 Remove the source identification tag from the package and keep it with the source.

7.3.2. To ship an empty 880SC package a second shipping plug assembly or dummy (inactive) A424-9 source wire DEMO assembly is required. If not available, contact QSA Global, Inc. to obtain an appropriate assembly before shipping an 880SC empty. Once the second assembly is obtained, perform the following:

7.3.1.1 Remove the authorized source assembly from the package in accordance with the instructions supplied with the package per 10 CFR 71.89.

7.3.1.2 Insert a shipping plug assembly into one of the locking assemblies on the package until the lock engages.

7.3.1.3 Depress the key plunger lock and remove the key. Rotate the shipping cap to the closed position and secure in place with the spring plunger.

7.3.1.4 Repeat steps 7.3.1.2 and 7.3.1.3 for the other locking assembly on the package using another shipping plug assembly or a dummy (inactive) A424-9 source wire DEMO assembly.

7.3.1.5 Remove the source identification tag from the package and keep it with the source.

7.3.3 Assure that the levels of removable radioactive contamination on the outside surface of the transport package do not exceed 4 Bq/cm^2 (when averaged over 300 cm^2).

7.3.4 When it is confirmed that the Model 880 Series transport package is empty, survey the device and prepare the transport package for shipment. Survey the assembled package to ensure the external surface radiation level does not exceed 5 μSv/hr.

7.3.5 Ship the container according to the procedure for transporting radioactive material as established in10 CFR 71.5.

7.4 Other Operations

7.4.1 Package Transportation By Consignor

Persons transporting the Model 880 Series transport package in their own conveyances should comply with the following:

7.4.1.1 For a conveyance and equipment used regularly for radioactive material transport, check to determine the level of contamination that may be present on these items. This contamination check is suggested if the package shows signs of damage upon receipt or during transport, or if a leak test on the special form source transported in the package exceeds the allowable limit of 185 Bq (0.005 μCi).

7.4.1.2 If contamination above 4 Bq/cm^2 (0.0001 μCi/cm^2) based on wiping an area of 300 cm^2 is detected on any part of a conveyance or equipment used regularly for radioactive material transport, or if a radiation level exceeding 5 μSv/h (0.5 mR/hr) is detected on any conveyance or equipment surface, then remove the affected item from use until decontaminated or decayed to meets these limits.

7.4.1.3 Ensure the package is properly blocked and braced prior to transport to prevent movement within the conveyance during transport.

7.4.2 Emergency Response

In the event of a transport emergency or accident involving this package, follow the guidance contained in "2012 Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident", or equivalent guidance documentation.

Reference: "2012 Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident.

7.5 Appendix

Not Applicable.

Section 8 - ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Test

8.1.1 Visual Inspections and Measurements

8.1.1.1 Visually inspect each transport package component to be shipped to assure the following:

a. The transport package was assembled properly to the applicable drawing referenced on the Type B transport certificate.

b. Evaluate each shield container for shielding integrity when used in the applicable Model 880 Series assembly to ensure the transport dose rate requirements are met when the container is loaded to capacity.

c. All fasteners as required by the applicable drawings referenced on the Type B transport certificate are properly installed and secured.

d. The relevant labels are attached, contain the required information, and are marked in accordance with 10 CFR 20.1904, 10 CFR 40.13(c)(6)(i), 10 CFR 34, and 10 CFR 71 or equivalent Agreement State regulations.

8.1.1.2 Visual inspections and measurements will be performed in accordance with QSA Global, Inc.'s USNRC approved Quality Assurance Program No. 0040.

8.1.2 Weld Examinations

Weld examinations will be performed in accordance with the applicable drawings requirements and in accordance with QSA Global, Inc.'s USNRC approved Quality Assurance Program No. 0040.

8.1.3 Structural and Pressure Tests

Prior to first use as part of a Model 880 Series Transport Package, container structural conformance will be evaluated in accordance with the applicable drawings requirements and in accordance with QSA Global, Inc.'s USNRC approved Quality Assurance Program No. 0040. The containment system is not designed to require increased or decreased operating pressures to maintain containment during transport, therefore pressure tests of package components prior to first use are not required.

8.1.4 Leakage Tests

The source capsules (primary containment) are wipe tested for leakage of radioactive contamination upon initial manufacture. The removable contamination must be less than 185 Bq (0.005 µCi). The source capsules will also be subjected to leak tests under ISO9978:1992(E) (or more recent editions). The source capsules are not used if they fail any of these tests.

8.1.5 Component and Material Tests

Component and material compliance is achieved in accordance with the requirements in QSA Global, Inc.'s USNRC approved Quality Assurance Program No. 0040.

8.1.6 Shielding Tests

The radiation levels at the surface of the transport package and at 1 meter from the surface are measured upon manufacture. This survey is performed in a low background area and involves a slow scan survey of the entire surface area as well as one meter from the surface of the package. This survey is used to identify any significant void volumes or shield porosity which could prevent the finished device from complying with the dose limits in 10 CFR 71.47.

The radiation profile survey is made with the radiation detector housing in contact with the surface of the package and then also at one meter from the surface of the container. The radiation profile survey for the Model 880SC package is performed twice with the radiation source loaded into each of the locking assemblies of the package. These radiation levels, when extrapolated to the rated capacity of the transport package, must not exceed 200 mR/hr at the surface, nor 10 mR/hr at 1 meter from the surface of the transport package. Failure of this test prevented use of the package as a Type B(U) package.

Rejected packages which do not comply with the construction requirements on the applicable drawings referenced on the Type B certificate, or that do not comply with the radiation profile requirements will not distributed as approved Type B(U) packages.

8.1.7 Thermal Tests

Not applicable. The source content of the Model 880 Series packages has minimal effect on the package surface temperature and therefore no additional testing is necessary to evaluate thermal properties of the packaging.

8.1.8 Miscellaneous Tests

Not applicable.

8.2 Maintenance Program

8.2.1 Structural and Pressure Tests

Not applicable. Material certification is obtained for Safety Class A components used in the transport package prior to their initial use. Based on the construction of the design, no additional structural testing during the life of the package is necessary if the container shows no signs of defect when prepared for shipment in accordance with the requirements of Section 7 of the SAR. The 880 Series packaging is not designed to require increased or decreased operating pressures to maintain containment during transport, therefore pressure tests of package components prior to individual shipment is not required.

8.2.2 Leakage Tests

As described in Section 8.1.4, "Leakage Tests," the radioactive source assembly is leak-tested at manufacture. In addition, the sources are leak tested in accordance with that Section at least once every six months thereafter if being transported to ensure that removable contamination is less than 185 Bq (0.005 μCi). Also a contamination wipe is performed of the shield source tubes whenever the shield is returned to the manufacturer (typically the shield is shipped to a customer with new sources and may be returned directly to the manufacturer with decayed sources for disposition)

8.2.3 Component and Material Tests

The transport package is inspected for tightness of fasteners, proper seal wires, general condition and fitness for use prior to each use (see Section 7.1.1). Prior to each use, a radiation survey of the transport package is made to assure that the radiation levels do not exceed 200 mR/hr at the surface, nor 10 mR/hr at 1 meter from the surface.

8.2.4 Thermal Tests

Not applicable. The source content of the Model 880 Series package has no adverse effect on the package surface temperature and therefore no additional testing is necessary to evaluate thermal properties of the packaging prior to shipment.

8.2.5 Miscellaneous Tests

Inspections and tests designed for secondary users of this transport package under the general license provisions of 10 CFR 71.17(b) are provided in Section 7.

8.3 Appendix

Not applicable.

Section 9 – Quality Assurance

9.1 U.S. Quality Assurance Program Requirements

All component fabrication (including assembly) is controlled under the QSA Global, Inc. Quality Assurance program approved by the USNRC (approval number 0040) and ISO 9001.

9.2 Canada Quality Assurance Program Requirements

Not applicable. This package is originally submitted for certification in the United States and complies with the criteria in Section 9.1.