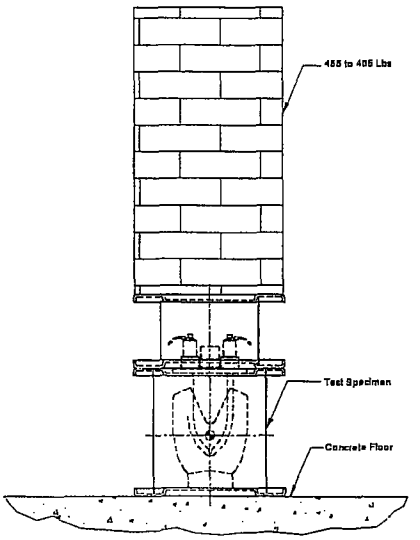
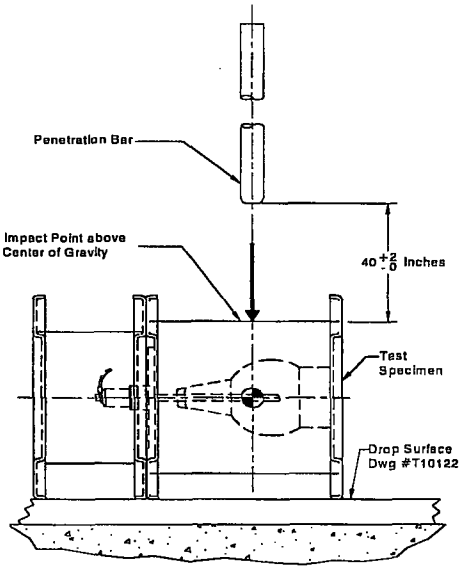
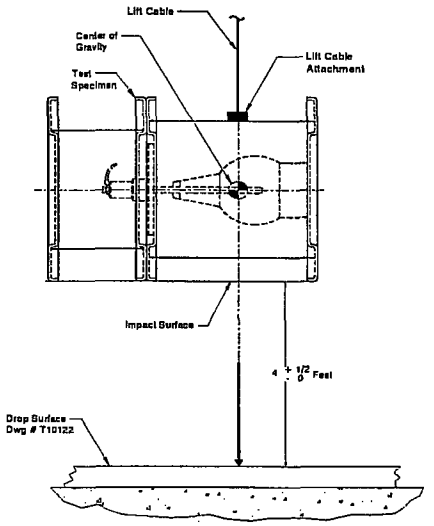
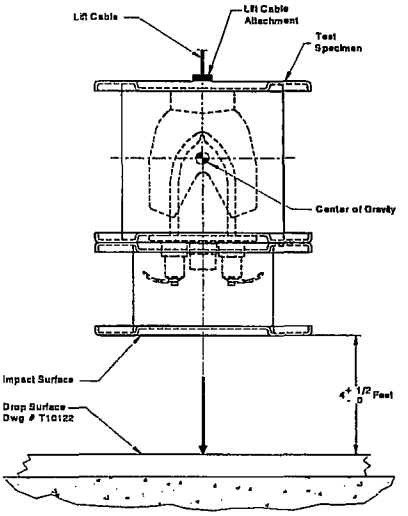
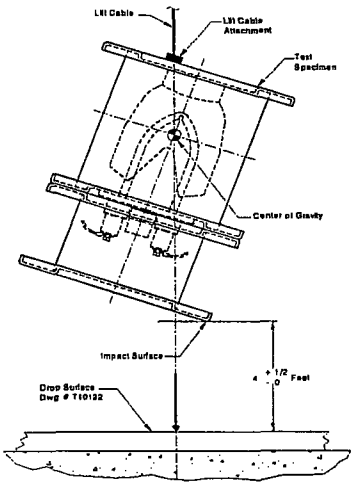
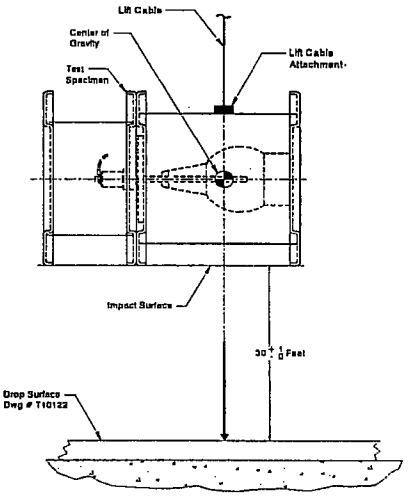
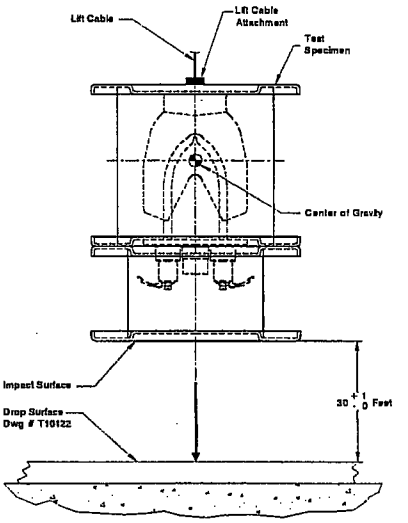
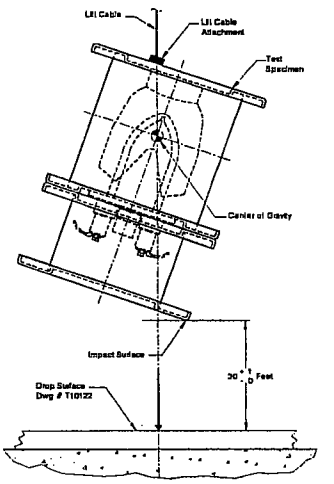
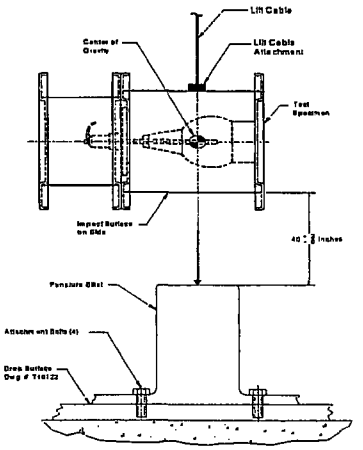
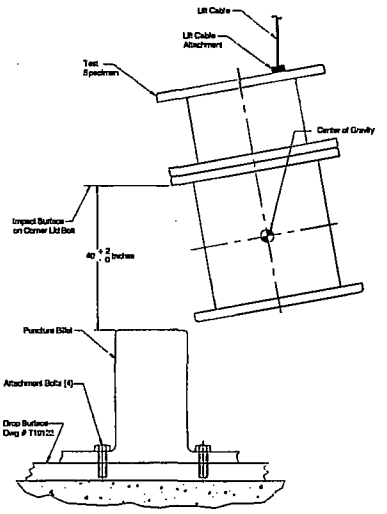
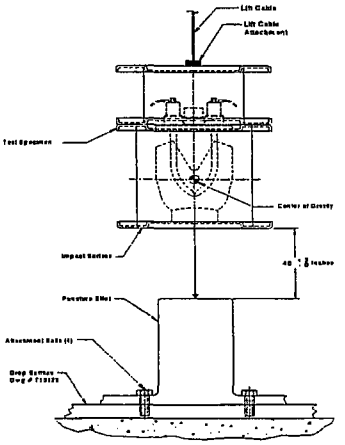
8.4 Summary of Test Schedule

Test	Paragraph	Specimen	Diagram
Compression	71.71(c)(9)	ALL	
Penetration	71.71(c)(10)	ALL	

Test	Paragraph	Specimen	Diagram
1.2 Meter (4 Foot) Free Drop, Case 1, Horizontal, Long Side Down	71.71(c)(7)	TP80(A)	
1.2 Meter (4 Foot) Free Drop, Case 2, Vertical, Upside Down	71.71(c)(7)	TP80(B)	
1.2 Meter (4 Foot) Free Drop, Case 3, Top Corner Down	71.71(c)(7)	TP80(C)	

Test	Paragraph	Specimen	Diagram
9 Meter (30 Foot) Free Drop, Case 1, Horizontal, Long Side Down	71.73(c)(1)	TP80(A)	
9 Meter (30 Foot) Free Drop, Case 2, Vertical, Upside Down	71.73(c)(1)	TP80(B)	
9 Meter (30 Foot) Free Drop, Case 3, Top Corner Down	71.73(c)(1)	TP80(C)	

Test	Paragraph	Specimen	Diagram
Puncture, Case 1, Horizontal, Long Side Down	71.73(c)(3)	TP80(A)	
Puncture, Case 2, Underneath Corner of Top Plate	71.73(c)(3)	TP80(B)	
Puncture, Case 3, Vertical Upright	71.73(c)(3)	TP80(C)	
Thermal	71.73(c)(4)	ALL	Requirement for thermal test to be determined for each unit following completion of drop and puncture tests.

8.5 Compression Test (10 CFR 71.71(c)(9))

The first test is the compression test, per 10 CFR 71.71(c)(9), in which the package is placed under a load of 455 pounds which is greater than five times the maximum package weight and greater than 2 lbf/in^2 multiplied by the vertically projected area:

5 x 90 lbf = 450 lbf

8 ¼" wide x 10" long x 2 lbf/in^2 = 165 lbf

Refer to *Equipment List 1* for information about required tools. Use *Checklist 1* to ensure that the test sequence is followed. Use *Data Sheet 1* to record testing results. Sign and date all action items and record required data on the appropriate worksheets.

8.5.1 Compression Test Setup

To prepare a specimen for the compression test:

1. Review the setup shown in Figure 2.
2. Place the specimen on a concrete surface oriented in its normal, upright transport position.
3. Gradually place 455 to 465 pounds uniformly distributed onto the specimen as shown in Figure 2.
4. Test specimen in accordance with *Checklist 1*.

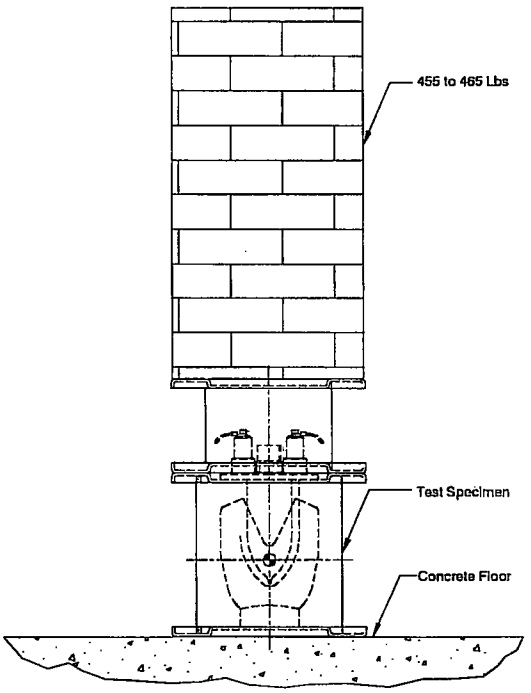


Figure 2. Compression Test Setup

8.5.2 Compression Test Assessment

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

1. Review the test execution to ensure that the test was performed in accordance with 10 CFR 71.

2. Make a preliminary evaluation of the specimen relative to the requirements of 10 CFR 71.

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

4. Evaluate the condition of the specimen to determine if changes are necessary in the package orientation for the penetration test to achieve maximum damage.

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

The compression test is followed by the penetration test, per 10 CFR 71.71(c)(10), in which a penetration bar is dropped from a height of at least 40 inches to impact a specified point on the package. The bar is dropped through free air.

Refer to *Equipment List 2* for information about required tools. Use *Checklist 2* to ensure that the test sequence is followed. Use *Data Sheet 2* to record testing results. Sign and date all action items and record required data on the appropriate worksheets.

8.6.1 Penetration Test Setup

This test requires that the test specimen be at -40°C or below at the time of the penetration bar release. The worksheet calls for measuring and recording the specimen temperature before and after the test.

To set up a package for the penetration test:

1. Place the specimen on the drop surface (Drawing AT10122, Revision B) and position it according to the orientation described in the next section. Use shims to position the package, if necessary.

2. Position the penetration bar shown in Drawing BT10129, Revision B, directly above the specified point of impact, and raise the bar 40 to 42 inches above the target.

3. Measure the specimen's internal and surface temperature to ensure that the package is at the required temperature.

4. Test specimen in accordance with *Checklist 2*.

8.6.2 Penetration Test Orientation

The 650L package is placed horizontally, long side down on the drop surface specified in Drawing AT10122, Revision B. The orientation of the package is shown in Figure 3. The desired impact point is on the long side of the outer shell, directly above the center of gravity of the package, to try to penetrate the shells.

Other orientations for this specimen were considered including the normal transport position. In the normal transport orientation, the lock assembly is protected by the 0.135" thick steel outer lid. The penetration bar dropped from four feet would cause only minor damage to the outer lid.

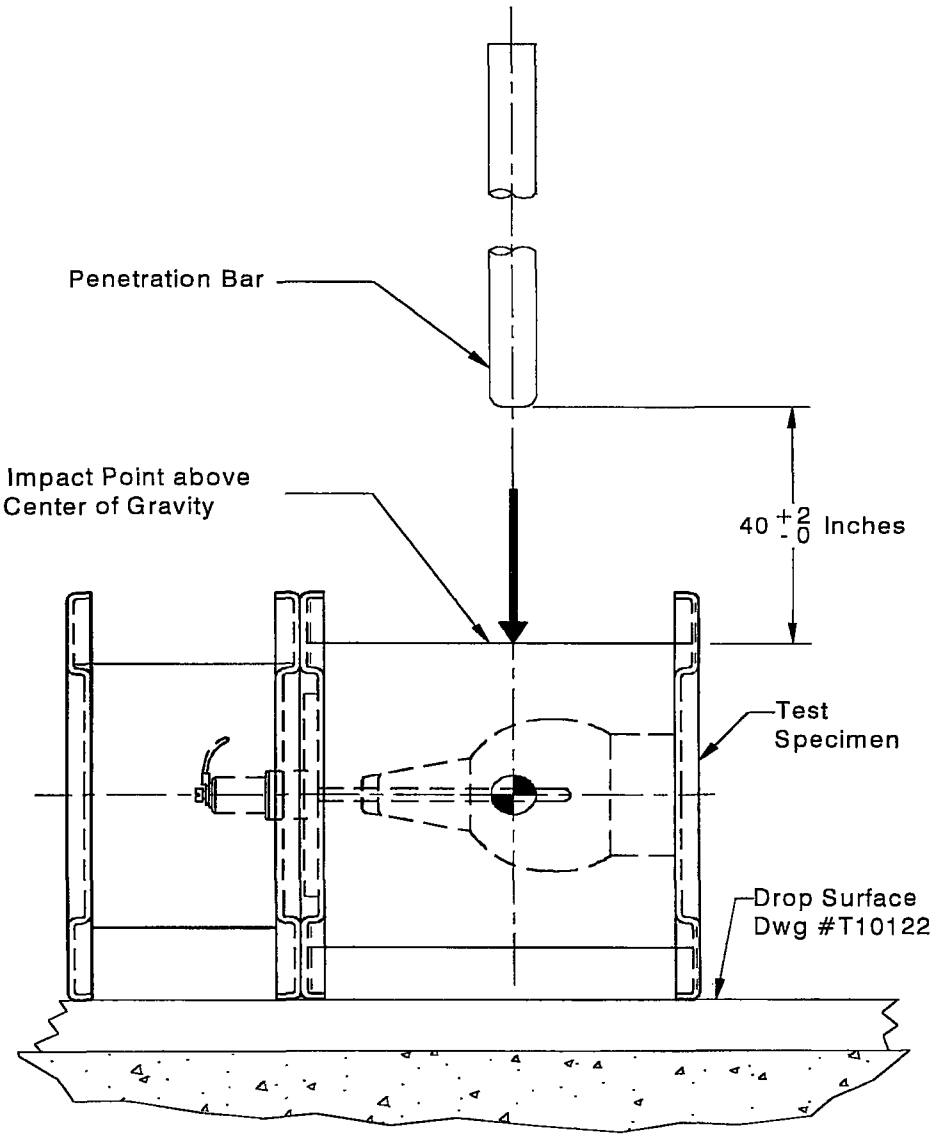


Figure 3. Penetration Test Orientation

8.6.3 Penetration Test Assessment

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

1. Review the test execution to ensure that the test was performed in accordance with 10 CFR 71.

2. Make a preliminary evaluation of the specimen relative to the requirements of 10 CFR 71.

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

4. Evaluate the condition of the specimen to determine if changes are necessary in the package orientation for the 1.2 meter (4 foot) free drop test to achieve maximum damage.

8.7 1.2 Meter (4 Foot) Free Drop Test (10 CFR 71.71(c)(7))

The final Normal Transport Conditions test is the 1.2 meter (4 foot) free drop as described in 10 CFR 71.71(c)(7). The drop compounds any damage caused in the first two tests. Upon completion of this step, the first intermediate test inspections will be performed.

Refer to *Equipment List 3* for information about required tools. Use *Checklist 3* to ensure that the test sequence is followed. Use *Data Sheet 3* to record testing results. Sign and date all action items and record required data on the appropriate worksheets.

8.7.1 1.2 Meter (4 Foot) Free Drop Test Setup

In this test, the package is released from a height of four feet and lands on the steel drop surface specified in Drawing AT10122, Revision B.

This test requires that all test specimen be at -40°C or below at the time of impact. Follow the instructions in the appropriate checklist for measuring and recording the test specimen temperature before and after the drop.

To set up a package for the 1.2 meter (4 foot) free drop test:

1. Use the drop surface specified in Drawing AT10122, Rev. B.

2. Measure and record the test specimen temperature to ensure that the package is at the specified temperature.

3. Place the specimen on the drop surface and position it according to the appropriate orientation:

   - Refer to Figure 4 for the Specimen TP80(A) package orientation
   - Refer to Figure 5 for the Specimen TP80(B) package orientation
   - Refer to Figure 6 for the Specimen TP80(C) package orientation

4. Align the selected center-of-gravity as shown in the referenced drawing.

5. Raise the package so that the impact target is 4.0 to 4.5 feet above the drop surface.

6. Test specimen in accordance with *Checklist 3*.

8.7.2 1.2 Meter (4 Foot) Free Drop Test Orientation, Specimen TP80(A)

The impact surface of Specimen TP80(A) is horizontal, long-side down.

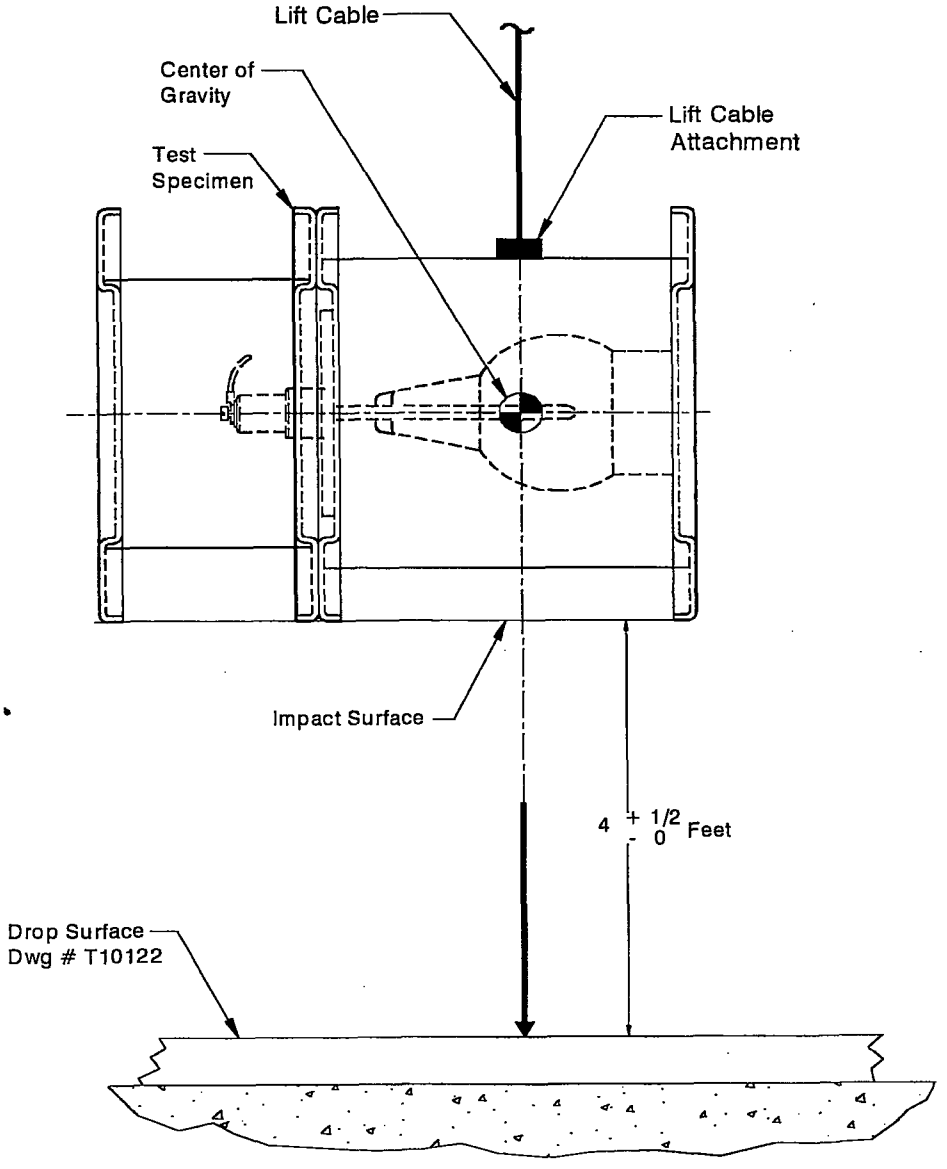


Figure 4. 1.2 Meter (4 Foot) Free Drop Orientation, Specimen TP80(A)

8.7.3 1.2 Meter (4 Foot) Free Drop Test Orientation, Specimen TP80(B)

The impact surface for Specimen TP80(B) is vertical, upside down.

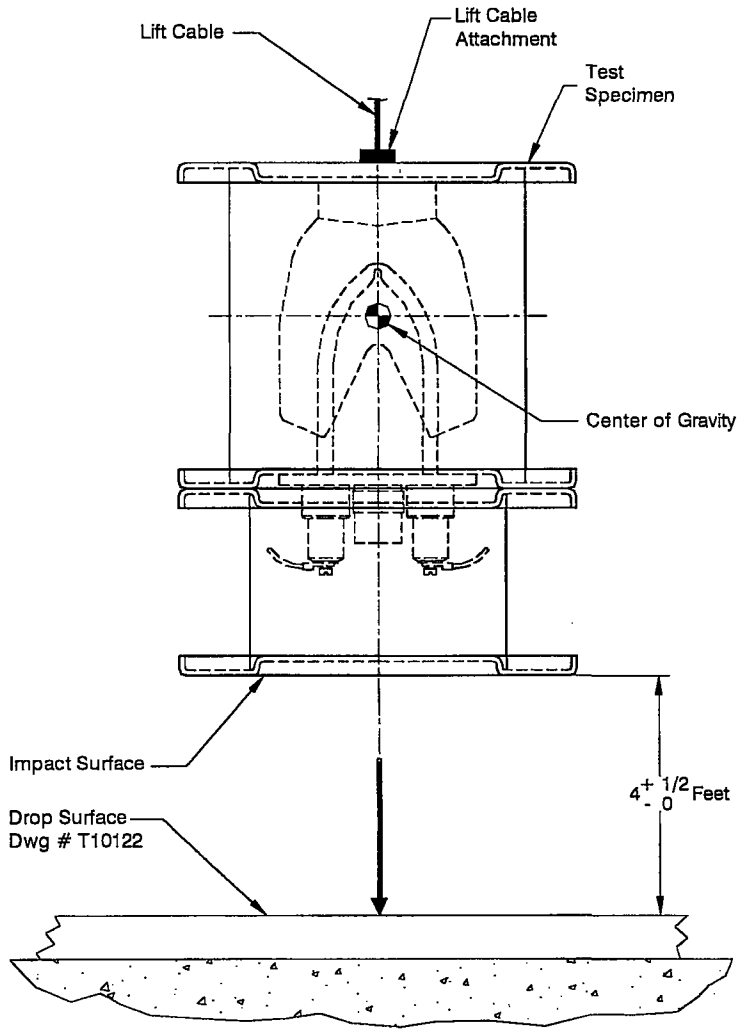


Figure 5. 1.2 Meter (4 Foot) Free Drop Orientation, Specimen TP80(B)

8.7.4 1.2 Meter (4 foot) Free Drop Test Orientation, Specimen TP80(C)

The impact surface for Specimen TP80(C) is the top (lid) corner.

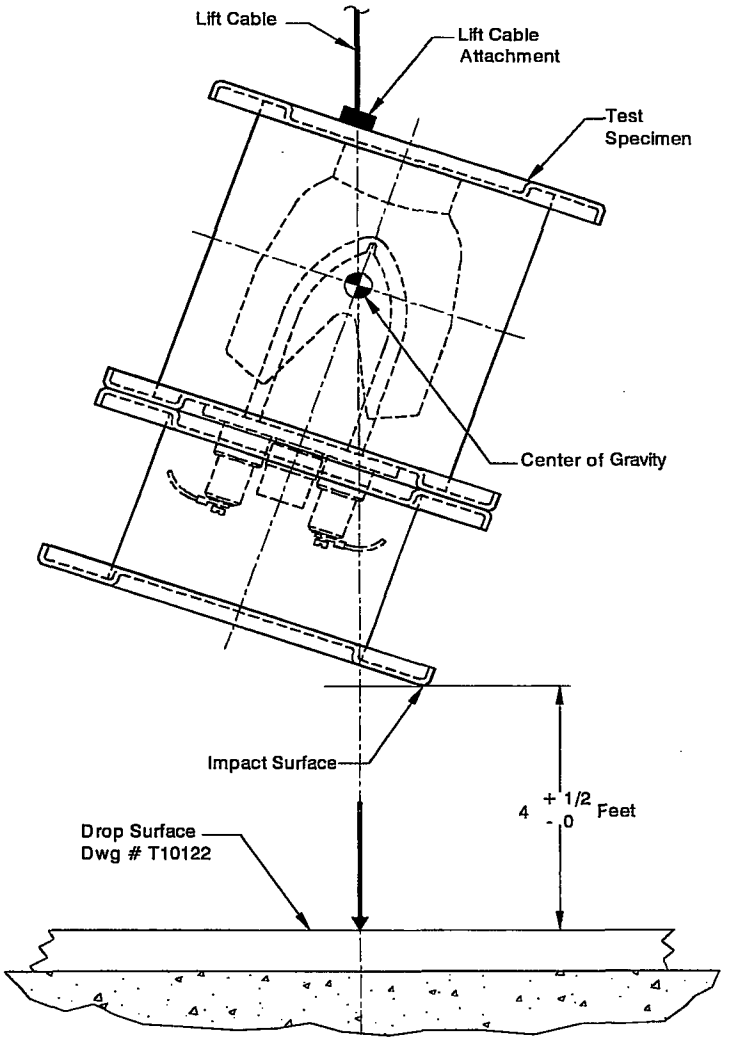


Figure 6. 1.2 Meter (4 Foot) Free Drop Orientation, Specimen TP80(C)

8.7.5 1.2 Meter (4 Foot) Free Drop Test Assessment

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

1. Review the test execution to ensure that the test was performed in accordance with 10 CFR 71.71.
2. Make a preliminary evaluation of the specimen relative to the requirements of 10 CFR 71.71.
3. Assess the damage to the specimen to decide whether testing of that specimen is to continue.
4. Evaluate the condition of the specimen to determine if changes are necessary in package orientation for the 9 meter (30 foot) free drop to achieve maximum damage.
5. Measure and record any damage to the test specimen.
6. Measure and record a radiation profile of the test specimen in accordance with AEAT/QSA Work Instruction WI-Q09.

8.8 First Intermediate Test Inspection

Engineering, Regulatory Affairs, and **Quality Assurance** team members will make an assessment of the test specimen and jointly determine whether the specimen meets the requirements of 10 CFR 71.71.

8.9 9 Meter (30 Foot) Free Drop Test (10 CFR 71.73(c)(1))

The first Hypothetical Accident Conditions test is the 9 meter (30 foot) free drop as described in 10 CFR 71.73(c)(1). This drop uses the same orientations as the 1.2 meter (4 foot) free drop and compounds any damage caused in that test.

Refer to *Equipment List 4* for information about required tools. Use *Checklist 4* to ensure that the test sequence is followed. Use *Data Sheet 4* to record testing results. Sign and date all action items and record required data on the appropriate worksheets.

8.9.1 9 Meter (30 Foot) Free Drop Test Setup

In this test, the package is released from a height of thirty feet and lands on the steel drop surface specified in Drawing AT10122, Revision B.

This test requires that the test specimen be at -40°C or below at the time of impact. Follow the instructions in the appropriate checklist for measuring and recording the test specimen temperature before and after the drop.

To set up a package for the 9 meter (30 foot) free drop test:

1. Use the drop surface specified in Drawing AT10122, Rev. B.
2. Measure and record the test specimen temperature to ensure that the package is at the specified temperature.

3. Place the specimen on the drop surface and position it according to the appropriate orientation:

   - Refer to Figure 7 for the Specimen TP80(A) package orientation
   - Refer to Figure 8 for the Specimen TP80(B) package orientation
   - Refer to Figure 9 for the Specimen TP80(C) package orientation

4. Align the selected center-of-gravity marker as shown in the referenced drawing.

5. Raise the package so that the impact target is 30 to 31 feet above the drop surface.

6. Test the specimen in accordance with *Checklist 4*.

8.9.2 9 Meter (30 Foot) Free Drop Test Orientation, TP80(A)

The impact surface for Specimen TP80(A) is horizontal, long-side down. This orientation is the same as the orientation for the 1.2 meter (4 foot) drop for Specimen TP80(A).

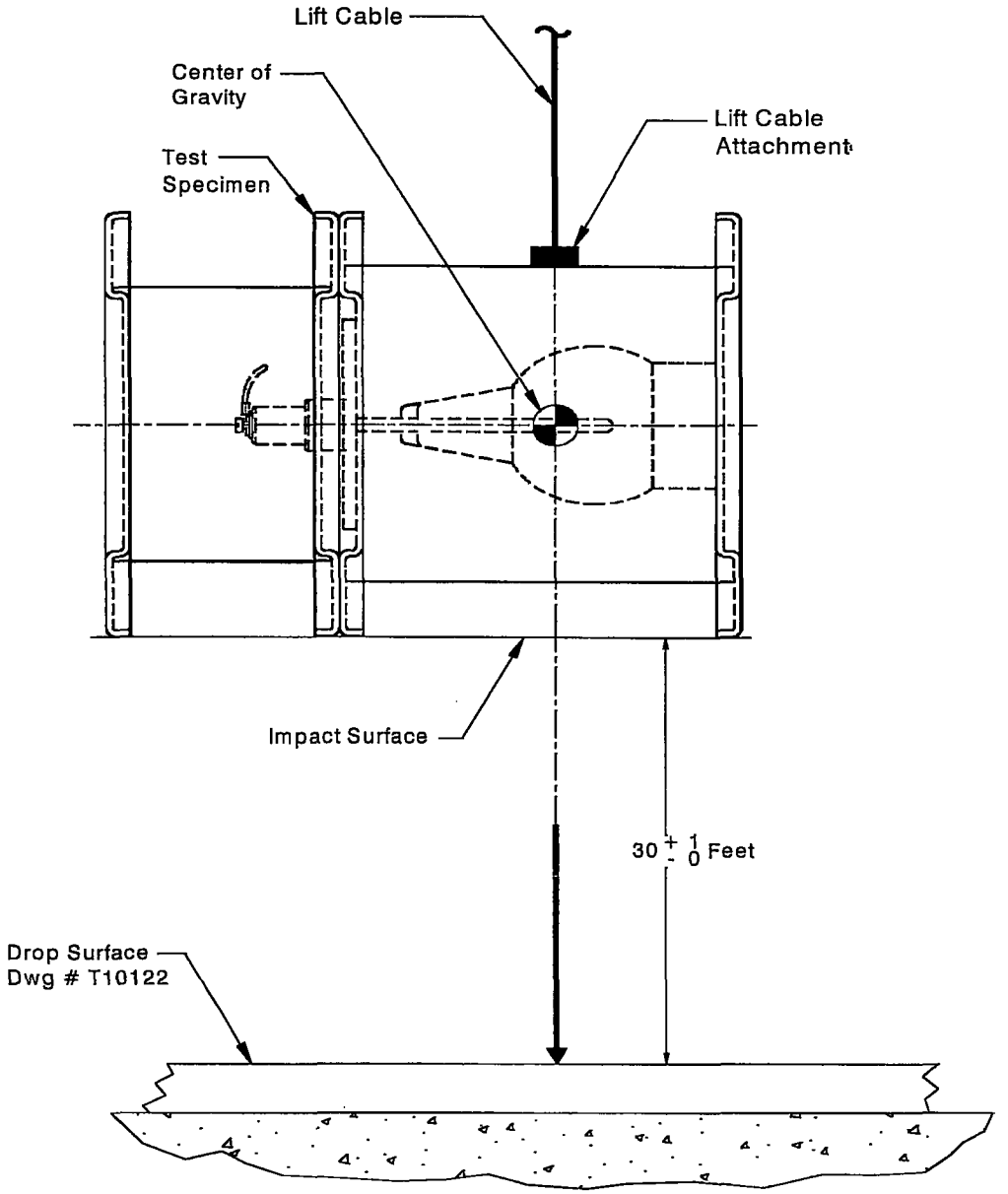


Figure 7. 9 Meter (30 Foot) Free Drop Orientation, Specimen TP80(A)

8.9.3 9 Meter (30 Foot) Free Drop Test Orientation, Specimen TP80(B)

The impact surface for Specimen TP80(B) is vertical, upside down. This orientation is the same as the orientation for the 1.2 meter (4 foot) drop for Specimen TP80(B).

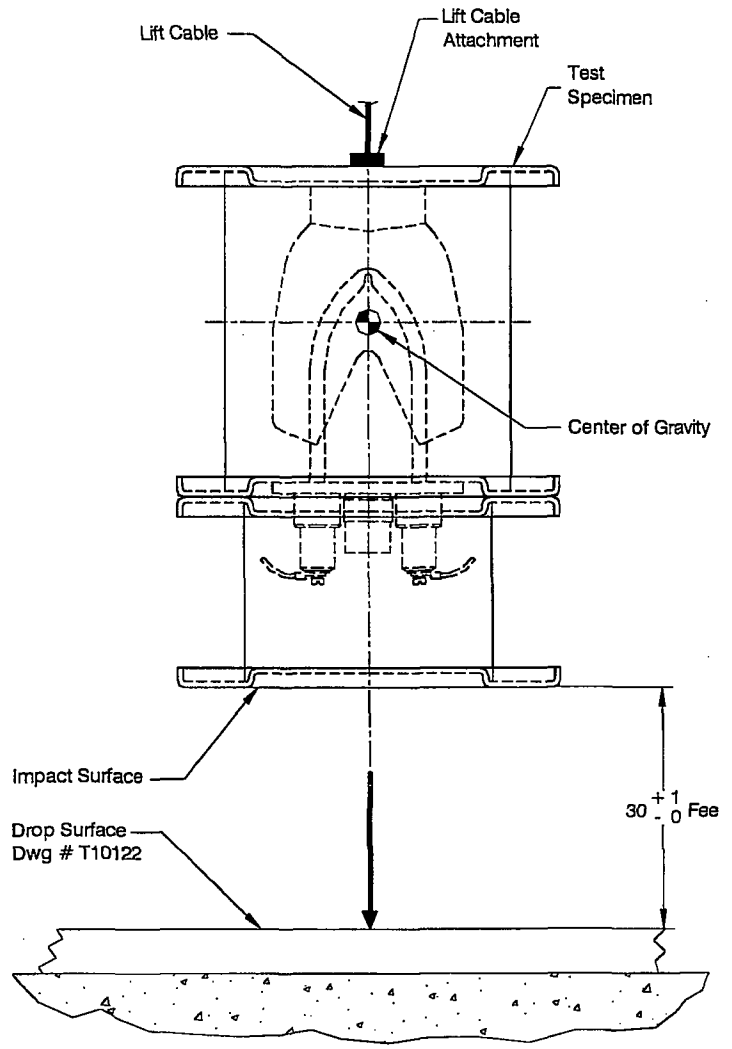


Figure 8. 9 Meter (30 Foot) Free Drop Orientation, Specimen TP80(B)

8.9.4 9 Meter (30 Foot) Free Drop Test Orientation, Specimen TP80(C)

The impact surface for Specimen TP80(C) is the top (lid) corner. This orientation is the same as the orientation for the 1.2 meter (4 foot) drop for Specimen TP80(C).

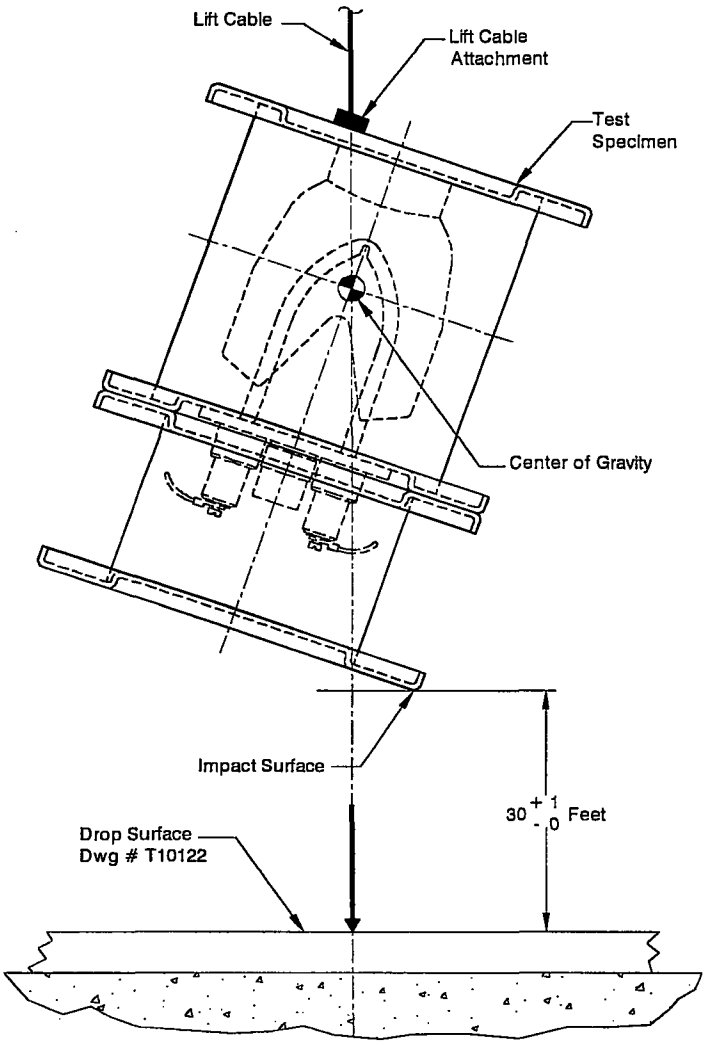


Figure 9. 9 Meter (30 Foot) Free Drop Orientation, Specimen TP80(C)

8.9.5 9 Meter (30 Foot) Free Drop Test Assessment

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

1. Review the test execution to ensure that the test was performed in accordance with 10 CFR 71.73, and in accordance with the impact orientation and other conditions specified in this plan.

2. Make a preliminary evaluation of the specimen relative to the requirements of 10 CFR 71.73.

3. Perform an assessment to determine if any change in puncture test orientation is necessary in order to sustain maximum specimen damage during the Puncture Test, and document.

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

The 9 meter (30 foot) free drop is followed by the puncture test, per 10 CFR 71.73(c)(3), in which the package is dropped from a height of at least 40 inches onto the puncture billet specified in the Drawing CT10119, Revision C.

The billet is to be bolted to the drop surface used in the free drop tests. The 12-inch high puncture billet meets the minimum height (8 inches) required in 10 CFR 71.73(c)(3). The specimen has no projections or overhanging members longer than 8 inches, which could act as impact absorbers, thus allowing the billet to cause the maximum damage to the specimen.

Refer to *Equipment List 5* for information about required tools. Use *Checklist 5* to ensure that the test sequence is followed. Use *Data Sheet 5* to record testing results. Sign and date all action items and record required data on the appropriate worksheets.

This test requires that the test specimen be at -40°C or below at the time of impact. Follow the instructions in the appropriate checklist for measuring and recording the test specimen temperature before and after the drop.

8.10.1 Puncture Test Setup

To set up a test specimen for the puncture test:

1. Measure and record the test specimen temperature to ensure that the package is at the specified temperature.

2. Place the specimen on the drop surface and position it according to the appropriate orientation (unless the 9 meter Test Assessment selects different orientations):

   - Refer to Figure 10 for the Specimen TP80(A) package orientation
   - Refer to Figure 11 for the Specimen TP80(B) package orientation
   - Refer to Figure 12 for the Specimen TP80(C) package orientation

3. Check the alignment of the specified center-of-gravity marker with the targeted point of impact.

4. Raise the package so that there are 40 to 42 inches between the package and the top of the puncture billet.

5. Test the specimen in accordance with *Checklist 5*.

8.10.2 Puncture Test Orientation, Specimen TP80(A)

The impact surface for Specimen TP80(A) is the horizontal, long-side of the outer shell.

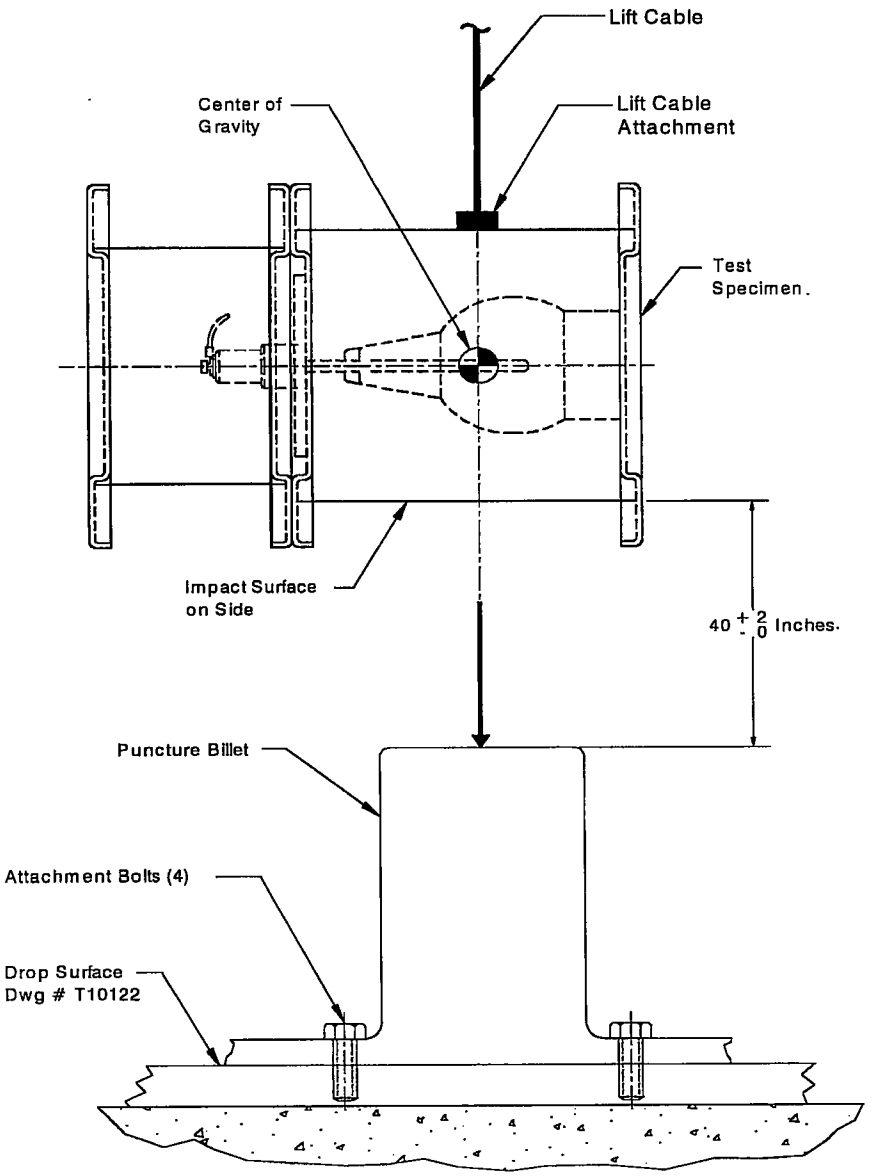


Figure 10. Puncture Test Orientation, Specimen TP80(A)

8.10.3 Puncture Test Orientation, Specimen TP80(B)

The impact surface for Specimen TP80(B) is the underside of the top plate. The puncture bar should impact the corner of the plate on the lid bolt.

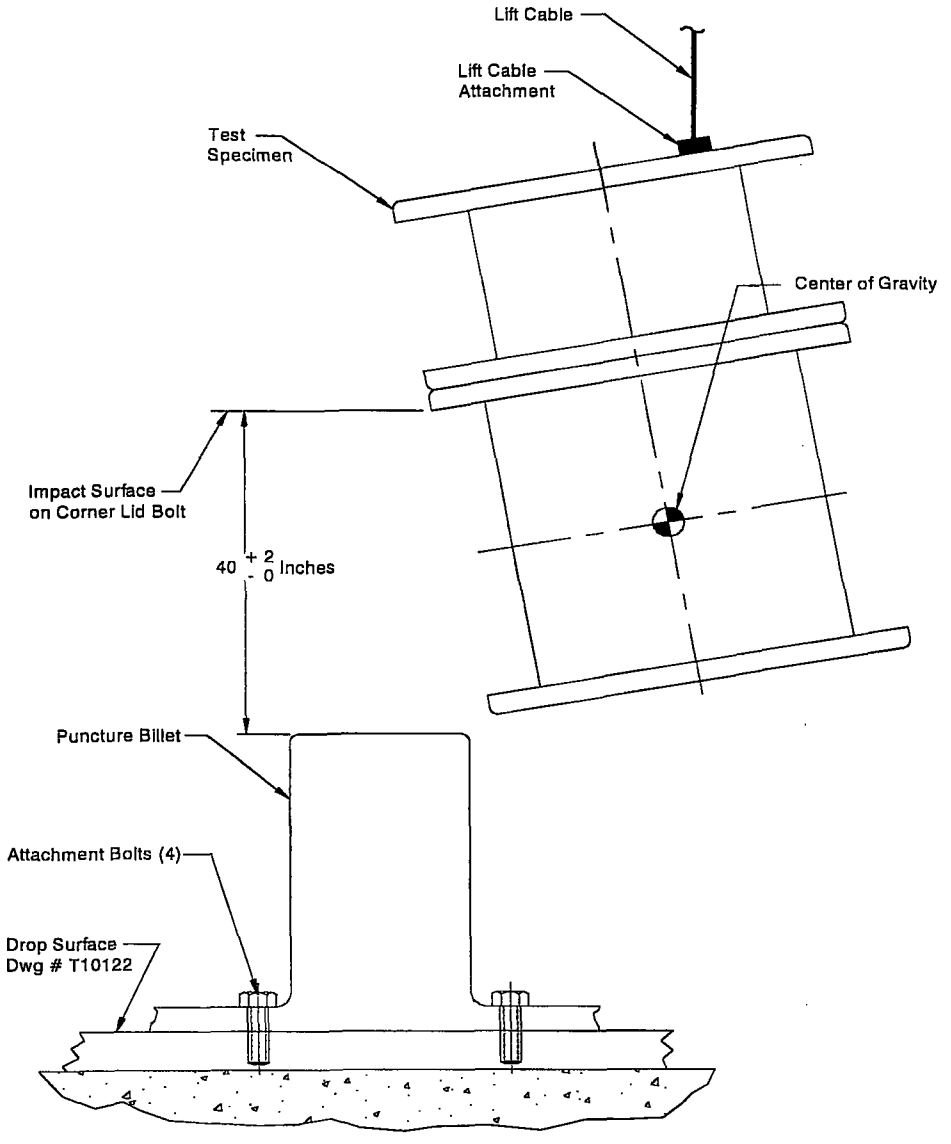


Figure 11. Puncture Test Orientation, Specimen TP80(B)

8.10.4 Puncture Test Orientation, Specimen TP80(C)

The impact surface for Specimen TP80(C) is the bottom of the package.

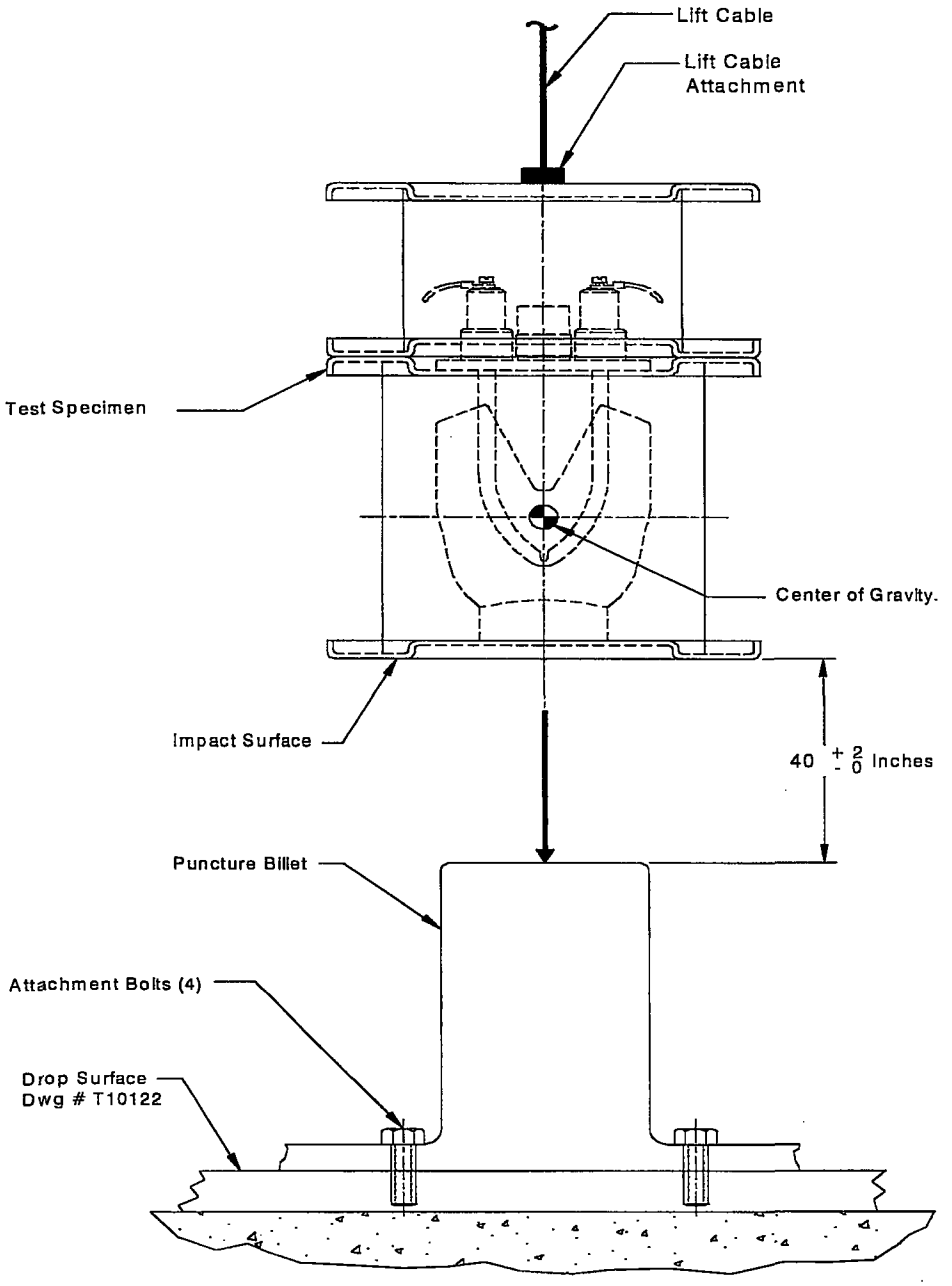


Figure 12. Puncture Test Orientation, Specimen TP80(C)

8.10.5 Puncture Test Assessment

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

1. Review the test execution to ensure that the test was performed in accordance with 10 CFR 71.73, and in accordance with any other conditions specified in this plan.

2. Make a preliminary evaluation of the specimen relative to the requirements of 10 CFR 71.73.

3. Assess the damage to the specimen to decide whether testing of the specimen is to continue.

8.11 Second Intermediate Test Inspection

Perform a second intermediate test inspection of all specimens after the puncture test and before the thermal test.

1. Measure and record any damage to the test specimen.

2. Determine and record the location of the source.

3. Remove and assess the condition of the simulated source.

4. Reassemble the package using an active source, making sure that the source wire position and the package configuration are the same as they were immediately after the puncture test.

5. Measure and record a radiation profile of the test specimen in accordance with AEAT/QSA Work Instruction WI-Q09.

6. Reassemble the package using the same simulated source used in the specimen during the previous tests.

7. Make sure that the source wire position and the package configuration are the same as they were immediately after the puncture test.

8. Weigh package.

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

The final requirement is the thermal test specified in 10 CFR 71.73(c)(4).

Refer to *Equipment List 6* for information about required tools. Use *Checklist 6* to ensure that the test sequence is followed. Use *Data Sheet 6* to record testing results. Sign and date all action items and record required data on the appropriate worksheets.

8.12.1 Test Specimen Selection

The specimen(s) selected for thermal testing will be based on an assessment of the damage sustained by the packages following the puncture test. The selected package testing orientation will also be determined based on an assessment of the test specimen condition. As a minimum requirement, the vertical, upside down drop orientation (TP80(B)) will be tested in a vertical, right

side up orientation for the thermal test. The TP80(B) specimen is most likely to have the source pull out from its shielded position due to deflection of the top plate during the drop tests and melting of lead shielding/shims below the DU shield during the thermal test.

8.12.2 Thermal Test Setup

To ensure sufficient heat input to the test specimens, the oven will be pre-heated to a temperature of not less than 810°C. This temperature, above the required 800°C, includes an allowance for measurement uncertainty.

The test environment is a vented electric oven capable of creating a time weighted average temperature of 800°C.

Thermocouples will be attached to the specimen top, bottom, and 2 side surfaces. The 2 side surface thermocouples will be positioned 180° apart, facing the front and back of the oven. A fifth thermocouple will be inserted into one of the source tubes to measure source changer internal temperature. The external thermocouples will be shielded from the radiant heat of the oven so that the surface temperature of the source changer can be accurately measured.

When the oven has been pre-heated to 810°C, the package will be placed in the oven in the orientation determined to be worst case, per Section 8.10.2. When the temperature of the source changer surface has risen to no less than 810°C, the test will start. The package will remain in the oven for a period of 30 minutes after the start of the test.

To allow for combustion of the foam during the thermal test, the oven door will remain slightly open. It has been determined that a gap of one inch at the top and bottom of the oven door allows airflow into the oven and allows the oven to maintain its temperature. The oven door is 36 inches long. As a result, there will be about a 36 square inch opening at both the top and bottom of the furnace door. This allows for the natural convection of air into the furnace.

If the specimen is burning when the oven is opened, the unit will be allowed to extinguish by itself and then cool naturally. Although solar radiation assumed during a hypothetical accident could reduce the rate of package cooldown, such a reduction in cooldown rate is considered to have a negligible effect on the package compared with the 30 minutes of exposure to 810°C. This test plan, therefore, does not require insolation effects to be explicitly modeled during package cooldown. Appropriate measures should be taken to avoid the radiological risks associated with this potential hazard. The final evaluation of the package is performed when the specimen reaches ambient temperature.

8.12.3 Thermal Test Procedure

To perform the thermal test:

1. Attach the thermocouples to the test specimen's measurement locations.

2. Preheat the oven temperature to not less than 810°C.

3. When the oven temperature is stable at above 810°C, place the specimen in the oven, and partially close the door.

4. When the temperature of the surface of the specimen rises above 810°C, start the 30-minute time interval.

5. Throughout the test, measure and record the oven and the test specimen temperatures.

6. At the end of the 30 minute time interval, open the oven door and shut off the oven.

WARNING: If the package is burning, appropriate safety measures must be in place to avoid the risks associated with burning polyurethane foam and/or depleted uranium. Consult with the oven operator and other appropriate personnel.

7. Allow the package to self-extinguish and cool.

8. Record any damage to the package and make a photographic and radiographic record of shield position and damage.

8.12.4 Thermal Test Assessment

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

1. Review the test execution to ensure that the test was performed in accordance with 10 CFR 71.73 and the test conditions specified in this plan.

2. Make a preliminary evaluation of the specimen relative to the requirements of 10 CFR 71.73.

8.13 Final Test Inspection

Perform the following inspections after completion of all the required testing:

1. Measure and record any damage to the test specimen.

2. Determine and record the location of the source.

3. Remove and assess the condition of the simulated source.

4. Reassemble the package using an active source, making sure that the source wire position and the package configuration are the same as they were immediately after the thermal test.

5. Measure and record a radiation profile of the test specimen in accordance with AEAT/QSA Work Instruction WI-Q09.

6. Document and assess the radiation level at one meter from the surface of the package.

7. Determine whether it is necessary to dismantle the test specimen for inspection of hidden component damage or failure.

8. If proceeding 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 specimen.

Engineering, Regulatory Affairs, and **Quality Assurance** team members will make a final assessment of the test specimen and jointly determine whether the specimen meets the testing requirements of 10 CFR 71.

9.0 Worksheets

Use the following worksheets for executing these tests. There are three worksheets for each test: an equipment list, a test procedure checklist, and a data sheet.

Use the test equipment list to record the serial number of each measurement device used. Attach a copy of the relevant inspection report or calibration certificate after verifying the range of accuracy of the equipment.

Quality Control will initial each step on the checklist as it is executed and record data as required. The **Engineering, Regulatory Affairs**, and **Quality Assurance** representatives must witness all testing to ensure the testing is performed in accordance with this test plan and 10 CFR 71.

Make copies of the forms for additional attempts. Maintain records of all attempts.

Specimen Preparation List

Step		TP80(A)	TP80(B)	TP80(C)
1.	Serial Number:			
2.	Total weight of package (lb):			
3.	Location of simulated source from top plate (in):			
4.	Location of lead shielding:			
5.	All fabrication and inspection records documented in accordance with the AEAT QA Program?			
6.	Does the unit comply with the requirements of Drawing R-TP80, Revision D?			
7.	Has the radiation profile been recorded in accordance with AEAT QSA Work Instruments WI-Q09?			
8.	Is the package prepared for transport?			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Equipment List 1: Compression Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Weight Scale		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:			
Verified by:			

Checklist 1: Compression Test

Step	TP80(A)	TP80(B)	TP80(C)
1. Position the specimen on concrete surface, per the appropriate drawing.	Figure 2	Figure 2	Figure 2
2. Measure the ambient temperature.			
Note the instrument used:			
3. Apply a uniformly distributed weight of 455 to 465 pounds on the top of the lid for a period of 24 hours.			
Record the actual weight:			
Note the instrument used:			
Record start time and date:			
4. After 24 hours, remove the weight.			
Record end time and date:			
5. Measure the ambient temperature.			
Note the instrument used:			
6. Photograph the test specimen and record any damage on Data Sheet 1.			
7. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record the assessment on Data Sheet 1. Determine what changes are necessary in package orientation for the penetration test to achieve maximum damage.			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Data Sheet 1: Compression Test

Test Unit Model and Serial Number:		Test Specimen:
Test Date:	Test Time:	Test Plan 80 Step No.: **8.5**
Describe test orientation and setup:		
Describe on-site inspection (damage, broken parts, etc.):		
On-site assessment: Engineering: _____ Regulatory: _____ QA: _____		
Describe any post-test disassembly and inspection:		
Describe any change in source position:		
Describe results of any pre- or post-test radiography:		
Completed by:		Date:

Equipment List 2: Penetration Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Penetration Bar	Drawing BT10129, Rev. B	
Drop Surface	Drawing AT10122, Rev. B	
Thermometer		
Thermocouple		
Thermocouple		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:			
Verified by:			

Checklist 2: Penetration Test

Step	TP80(A)	TP80(B)	TP80(C)
1. Immerse the test specimen in dry ice or cool in freezer as needed to bring specimen temperature below –40°C.			
2. Position the package as shown in the referenced figure, or by Step 7, Checklist 1.	Figure 3	Figure 3	Figure 3
3. Begin video recording of the test.			
4. Inspect the orientation setup and verify the bar height.			
5. Photograph the set-up in at least two perpendicular planes.			
6. Measure the ambient temperature and the specimen's internal and surface temperatures. Ensure that the specimen is at the specified temperature.			
Record the ambient temperature:			
Note the instrument used:			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
7. Drop the penetration bar.			
8. Check to ensure that penetration bar hit the specified area.			
9. Measure the specimen's surface temp. Ensure that specimen is at specified temp.			
Note the instrument used:			
10. Photograph the test specimen and record any damage on Data Sheet 2.			
11. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record the assessment on Data Sheet 2. Determine what changes are necessary in package orientation for the 1.2 meter (4 foot) free drop to achieve maximum damage.			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Data Sheet 2: Penetration Test

Test Unit Model and Serial Number:		Test Specimen:
Test Date:	Test Time:	Test Plan 80 Step No.: **8.6**
Describe test orientation and setup:		
Describe impact (location, rotation, etc.):		
Describe on-site inspection (damage, broken parts, etc.):		
On-site assessment: Engineering: _____ Regulatory: _____ QA: _____		
Describe any post-test disassembly and inspection:		
Describe any change in source position:		
Describe results of any pre- or post-test radiography:		
Completed by:		Date:

Equipment List 3: 1.2 Meter (4 Foot) Free Drop

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Drop Surface	Drawing AT10122, Rev. B	
Thermometer		
Thermocouple		
Thermocouple		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:			
Verified by:			

Checklist 3: 1.2 Meter (4 Foot) Free Drop

Step	TP80(A)	TP80(B)	TP80(C)
1. Immerse specimen in dry ice or cool in freezer to bring specimen below –40°C.			
2. Measure the ambient temperature.			
Note the instrument used:			
3. Attach the test specimen to the release mechanism.			
4. Begin video recording of the test.			
5. Measure specimen internal and surface temps. Ensure specimen is at specified temp.			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
6. Lift and orient the test specimen as shown in the specified referenced figure.	Figure 4	Figure 5	Figure 6
7. Inspect the orientation setup and verify drop height.			
8. Photograph the set-up in at least two perpendicular planes.			
9. Release the test specimen.			
10. Measure specimen internal and surface temps. Ensure specimen is at specified temp.			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
11. Photograph the test specimen and record any damage on Data Sheet 3.			
12. Measure and record a radiation profile of the test specimen in accordance with AEAT/QSA Work Instruction WI-Q09.			
13. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71, and record on Data Sheet 3. Determine package orientation for the 9 meter free drop to achieve maximum damage.			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Data Sheet 3: 1.2 Meter (4 Foot) Free Drop

Test Unit Model and Serial Number:		Test Specimen:
Test Date:	Test Time:	Test Plan 80 Step No.: **8.7**
Describe drop orientation and drop height:		
Describe impact (location, rotation, etc.):		
Describe on-site inspection (damage, broken parts, etc.):		
On-site assessment: Engineering: _____ Regulatory: _____ QA: _____		
Describe any post-test disassembly and inspection:		
Describe any change in source position:		
Describe results of any pre- or post-test radiography:		
Completed by:		Date:

Equipment List 4: 9 Meter (30 Foot) Free Drop

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Drop Surface	Drawing AT10122, Rev. B	
Thermometer		
Thermocouple		
Thermocouple		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:			
Verified by:			

Checklist 4: 9 Meter (30 Foot) Free Drop

Step	TP80(A)	TP80(B)	TP80(C)
1. Immerse test specimen in dry ice or cool in freezer to bring specimen temperature below –40°C.			
2. Measure the ambient temperature.			
Note the instrument used:			
3. Attach the test specimen to the release mechanism.			
4. Begin Video Recording of the test.			
5. Measure specimen's internal and surface temps. Ensure specimen is at the specified temperature.			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
6. Lift and orient the test specimen as shown in the specified referenced figure.	Figure 7	Figure 8	Figure 9
7. Inspect the orientation setup and verify drop height.			
8. Photograph the setup in at least two perpendicular planes.			
9. Release the test specimen.			
10. Measure specimen's internal and surface temps. Ensure specimen is at specified temperature.			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
11. Photograph the test specimen and record any damage on Data Sheet 4.			
12. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record assessment on Data Sheet 4. Determine what changes are necessary in package orientation for the puncture test to achieve maximum damage.			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Data Sheet 4: 9 Meter (30 Foot) Free Drop

Test Unit Model and Serial Number:		Test Specimen:
Test Date:	Test Time:	Test Plan 80 Step No.: **8.9**
Describe drop orientation and drop height:		
Describe impact (location, rotation, etc.):		
Describe on-site inspection (damage, broken parts, etc.):		
On-site assessment: Engineering: _____ Regulatory: _____ QA: _____		
Describe any post-test disassembly and inspection:		
Describe any change in source position:		
Describe results of any pre- or post-test radiography:		
Completed by:		Date:

Equipment List 5: Puncture Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Drop Surface	Drawing AT10122, Rev. B	
Puncture Billet	Drawing CT10119, Rev. C	
Thermometer		
Thermocouple		
Thermocouple		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:			
Verified by:			

Checklist 5: Puncture Test

Step	TP80(A)	TP80(B)	TP80(C)
1. Immerse specimen in dry ice or cool in freezer to bring specimen temp. below –40°C.			
2. Measure the ambient temperature.			
Note the instrument used:			
3. Attach the test specimen to the release mechanism.			
4. Begin Video Recording of the test.			
5. Measure specimen's internal and surface temps. Ensure that specimen is at specified temp.			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
6. Lift and orient the test specimen as shown in the specified referenced figure, or as determined during the assessment of the 9 Meter (30 Foot) Drop Test.	Figure 10	Figure 11	Figure 12
7. Inspect the orientation setup and verify drop height.			
8. Photograph the set-up in at least two perpendicular planes.			
9. Release the test specimen.			
10. Measure the specimen's internal and surface temperatures.			
Record the specimen's internal temperature:			
Note the instrument used:			
Record the specimen's surface temperature:			
Note the instrument used:			
11. Photograph the test specimen and record any damage on Data Sheet 5.			
12. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record assessment on Data Sheet 5. Determine what changes are necessary in package orientation for thermal test to achieve maximum damage.			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Data Sheet 5: Puncture Test

Test Unit Model and Serial Number:		Test Specimen:
Test Date:	Test Time:	Test Plan 80 Step No.: **8.10**
Describe drop orientation and drop height:		
Describe impact (location, rotation, etc.):		
Describe on-site inspection (damage, broken parts, etc.):		
On-site assessment: Engineering: _____ Regulatory: _____ QA: _____		
Describe any post-test disassembly and inspection:		
Describe any change in source position:		
Describe results of any pre- or post-test radiography:		
Completed by:		Date:

Equipment List 6: Thermal Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Bottom Surface Thermocouple 1		
Top Surface Thermocouple 2		
Side Surface Facing Oven Front Thermocouple 3		
Side Surface Facing Oven Rear Thermocouple 4		
Source Tube Thermocouple 5		
Oven		
Oven thermostat		
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:			
Verified by:			

Checklist 6: Thermal Test

Step	TP80(A)	TP80(B)	TP80(C)
1. Record Test Specimen Serial Number.			
2. Preheat the oven to 810°C.			
3. Attach the thermocouples as described in Equipment List 6. Ensure the recording devices are active, and that the external thermocouples are shielded.			
4. Place the package in the oven in the worst case orientation and partially close the oven door such that a 1 inch by 36 inch opening is provided. Record the time.			
5. When all of the test specimen's surface temperatures exceed 810°C, begin the 30-minute time interval. Record the time.			
6. Monitor and record the test specimen and the oven temperatures throughout the 30-minute period to ensure that they are above 810°C			
7. At the end of the 30-minute test period, shut off the oven and open the door. Record the time.			
8. Describe combustion when door is opened.			
9. Allow the specimen to cool, then remove the specimen from the oven. Record the time.			
NOTE: If specimen continues to burn, let it self-extinguish and cool naturally.			
10. Measure and record the ambient temperature.			
11. Photograph the test specimen and record any damage on data sheet 6.			
12. Radiograph the unit to determine the shield location.			
13. Measure and record the source location.			
14. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record assessment on Data Sheet 6.			

Verified by:	Print Name:	Signature:	Date:
Engineering			
Regulatory Affairs			
Quality Assurance			

Data Sheet 6: Thermal Test

Test Unit Model and Serial Number:		Test Specimen:
Test Date:	Test Time:	Test Plan 80 Step No.: **8.12**
Describe test orientation and setup:		
Describe package during testing:		
Describe on-site inspection (damage, broken parts, etc.):		
On-site assessment: Engineering: _____ Regulatory: _____ QA: _____		
Describe any post-test disassembly and inspection:		
Describe any change in source position:		
Describe results of any pre- or post-test radiography:		
Completed by:		Date:

Appendix A: Drawing R-TP80, Revision D

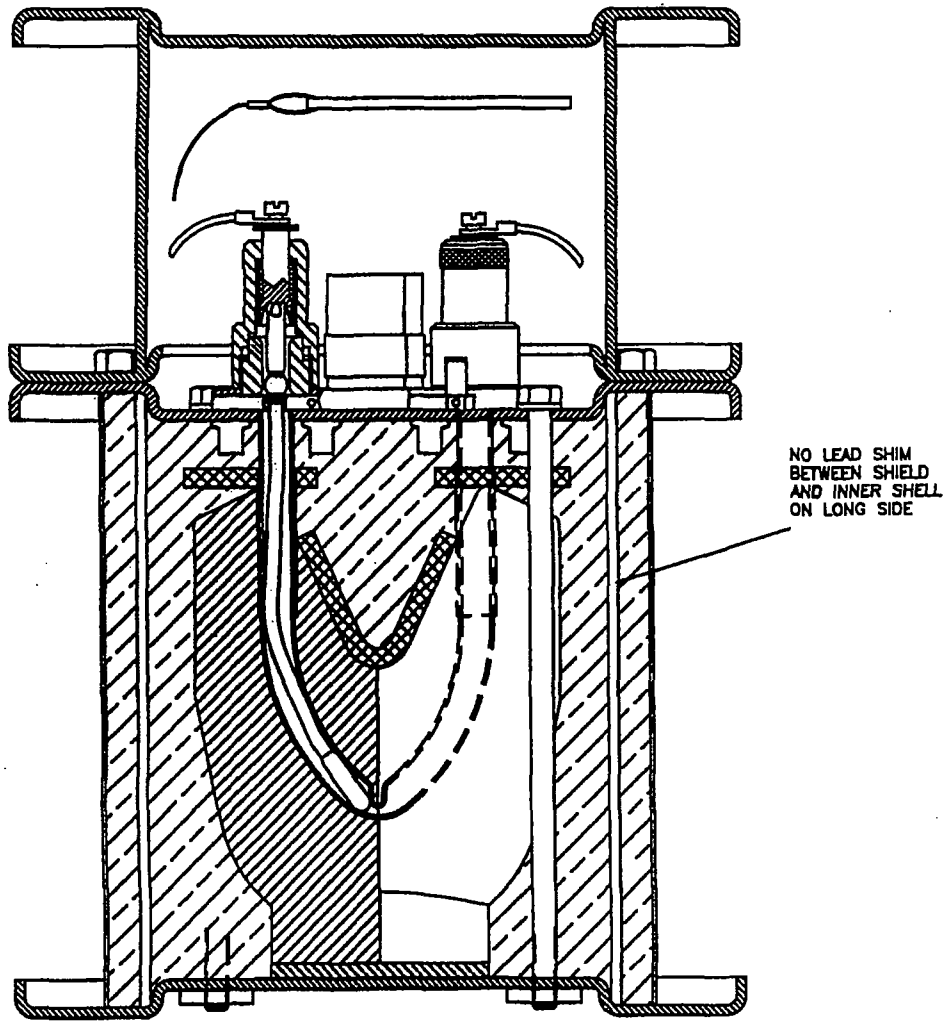
Security-Related Information
Figure Withheld Under 10 CFR 2.390

AEA TECHNOLOGY QSA
40 NORTH AVE, BURLINGTON, MA 01803

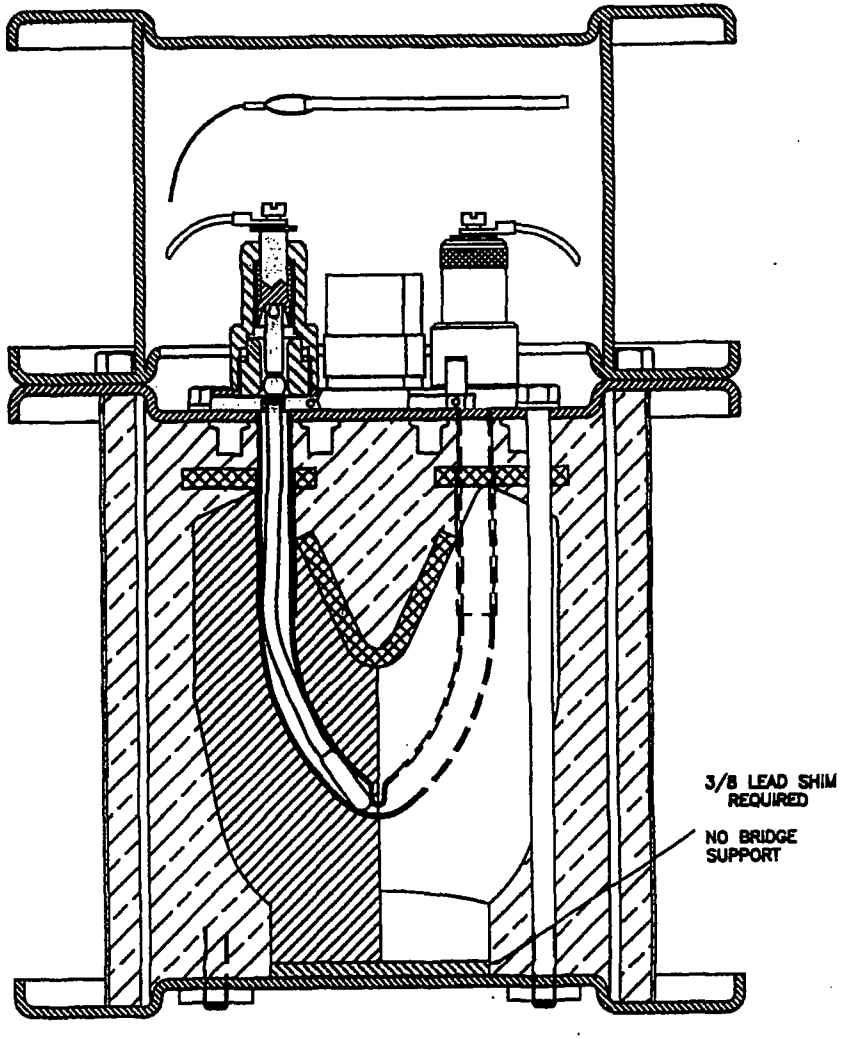
DESCRIPTIVE DRAWING

TITLE 650L SOURCE CHANGER TEST UNITS

SIZE	DWG. NO.	REV
A	R-TP80	D
	SCALE: NONE SHEET 1 OF 2	



TP 80 (A)



TP 80 (B)

NOTE:
NO SPECIAL REQUIREMENTS
FOR
LEAD LOCATION IN TP80(C)

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE REFERENCE			
SIZE A	DWG. NO. R-TP80		REV D
	SCALE: NONE	SHEET 2 OF 2	

2.12.9 Test Plan 80 Report Minus Manufacturing Records (Jun 1999)

AEA TECHNOLOGY QSA

TEST PLAN NO. 80, REV. 1	
TEST PLAN COVER SHEET	
TEST TITLE: TEST PLAN 80, REVISION 1, MODEL 650L SOURCE CHANGER TYPE B TRANSPORT TESTS	
PRODUCT MODEL: 650L	
ORIGINATED BY: [signature] (MPR)	DATE: 12 MAR 99
TEST PLAN REVIEW	
ENGINEERING APPROVAL: [signature]	DATE: 12 MAR 99
QUALITY ASSURANCE APPROVAL: Daniel W. Kurtz	DATE: 12 Mar 99
REGULATORY APPROVAL: [signature]	DATE: 12 Mar 99
COMMENTS:	
TEST RESULTS REVIEW	
ENGINEERING APPROVAL: [signature]	DATE: 12 JUL 99
QUALITY ASSURANCE APPROVAL: Daniel W. Kurtz	DATE: 13 Jul 99
REGULATORY APPROVAL: C. [signature]	DATE: 13 Jul 99

SENTINEL

TEST PLAN 80 REPORT

MODEL 650L

June 1999

Prepared By: Laura Ridzon Date: 28 JUN 99
Laura Ridzon, MPR Associates, Inc.

Reviewed By: Nicholas J. Marrone Date: 28 June 99
Nicholas J. Marrone, MPR Associates, Inc.

Approved By: Caroline S. Schlaseman Date: 28 JUN 99
Caroline S. Schlaseman, MPR Associates, Inc.

AEA Technology QSA, Inc.
Burlington, MA

TABLE OF CONTENTS

APPENDICES

1. PURPOSE

This report describes the Type B test results for the Model 650L source changer. These tests were performed in accordance with Test Plan 80 and were conducted March 15 through 20, 1999. The Test Plan specified testing necessary to demonstrate compliance with the requirements in 10 CFR Part 71 and IAEA Safety Series No. 6 (1985 as amended 1990) for "Normal Conditions of Transport" and "Hypothetical Accident Conditions." Evaluation of the compliance of the Model 650L with these requirements is provided in the Safety Analysis Report (SAR).

2. SCOPE OF TESTING

Test Plan 80 identified three orientations that could potentially cause the most significant damage to the Model 650L source changer in the 9 meter (30 foot) drop tests. Therefore, the test plan required three test specimens. Each of these test specimens was subjected to the tests described below.

1. Normal Conditions of Transport Tests per 10 CFR 71.71, including the following for each test specimen:
   a) Compression test, with the test specimen under a load greater than or equal to five times the Model 650L maximum weight for at least 24 hours.
   b) Penetration test, in which a 13.4 lb (6.08 kg) penetration bar is dropped from at least 1 meter (40 inches) onto the test specimen in the most vulnerable location.
   c) 1.2 meter (4 foot) drop test, in which the test specimen is dropped in an orientation expected to cause maximum damage.

   Water spray preconditioning of the test specimens prior to testing was not required in the test plan and is evaluated separately.

2. Hypothetical Accident Condition Tests per 10 CFR 71.73, including the following for each of the test specimens:
   a) 9 meter (30 foot) drop test, in which the test specimen is dropped in an orientation expected to cause maximum damage.
   b) Puncture test, in which the test specimen is dropped from at least 1 meter (40 inches) onto a 6 inch (152.4 mm) diameter vertical bar in an orientation expected to compound damage from the 9 meter (30 foot) drop test.
   c) Thermal test, in accordance with 10 CFR71.73(c)(4), in which the test specimen is exposed for 30 minutes to an environment which provides a time-averaged environmental temperature of at least 800°C (1472°F), and an emissivity coefficient of at least 0.9. For the Model 650L, the test plan specified that the thermal test would be performed for only one of the three test specimens, unless other test units suffered significant damage in the drop and puncture tests. This requirement was based on the evaluation of the construction of the unit, and on the potential failure modes, which are discussed in the following section.

   The crush test specified in 10 CFR 71.73(c)(2) was not required because the source capsules are qualified as Special-Form radioactive material.

   The water immersion test specified in 10 CFR 71.73(c)(6) and other tests specified in 10 CFR 71 are evaluated separately.

   For all tests, sufficient margin was included in test parameters to account for measurement uncertainty. These test parameters included test specimen weight, temperature, and drop height.

3. FAILURE MODES

For the Model 650L source changer, the key function important to safety is the positive retention of the radioactive source in its stored position within the depleted uranium shield. Displacement of either the source or the shield from the design position or failure of the shield could cause radiation from the package to increase above regulatory limits. Mechanisms, which could cause these modes of failure, include:

- Oxidation of the DU Shield - During the thermal test, oxidation of the DU shield could lead to reduced shielding effectiveness and higher radiation exposure. This could occur if failure of the inner and outer shells or failure of the through-bolts during drop testing results in a large, open path to the DU shield.

- Source Pull-Out from the Shield - During drop testing or during the thermal test, source pull-out could lead to higher radiation exposure. This could occur if there is significant relative displacement between the shield and the lock assembly on the top cover plate. Such displacement could occur if the top plate is deformed outward, and the shield moves laterally or downward through the polyurethane foam.

The drop orientations for the normal and hypothetical accident tests were selected to challenge the components that are intended to prevent these failures. For the 1.2 meter (4 foot) and 9 meter (30 foot) drop tests, these orientations include the following:

- Horizontal with the long side of the unit down - This orientation could cause movement of the shield or failure of the inner and/or outer shells.
- Vertical upside down - This orientation could cause deformation of the top plate, failure of the through-bolts, or failure of the lock assembly which would all lead to source pull-out from the shield. Additionally, movement of the shield through the foam in the upper part of the unit would put a large lateral load on the upper portion of the inner shell, which is subject to brittle failure.
- Top corner down - This orientation could cause failure of the bolts holding the protective lid in place, exposing the lock assembly to damage during the puncture test. This orientation also loads the through-bolts, top plate, and inner shell similar to the vertical upside down orientation.

Because of the potential for brittle failure of carbon steel components, all test units were packed in dry ice and cooled to less than -40°C (-40°F) (the minimum temperature required by IAEA Safety Series 6) for the penetration, 1.2 meter (4 foot) drop, 9 meter (30 foot) drop, and puncture tests.

In selecting test units for the thermal test, it was concluded that an undamaged unit would not be significantly affected by exposure to the conditions of the thermal test. In particular, for an undamaged unit, the depleted uranium shield would still be completely enclosed within the inner and outer shells and be supported by foam and a shim of either copper, steel, or lead. Under the thermal test conditions, degradation of the foam and melting of the shim, if it is lead, will allow

the shield to move by a small amount. This could result in limited movement of the source relative to the shield, but not enough to significantly increase radiation levels.

Therefore, the thermal test is only expected to have a significant effect on those units which sustained damage relating to the two modes of failure described above, specifically: (1) an opening in the inner and outer shells to allow oxidation of the shield, or (2) relative displacement of the lock assembly and shield which could be compounded by shield movement during the thermal test. Since relative displacement of the lock assembly was expected in the vertical upside down drop orientation, it was planned to perform the thermal test with the unit dropped in this orientation. The test plan required thermal tests of the other test specimens only if they sustained damage that could lead to failure during the thermal test.

4. TEST UNIT DESCRIPTION

The Model 650L test specimens, identified below, were originally constructed in accordance with drawing C65009 and were prepared for testing in accordance with drawing R-TP80, Rev. E. The manufacturing route cards for the units document the compliance of these units with the AEA Technology QSA Inc. QA program (see Appendix B).

Specimen	Serial No.	Total Weight	Lead Configuration
TP80(A)	2243	80.0 lb (36.3 kg)	No lead between DU shield and long side of inner shell.
TP80(B)	182	83.6 lb (37.9 kg)	Thickest lead under DU shield (total 3/8" thick).
TP80(C)	195	89.0 lb (40.4 kg)	Any location.

Important features of the test unit construction include the following:

- The configuration of lead added to each unit for supplemental shielding was specified as shown above to provide the worst case for the each drop orientation.
- For TP80(B), the original steel shim used in the unit was replaced with a solid 3/8" thick lead shim.
- The original carbon steel through-bolts were replaced with stainless steel bolts.
- The original carbon steel lid bolts were replaced with high strength, strain hardened stainless steel bolts.
- The weights of the test specimens are representative of the heaviest 650L units in use. The range of weights of 650L units is 75 lb to 90 lb (34.0 kg to 40.8 kg).

The test specimens were radiographed to document the lead configuration and the position of the internal components. Also, the position of the "dummy" source used in the units was measured prior to testing.

5. SUMMARY AND CONCLUSIONS

All test specimens met the requirements for 10 CFR 71 Type B(U) Transport Testing, as shown in the following table of Radiation Profile results.

Specimen	Specimen Surface	At Surface, Before Test	At One Meter, Before Test	At Surface, After 4 ft Drop Test	At One Meter, After 4 ft Drop Test	At One Meter, After Final Test (Notes 1,2)
	Reg. Limits	200 mR/hr	10 mR/hr	200 mR/hr	10 mR/hr	1000 mR/hr
TP80(A) S/N 2243	Top	84	3.2	94	2.4	2.7
	Right	47	0.6	47	0.7	0.8
	Front	88	0.7	89	0.8	1.0
	Left	56	0.6	65	0.7	0.7
	Rear	74	0.7	89	0.8	0.9
	Bottom	51	0.4	94	0.7	0.6
TP80(B) S/N 182	Top	60	3.1	71	2.0	28
	Right	56	0.4	53	0.6	5.6
	Front	84	0.8	83	0.8	5.6
	Left	88	0.6	83	0.6	7.9
	Rear	79	0.8	77	0.8	7.9
	Bottom	74	0.5	83	0.7	1.1
TP80(C) S/N 195	Top	72	2.2	59	2.0	2.2
	Right	105	0.7	71	0.7	0.9
	Front	50	0.6	47	0.5	0.6
	Left	127	0.7	106	0.8	1.0
	Rear	50	0.6	53	0.6	0.6
	Bottom	61	0.6	59	0.5	0.5

Notes:
1. The final Hypothetical Accident Condition test for test specimens TP80(A) and TP80(C) was the Puncture Test. The final test for specimen TP80(B) was the Thermal Test.
2. Radiation profile at the surface is not required for the Hypothetical Accident Condition test (see 10 CFR 71.51(a)(2)).

Results of each test are summarized in the table below, in the sequence in which the tests were completed. Detailed results are provided in the following sections of this report, test data sheets are in Appendix C, and photographs are included in Appendix D.

Specimen	Test Performed	Test Results (Note 1)
TP80(A)	Compression Test	No damage
	1 meter (40 inch) penetration bar on side	Impact mark; no visible damage
	1.2 meter (4 foot) drop, horizontal on long side	• Impact mark on edge of plates • Small change in radiation profile
	9 meter (30 foot) drop, horizontal on long side	Bent bottom plate flange inward
	1 meter (40 inch) puncture, horizontal on long side (dropped twice to ensure specimen temperature was below-40°C (-40°F))	Shallow dent on outer shell at impact point
	Post-Drop Inspection	• Lid secured in place • Locks undamaged; source secured • No significant change in source position • Small change in radiation profile
TP80(B)	Compression Test	No damage
	1 meter (40 inch) penetration bar on side	Impact mark; no visible damage
	1.2 meter (4 foot) drop, vertical upside down	• Impact mark on top of lid • Small change in radiation profile
	9 meter (30 foot) drop, vertical upside down	• Outer shell split open from top to bottom • Inner shell cracked, creating a 3 inch (76.2 mm) high by 0.5 inch (12.7 mm) wide opening • Small upward deflection of top plate • Top and bottom plates remained secured by the through bolts.
	1 meter (40 inch) puncture on crack in shell	Bent shell inward slightly in area of crack

Specimen	Test Performed	Test Results (Note 1)
TP80(B) (con't)	Post-Drop Inspection	• Lid secured in place • Locks undamaged; source secured • Top plate deflection at center about 0.16 inch (4.1 mm). • No damage to through bolts • No significant change in source position. • Outer and inner shells cracked; opening about 3 inch (76.2 mm) by 0.5 inch (12.7 mm).
	Thermal test	• Some oxidation of DU shield near crack in shell • Shield moved down (as expected) • Polyurethane foam burned off, exposing the shield • Some oxidation of shield near crack in shell • Shield self-extinguished after removal from oven • Source pullout less than 0.5 inch (12.7 mm). • Max. radiation level at one meter was 28 mR/hr (which is much less than 1000mR/hr allowable)
TP80(C)	Compression Test	No damage
	1 meter (40 inch) penetration bar on side	Impact mark; no visible damage
	1.2 meter (4 foot) drop on top edge of lid	• Bent corner of lid and cracked top plate of lid (brittle failure) • Small change in radiation profile
	9 meter (30 foot) drop on top edge of lid	• Increased lid top plate crack length in vicinity of impact point • Locks still protected by lid
	1 meter (40 inch) puncture vertical upside down on lid and on underside of top plate	Broke inside of lid top plate (locks still protected)
	Post-Drop Inspection	• Locks undamaged; source secured • No significant change in source position • Small change in radiation profile

Note 1: None of the new stainless steel bolts installed in the test specimens failed.

Specimen TP80(A) was not significantly damaged in the testing. On specimen TP80(C), the top plate of the protective lid was substantially cracked and portions broke away; however, the rectangular tube section which surrounds the locks was undamaged and still attached to the lower portion which in turn was secured to the body of the changer. As such, the locks remained protected. The post-test radiation profiles showed a slight increase in radiation levels for these units, but these radiation levels were well below the allowable values.

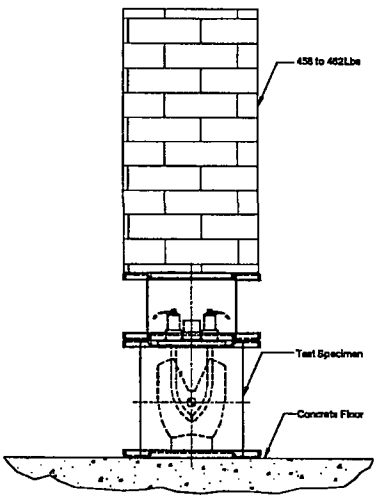
The only significant damage to any unit was the cracked shell in specimen TP80(B). Because of this crack, the depleted uranium shield was exposed to air during the thermal test, and portions of the shield near the crack opening were oxidized. In addition, after the lead shim melted, the shield was free to move downward, pulling the dummy source out of its fully inserted position in the shield. However, even with the oxidized shield and source pull-out, the post-test radiation profile showed a maximum radiation level of 28 mR/hr at one meter. This is well below the maximum allowable level of 1,000 mR/hr at one meter following the hypothetical accident conditions.

6. TP80 NORMAL TESTS

Compression Test

All three test specimens were loaded as shown in the figure below. Lead weights were placed on a steel plate, which was positioned on top of each test specimen.

The vertical projected area of the unit is 8.25 inch (209 mm) x 10 inch (254 mm) or 82.5 square inches (531 square centimeters), yielding a total load of 165 lb (74.8 kg) for an applied pressure of 2 psi. Since the maximum weight of the Model 650L source changer is 90 lb (40.8 kg), a load of 5 times the weight, or 450 lb (204 kg), is more conservative. The total compressive load actually used was 458 lb to 462 lb (208 kg to 210 kg).



Compression Test Orientation – All Specimens

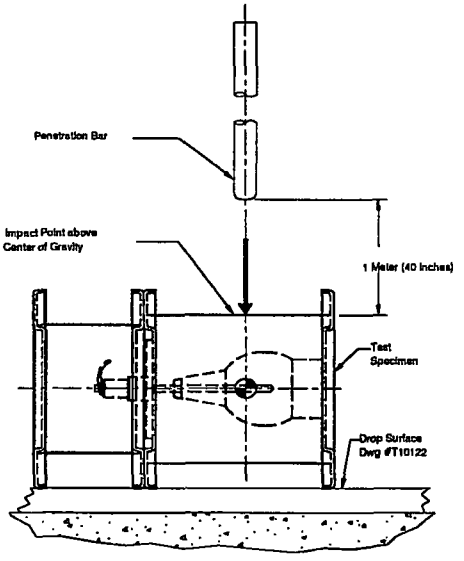
After a period of 24 hours, the weights were removed. No visible deformation or buckling occurred and no other damage was observed for any of the test specimens.

Penetration Test

The three test specimens were subjected to the penetration test. Temperature readings taken just before the test are summarized below.

Specimen	Ambient	Surface	Internal
TP80(A)	10°C (50°F)	-96°C (-141°F)	-95°C (-139°F)
TP80(B)	9°C (48°F)	-93°C (-135°F)	-83°C (-117°F)
TP80(C)	10°C (50°F)	-90°C (-130°F)	-90°C (-130°F)

The penetration bar target was the side of the unit in an attempt to damage the shell. For this test, each specimen was positioned with its horizontal long side down, as shown below.



Penetration Test Orientation – All Specimens

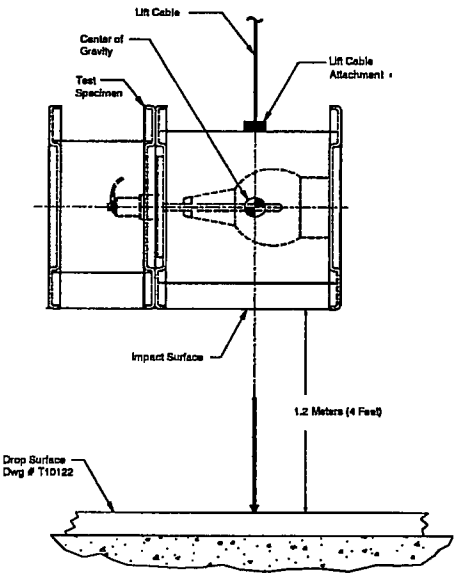
The penetration bar was dropped from a height of at least 1 meter (40 inches) above the impact point. The bar hit as intended on each package, leaving a visible impact mark, but no other damage.

1.2 Meter (4 Foot) Drop Test

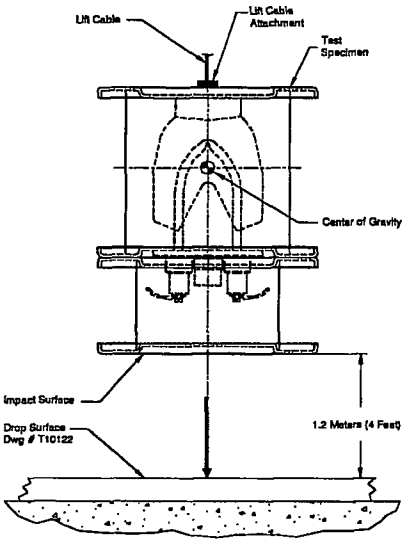
The three test specimens were then subjected to the 1.2 meter (4 foot) drop test. Temperature readings taken just before the test are summarized below.

Specimen	Ambient	Surface	Internal
TP80(A)	13°C (55°F)	-92°C (134°F)	-90°C (-130°F)
TP80(B)	13°C (55°F)	-87°C (-125°F)	-89°C (-128°F)
TP80(C)	13°C (55°F)	-95°C (-139°F)	-92°C (-134°F)

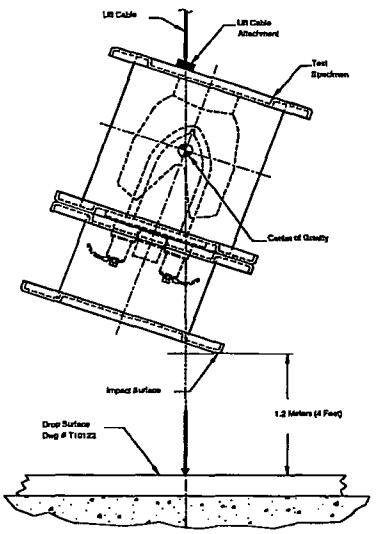
The drop orientations for each unit are shown below and on the next page. These orientations are the same as those used for each specimen in the 9 meter (30 foot) drop tests.



1.2 Meter (4 Foot) Drop Orientation for Specimen TP80(A)



1.2 Meter (4 Foot) Drop Orientation for Specimen TP80(B)



1.2 Meter (4 Foot) Drop Orientation for Specimen TP80(C)

Each test specimen impacted as intended. Visual inspections showed impact marks but no significant damage to either TP80(A) or TP80(B). For TP80(C), a 2 inch (50.8 mm) long crack in the top of the protective lid was observed, and the flange corner was bent.

Post-Test Inspection and Assessment

Results of the first intermediate inspections and assessments are summarized below. The radiation profile of each specimen was measured, and data sheets are provided in Appendices B and C.

Specimen	Damage	Source Movement	Radiation Profile (Note 1)
TP80(A)	No visible damage, locks functional	No significant change observed	Largest change at bottom surface: 51mR/hr to 94 mR/hr (Note 2)
TP80(B)	No visible damage, locks functional	No significant change observed	Largest change at top surface: 60 mR/hr to 71 mR/hr
TP80(C)	Cracked top lid, locks functional	No significant change observed	Largest change at rear surface: 50 mR/hr to 53 mR/hr

Note 1: Radiation levels at one meter were 2.4 mR/hr or less after Normal Condition Tests.

Note 2: All other surfaces measured remained essentially the same, exhibiting no corresponding shift in radiation levels. Additionally, no source movement was measured. Therefore, this change was considered insignificant.

7. TP80 ACCIDENT DROP TESTS – TP80(A)

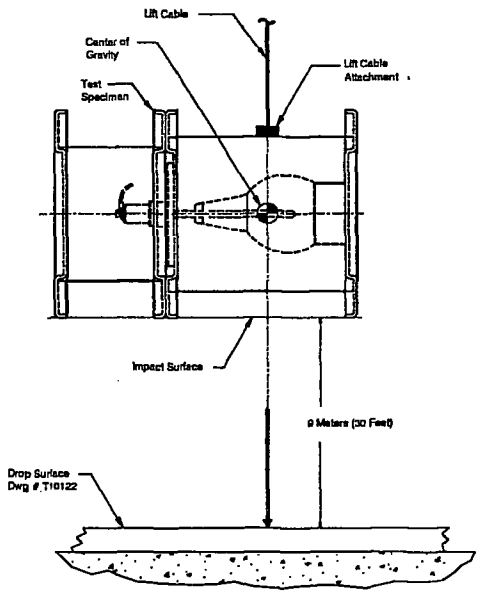
Specimen TP80(A) was subjected to a 9 meter (30 foot) drop test and a puncture test in accordance with Test Plan 80. The results are described below.

9 Meter (30 Foot) Drop Test

Just before the drop test, thermocouple readings for Specimen TP80(A) were as follows:

- Internal (source tube): -93°C (-135°F)
- Surface (shell): -92°C (-134°F)

The orientation for Specimen TP80(A), shown below, was the same as for the 1.2 meter (4 foot) drop. The intention was to cause the shield to move relative to the lock assembly and/or to cause failure of the inner and outer shells.

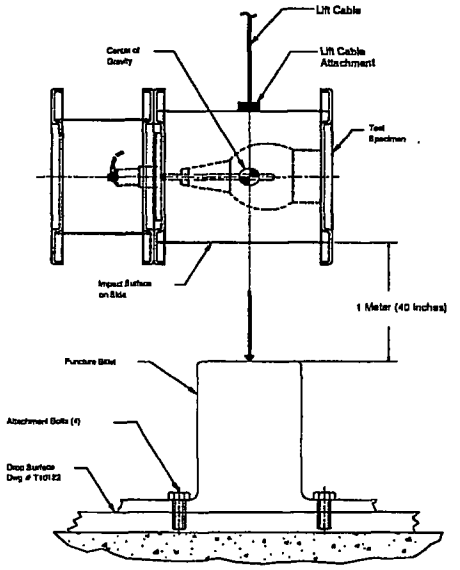


9 Meter (30 Foot) Drop Orientation for Specimen TP80(A)

The package rotated very slightly causing the edge of the bottom plate to impact first. However, the impact was sufficiently close to ideal as to impart the desired force into the package. Visual inspections showed that the edge of the bottom plate had bent inward to the point where it contacted and dented the outer shell. The edge of the top plate of the lid also bent inward slightly.

Puncture Test

For the puncture test, TP80(A) was dropped, as planned, on its side with the center of gravity over the impact area, as shown below. The intention of this orientation was to inflict further damage to the shell. The thermocouple reading on the surface of the unit before the puncture test was -69°C (-92°F) but warmed to -26°C (-15°F) just after the test due to delays in rigging the unit for the drop. Consequently, the unit was cooled again and dropped a second time. For the second test, the surface temperature was -46°C (-51°F) before the test and -42°C (-44°F) after the test.



Puncture Drop Orientation for Specimen TP80(A)

For both drops, the unit impacted on its side as intended. Each impact caused the side of the shell to deform inward slightly, but no significant damage was observed.

Post-Test Inspection and Assessment

Following the test, the protective lid was removed and the unit was inspected. No damage to the lock assembly was observed, and no significant source movement was measured. Radiographs of the unit showed no discernable change in the position of the shield. The post-test radiation profile showed no significant change in radiation levels from the pre-test profile (see Appendices B and C). Because no significant damage occurred to the unit, the thermal test was not considered necessary (see Section 3). In addition, Specimen TP80(B) was considered worst case.

8. TP80 ACCIDENT DROP TESTS – TP80(B)

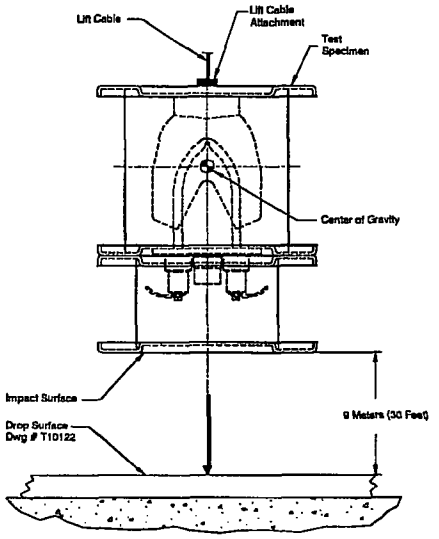
Specimen TP80(B) was subjected to a 9 meter (30 foot) drop test and a puncture test in accordance with Test Plan 80. The results are described below.

9 Meter (30 Foot) Drop Test

Just before the drop test, thermocouple readings for Specimen TP80(B) were as follows:

- Internal (source tube): -94°C (-137°F)
- Surface (shell): -93°C (-135°F)

The package orientation for Specimen TP80(B), shown below, was the same as for the 1.2 meter (4 foot) drop. The intention was to cause deformation of the top plate, failure of the through-bolts, and failure of the lock assembly, leading to source pull-out from the shield.



9 Meter (30 Foot) Drop Orientation for Specimen TP80(B)

The package impacted as intended. The impact caused the depleted uranium shield to move into the foam below the top plate, putting a large lateral load on the inner shell, and causing the shell to crack. The cracking of the inner shell resulted in a transfer of the lateral load to the outer shell, breaking the spot welds that hold the outer shell together. The outer stainless steel wrap also failed and sprung open. One of the rivnuts in the top plate broke, but its associated bolt and the all the other lid bolts were undamaged and the lid remained secured to the package.

Puncture Test

For the puncture test, the planned orientation was changed in order to inflict the greatest damage, based on the on-site assessment of Engineering, Regulatory and QA. As such, TP80(B) was dropped so that the cracked shell was aligned with the top edge of the puncture bar. The intention was to open up the crack or cause additional cracking in the damaged area. The thermocouple reading on the outside surface of the unit was -57°C (-71°F) before the puncture test and -44°C (-47°F) after the test.

The unit impacted directly on the crack. The outer shell was deformed inward at the impact area, but additional cracking was not observed.

Post-Test Inspection and Assessment

Following the test the protective lid was removed and the unit was inspected. The through-bolts were all intact. One of the locks had broken out, but the dummy source remained securely retained (i.e., the lock slide was still secure). The top plate (with the lock assembly) deflected outward by about 0.16 inch (4.1 mm). The resulting source pull-out was measured to be 0.027 inch (0.69 mm) in one side and 0.064 inch (1.6 mm) in the other side. Radiographs showed the crack in the inner shell extended from the top plate to the bottom plate.

9. TP80 ACCIDENT DROP TESTS – TP80(C)

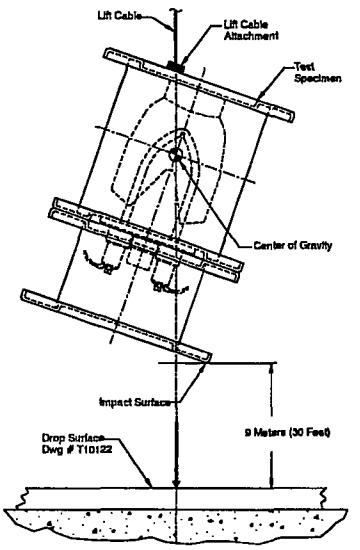
Specimen TP80(C) was subjected to a 9 meter (30 foot) drop test and a puncture test in accordance with Test Plan 80 and results are described below.

9 meter (30 Foot) Drop Test

Just before the drop test, thermocouple readings for Specimen TP80(C) were as follows:

- Internal (source tube): -97°C (-143°F)
- Surface (shell): -98°C (-144°F)

The package orientation for Specimen TP80(C), shown below, was the same as for the 1.2 meter (4 foot) drop. The intention was to fail the bolts holding the protective lid to the rest of the unit. This would expose the lock assembly to further damage during the puncture test.



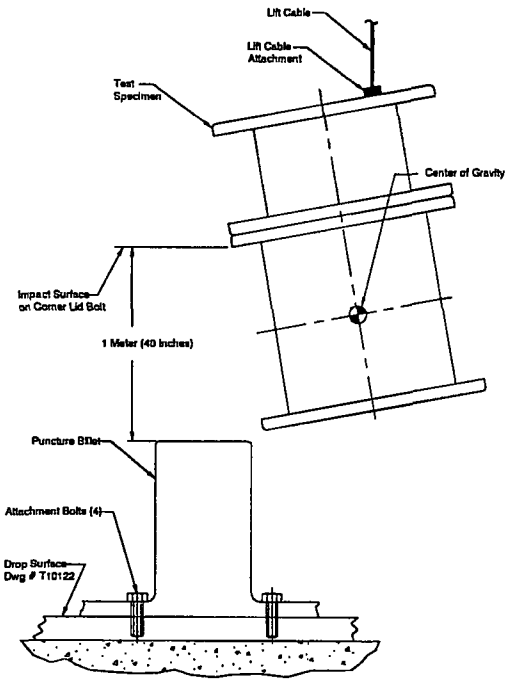
9 Meter (30 Foot) Drop Orientation for Specimen TP80(C)

The package impacted as intended. Visual inspections showed that none of the lid bolts failed, but the lid crack initiated in the 1.2 meter (4 foot) drop increased in both directions. The crack went around the top plate at its interface with the rectangular tube section that protects the locks. The crack went about halfway around the lid, and the top plate was deflected downward about 0.5 inch (13 mm). Portions of the top plate flange also broke off.

Puncture Test

Specimen TP80(C) was subjected to two puncture tests. An additional puncture drop was added as two possible orientations were deemed "worst case". In the first test, the unit was dropped vertically upside down, with the intention of breaking through the lid and damaging the locks. The thermocouple reading on the surface of the unit was -53°C (-63°F) before the puncture test and -50°C (-58°F) after the test.

For the second test, the unit was dropped such that the impact was on the underside of the top plate, as shown below. The objective of this drop was to damage the rivnuts, which hold the lid to the top plate, and to pry the top plate off of the unit by overloading the through-bolts. The initial surface temperature was -47°C (-53°F).



Second Puncture Drop Orientation for Specimen TP80(C)

The unit impacted as intended in both drops. In the first drop, the top of the lid was damaged further, however, the lid remained intact and the puncture bar did not impact the lock assembly. In the second drop, the top plate deformed slightly, but no significant damage was observed.

Post-Test Inspection and Assessment

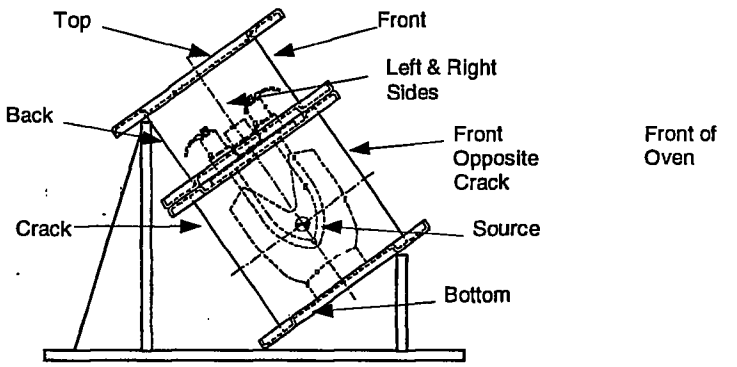
Following the test, the protective lid was removed and the unit was inspected. No damage to the locks was observed and no significant movement of the source was measured. The post-test radiation profile showed no significant change in radiation levels from the pre-test profile (see Appendix B). Because no significant damage occurred to the unit, the thermal test was not considered necessary (see Section 3). In addition, Specimen TP80(B) was considered worst case.

10. TP80 THERMAL TEST – TP80(B)

Based on the results of the drop tests, a thermal test was performed with specimen TP80(B). The damage to this unit was such that the maximum source pull-out, as well as oxidation of the depleted uranium shield, could occur during the thermal test. The thermal test was not considered necessary for the other test specimens since the results are bounded by those for TP80(B).

Orientation and Setup

Based on the damage observed in the drop tests, it was concluded that worst orientation for the thermal test was to have the unit at an angle such that the center of gravity of the shield was over the bottom corner edge of the inner shell. The cracked side of the unit was oriented downward, so that the shield would move toward the crack as the lead shim melted and the shield dropped down. The worst case angle was determined to be 53° based on the internal geometry of the unit. This would allow the maximum amount of shield movement relative to the top plate, pulling the source out of position. To hold the specimen in this orientation, a steel jig was constructed as shown below.



TP80(B) Orientation and Thermocouple Locations

Seven thermocouples were attached to the specimen on the top, bottom, and four side surfaces (two thermocouples on the front side). An eighth thermocouple was inserted into one of the source tubes to measure the internal temperature. A ninth thermocouple was used to measure the ambient oven temperature.

To allow for combustion during the thermal test, the oven door was blocked open with a gap of 1 inch (25.4 mm) at the top and bottom of the door, permitting airflow into the oven while allowing the oven to maintain its temperature. Since the oven door is 36 inches (914 mm) long, each opening was approximately 36 square inches (232 square centimeters).

Test Chronology

Temperatures were recorded from the time the specimen was inserted in the oven until after it had cooled and was moved to a temporary storage area. The total duration of this period was about 1,000 minutes (16 hours). Plots of the temperature data are included in Appendix C. The overall test chronology is as follows:

- Zero to 32 minutes – heat up of the specimen from ambient to over 810°C (1490°F). The 30 minute test started when all surfaces of the specimen exceeded 810°C (1490°F). The thermocouple on the bottom of the unit was the last to reach the target temperature, and the test was started when it reached 813°C (1495°F).

- 32 to 64 minutes – 30 minute test period, with all temperatures maintained above 810°C (1490°F). The maximum temperature was 996°C (1825°F) on the side of the unit facing the rear of the oven, while the minimum temperature was 813°C (1495°F) on the bottom of the unit. The initial and final temperatures of all thermocouples over the 30 minute period are shown below. Flames due to combustion of the foam were observed, however these diminished and stopped before the end of the 30 minute test.

Location	Initial Temp.	Final Temp.	Average Temp.
Bottom	813°C (1495°F)	861°C (1582°F)	872°C (1602°F)
Top	980°C (1796°F)	879°C (1614°F)	913°C (1675°F)
(Lid) Front Oven	934°C (1713°F)	848°C (1558°F)	879°C (1614°F)
(Lid) Back Oven	995°C (1823°F)	884°C (1623°F)	923°C (1693°F)
(Lid) Left Side	949°C (1740°F)	865°C (1589°F)	899°C (1650°F)
(Lid) Right Side	979°C (1794°F)	872°C (1602°F)	909°C (1668°F)
Side (Opposite Crack)	830°C (1526°F)	810°C (1490°F)	823°C (1513°F)
Source Tube	906°C (1663°F)	865°C (1589°F)	886°C (1627°F)
Oven/Ambient	940°C (1724°F)	839°C (1542°F)	877°C (1611°F)

- 64 minutes – removal from oven. The depleted uranium shield was visible, with a slightly red glow in areas. Some depleted uranium oxide (black power) was observed coming out of the crack and onto the surface below, indicating the shield was oxidizing.

- 64 to 700 minutes – cool down to below 100°C (212°F). During this time, the shield was allowed to self-extinguish.

During the cool down period, the unit was allowed to cool via natural convection with no additional heat input. The hypothetical accident conditions specified in the IAEA Safety Series 6 regulations include a requirement to account for heat input due to insolation during the cool down period. This heat input could reduce the cool down rate. However, the reduction was not considered to have any effect on the damage sustained by the test specimen, particularly compared with the 30 minute exposure to 810°C (1490°F) in the oven.

Post-Test Inspection and Assessment

The initial on-site assessment of the test specimen included the following observations:

- A cracked piece of the inner shell was dislodged and had dropped out of position.
- Most paint had vaporized. Radiation labels were still legible.
- All the foam had burned off, leaving a small amount of carbon char.
- The lead shielding and shim melted and some lead had dripped out the bottom of the unit.
- Radiography showed the shield moved laterally and downward as expected. The resulting source pull-out was measured to be 0.436 inch (11.1 mm) on one side and 0.480 inch (12.2 mm) on the other side.
- The lock assemblies were functional; however, the source tubes had completely pulled out of the top plate and had shifted laterally. This caused an interference between the source wire and the top plate, and required that the top plate be machined to enlarge the holes before the unit could be profiled.

After the thermal test, visual observations indicated that the shield had come to rest on the through bolts and bottom plate. However, to securely fix the shield in position for shipping and extensive handling, holes were drilled in the shell of the unit so that foam could be poured in, and the shield was foamed in place. A radiation profile was then done on site with the source located to replicate the amount of observed source pull-out. The highest radiation measurement was 28 mR/hr at one meter (when scaled to the 240 Ci licensed capacity of the unit) at the top of the unit. The small amount of shield oxidation experienced in the test had a minimal effect on the overall effectiveness of the shielding.

APPENDIX A

CALIBRATION RECORDS

METTLER TOLEDO

SCALE CALIBRATION RECORD Date: 11-16-98

SCALE LOCATION Shipping + Rec. TAG NO. ASSY II
MANUFACTURER FAIRBANKS SERIAL NUMBER L4823G7
MODEL NUMBER Port Beam
CAPACITY 2000 X 1/2 DIVISIONS 4000
TEST PROCEDURE HB44 CSWA#

TEST PROCEDURE REFERENCE: METTLER TOLEDO MANUAL FOR CALIBRATIONS SERVICES, HANDBOOK 44 FIELD MANUAL

Shift Test	Weights Applied	Scale Reading	Error (+/-)	Scale Reading After Adjustment		
Position 1	500 lb	501 lb	+1 lb		(Acc.)	Rej.
Position 2	500	500	0		(Acc.)	Rej.
Position 3	500	500 1/2	+1/2		(Acc.)	Rej.
Position 4	500	500 1/2	+1/2		(Acc.)	Rej.
Test Load	**Weights Applied**	**Scale Reading**	**Error (+/-)**	**Scale Reading After Adjustment**		
Zero Balance	0 lb	0 lb	0 lb		(Acc.)	Rej.
	500	500 1/2	+1/2		(Acc.)	Rej.
	1000	999 1/2	-1/2		(Acc.)	Rej.
	1500	1501	+1		(Acc.)	Rej.
Maximum Test Load	2000	1998	-2		(Acc.)	Rej.
					Acc.	Rej.
	1000		-1/2		(Acc.)	Rej.
					Acc.	Rej.
Zero Balance	0		0		(Acc.)	Rej.

TEST WEIGHT ID NUMBERS: 01 thru 28

COMMENTS/ACTIONS:

CUSTOMERS SIGNATURE (FOR OFF TOLERANCE):

TECHNICIANS SIGNATURE: J. Draper + B. Clarke

127 Riverneck Road
Chelmsford, MA 01824
Telephone: 978 - 459-9480
FAX # 978 - 453-6336
WEB SITE: http://www.tekserv.com

Dd 8 OCT 98

CALIBRATION REPORT

SERVICE NUMBER:	SN-0226210
CONTRACT NUMBER:	SENTINEL

A59847

AEA TECHNOLOGIES
40 NORTH AVENUE

BURLINGTON MA 01803

DATE RECEIVED	CUSTOMER P.O.	ASSET NUMBER
10/08/98	2887	ENG-12

MANUFACTURER: OMEGA

MODEL	SERIAL NUMBER
HH-21	T-179139

DESCRIPTION: THERMOMETER

TEMP.	HUMIDITY	PRIOR CAL	CAL CYCLE	DATE OF TEST	NEXT TEST DUE
23.00°C	30.00%	9/25/97	12 MO	10/08/98	10/08/99

WORK REQUESTED	SERVICES RENDERED	REMARKS
CALIBRATE/CERTIFY	CALIBRATED/CERTIFIED	IN TOLERANCE AS RCV'D

PROCEDURE USED	N.I.S.T. TEST NUMBER	TECHNICIAN
MANUFACTURER'S	413348-433349-259071-LRAN	POULIN

CALIBRATION CHECKED TO: MANUFACTURER'S SPECIFICATIONS — ADJUSTED TO: MANUFACTURER'S SPECIFICATIONS

MANUFACTURER	MODEL	SERIAL	ACCURACY	DATE CALIBRATED
ANALOGIC	AN6520	8904010	MFG.	7/03/98

TEKSERV CERTIFIES THAT ALL CALIBRATION EQUIPMENT USED IN THE TEST IS TRACEABLE TO N.I.S.T. AND THE TEST WAS PERFORMED IN ACCORDANCE WITH MIL-STD-45662A, ISO9002, ISO-10012-1, ANSI/NCSL-Z540-1-1994.

CERTIFIED BY _____

IN TOLERANCE
AS RECEIVED

TEKSERV
CALIBRATION DATA

OMEGA Model HH-21
Serial Number: T 179139
Date of test: 10-8-98
Prior Cal: 9-25-97
Technician: M. P.

Data as Received ✓
Data After Adjustment
Data After Repair
Asset Number: ENG-12

Range	Reading	Specification
Deg.C Type J		
- 100.0	-99.6	+/-(0.1%rdg+0.5'C)
0.0	0.3	"
100.0	100.3	"
500.0	500.0	"
Deg.F Type J		
- 100.0	-99.3	+/-(0.1%rdg+1.0'F)
32.0	32.6	"
200.0	200.5	"
650.0	650.4	"
1200.0	1199.9	"
Deg.C Type K		
- 100.0	-99.5	+/-(0.1%RDG+0.5'C)
0.0	0.4	"
100.0	100.4	"
600.0	599.9	"
1000.0	1000.2	"
Deg.F Type K		
- 100.0	-99.1	+/-(0.1%rdg+1.0'F)
32.0	32.9	"
200.0	200.7	"
600.0	600.4	"
1600.0	1600.5	"
Deg.C Type T		
- 100.0	-99.5	+/-(0.1%rdg+0.5'C)
0.0	0.3	"
100.0	100.2	"
350.0	350.1	"
Deg.F Type T		
- 100.0	-99.4	+/-(0.1%rdg+1.0'F)
32.0	32.5	"
100.0	100.3	"
500.0	500.3	"

Established in 1972

HUNT METROLOGY SERVICE, INC.
175 Jackson St. Methuen, Ma. 01844-5042
Phone : (978) 688-7278 Fax : (978) 794-4632

Calibration Certificate

Company Name: **SENTINEL**
Address: **40 NORTH AVENUE**
BURLINGTON, MA. 01803

Calibration No: **HMSCC-08487**
Dated: **APR 1-2, 1998**
Pages: **28**

Department:

Phone No.: **(781) 272-2000** Ext:
Attention: **DAVE ANNIS**
P.O. No.:
Technician: **PAUL RABS**

Fax No: **(781) 273-2216**

The calibration performed on the following measuring and test equipment (M&TE) of this document are traceable to the National Institute of Standards and Technology (N.I.S.T.) through N.I.S.T. test number 821/256504-96; Dated February 26, 1997 for dimensional calibration, and/or through N.I.S.T. test number 822/254480 dated February 26, 1997 for mass 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 (+/- 2 degrees F.) 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 and ISO 10012-1:1994(E).

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.

Keith R. Young
Technical Manager

Customer: AMERSHAM CORPORATION - SENTINEL DIVISION P.O. No.:

ID.No.: 183 Manufacturer: CHATILLON Date Cal: 04/01/98
2 ID.No.: Serial No.: 17938 Date Due: 04/01/99
Department: QC Model No.: DPP-10 Technician: PR
Deviation u.: Standard No.: 018 Cal.: 03/06/98 Cal. Proc. No: 22
Accuracy: +/-1% OF FS Standard No.: Cal.: Due: 03/31/99
Accuracy: Standard No.: Cal.: Due:
Standard No.: Cal.: Due:
Gage Type: 10 lb FORCE GAGE

Required:	1	2	4	6	8	10	lb
Deviation:	0	0	0	0	0	0	lb
Measured:	1.0	2.0	4.0	6.0	8.0	10.0	lb

Customer: AMERSHAM CORPORATION - SENTINEL DIVISION P.O. No.:

ID.No.: 186 Manufacturer: CHATILLON Date Cal: 04/01/98
2 ID.No.: Serial No.: 19108 Date Due: 04/01/99
Department: RI LAB Model No.: DPP-10 Technician: PR
Deviation u.: Standard No.: 018 Cal.: 03/06/98 Cal. Proc. No: 22
Accuracy: +/-1% OF FS Standard No.: Cal.: Due: 08/31/98
Accuracy: Standard No.: Cal.: Due:
Standard No.: Cal.: Due:
Gage Type: 10 lb FORCE GAGE

Required:	1	2	4	6	8	10	lb
Deviation:	0	0	0	0	0	0	lb
Measured:	1.0	2.0	4.0	6.0	8.0	10.0	lb

Customer: AMERSHAM CORPORATION - SENTINEL DIVISION P.O. No.:

ID.No.: 236 (1) Manufacturer: MITUTOYO Date Cal: 04/01/98
2 ID.No.: Serial No.: 314390 Date Due: 04/01/99
Department: QC Model No.: Technician: PR
Deviation u.: Standard No.: 026 Cal.: 02/04/98 Cal. Proc. No: 16
Accuracy: +/-0.0010"/12" Standard No.: 088 Cal.: 02/04/98 Due: 08/31/98
Accuracy: Standard No.: 137 Cal.: 02/02/98 Due: 02/28/99
Standard No.: Cal.: Due: 02/28/99
Gage Type: 0-18" VERNIER PART 1 OF 2

Required:	0	PARA	ID	OD	1.0	2.0	4.0
Deviation:	REF	.001	0		0	0	0
Measured:	REF	.001	1.0000		1.0000	2.0000	4.0000

Customer: AMERSHAM CORPORATION - SENTINEL DIVISION P.O. No.:

ID.No.: 236 (2) Manufacturer: MITUTOYO Date Cal: 04/01/98
2 ID.No.: Serial No.: 314390 Date Due: 04/01/99
Department: QC Model No.: Technician: PR
Deviation u.: Standard No.: 026 Cal.: 02/04/98 Cal. Proc. No: 16
Accuracy: +/-0.0010"/12" Standard No.: 088 Cal.: 02/02/98 Due: 08/31/98
Accuracy: Standard No.: 137 Cal.: 02/02/98 Due: 02/28/99
Standard No.: Cal.: Due: 02/28/99
Gage Type: 0-18" VERNIER PART 2 OF 2

Required:	6.0	8.0	10.0	12.0	18.0
Deviation:	0	0	0	0	0
Measured:	6.0000	8.0000	10.0000	12.0000	18.0000

AND RECORD

T10129 | REV: B | PROCEDURE: PERIODIC MAINTENANCE

DESCRIPTION: PENETRATION TEST BAR | CM - NA

CHARACTERISTICS	TOLERANCE	AQL	1	2	3	4	5	6	7	8	9	10	11	12
GENERAL VISUAL	N/A	C/100%	0/1	0/1										
VERIFY WEIGHT	13/13.5 lbs	C/100%	0/1	0/1										

ORIGINATOR / DATE: Dave Quint 2 SEPT 97	~~P.O. / W.O.~~ FREQ. DAYS	365												
ENGINEERING APPROVAL / DATE: N/A	~~RECEIVING RECORD #~~ DUE DATE	2 Sep 98	2 Sep 99											
REGULATORY APPROVAL / DATE: N/A	LOT / SERIAL NO.	01	01											
Q A APPROVAL / DATE: 3 Sep 97	LOT QTY.	1	1											
COMMENTS:	QTY REJ / NCR NO.	0 / NA	0 / NA											
	QTY ACC.	1	1											
	INSP / DATE	DW 2 Sep 97	DW 2 Sep 97											

INSPECTION INSTRUCTION AND RECORD

PART/DWG. NO. T10122 | REV. B | VENDOR: PERIODIC MAINTENANCE | Page 1 of 1

DESCRIPTION: DROP TEST SURFACE | CM - NA

CHARACTERISTICS	TOLERANCE	AQL	1	2	3	4	5	6	7	8	9	10	11	12
GENERAL VISUAL SURFACE SECURE & NOT DAMAGED	N/A	C/100%	0/1											
REMOVE 4 ½-13 SCREWS LUBRICATE AND REINSTALL	N/A	C/100%	0/1											

ORIGINATOR DATE: Dave Amis 29 SEPT 97

~~P.O. / W.O.~~ DAYS, FREQ: 365

ENGINEERING APPROVAL DATE: N/A

~~RECEIVING RECORD #~~ DATE DUE: 25 SEPT 98

REGULATORY APPROVAL DATE: N/A

LOT / SERIAL NO.: 01

Q A APPROVAL DATE: [signature] 29Sep97

LOT QTY.: 1

COMMENTS:

QTY REJ / NCR NO.: 0 / N/A

QTY ACC.: 1

INSP / DATE: DW 25 SEPT

Simpson Gumpertz & Heger Inc.

Consulting Engineers
Arlington, MA
San Francisco, CA

297 Broadway
Arlington, MA
02174-5310

Telephone:
617 643 2000
Fax:
617 643 2009

9 June 1997

Sentinel Amersham Corporation
40 North Avenue
Burlington, Massachusetts 01803

Attention: Steven J. Grenier

Tel: 617-272-2000
Fax: 617-273-2216

Comm. 97276 – Test Foundation Study, Sentinel Amersham Test Site, Groveland, MA

Gentlemen:

At your request we studied a test foundation located on the property of Valley Tree Service, Inc. at 1210 Salem Street, Groveland, Massachusetts. The purpose of our study was to determine if the test foundation provides an essentially unyielding horizontal surface for purposes of a drop test.

Scope

The scope of our study included: visiting the site to examine the foundation; reviewing documents provided by you that describe the construction of the foundation; reviewing drawings describing the housing of your Model 676 Projector; and computing the performance characteristics of the foundation in a drop test of the Model 676 Projector.

Background and Information From Others

We understand from our discussions with Sentinel Amersham representatives that the test foundation is used as a reaction support in a drop test for the Model 676 Projector. The projector is dropped from a height of 30 ft onto the center portion of the foundation. The drawings for the Model 676 Projector show that the weight is 625 lbs, and the end plates are fabricated from 1 in. thick steel plate.

We understand from discussions with Sentinel Amersham representatives and from construction records that the test foundation was built in 1982. The delivery tickets show that 2-1/2 cubic yards of 3,000 psi concrete were utilized. We were also told that a 1 in. thick steel plate is embedded in the top surface of the foundation and welded to reinforcing steel in the foundation.

Observations

On 5 June 1997, Joseph J. Zona of Simpson Gumpertz & Heger Inc. visited the test facility and observed the following:

- The test foundation is 7 ft 4 in. x 7 ft 5 in.
- A steel plate is embedded in the top of the foundation so that the top of the plate is approximately flush with the top of the concrete. The plate is 47 in. x 48 in. At one

side of the plate, the concrete is chipped away exposing part of the plate edge. The bottom of the plate is not visible, but 7/8 in. of plate is exposed to view.

- The top surface of the steel plate is approximately horizontal. The plate slopes a maximum of 1/8 in. per 2 ft.
- The top surface of the concrete is weathered, but sound.
- Four cracks are visible in the foundation, each emanating from a corner of the steel plate. The cracks appear stable and show no signs of recent movement.
- The concrete is flush with the adjoining bituminous pavement. There is no evidence of settlement or heaving of the foundation.
- The exposed soil in the vicinity of the foundation is firm and sandy.

Results of Analysis

We estimated the depth of the foundation as 15 in. based on the measured plan dimensions and the reported volume of concrete delivered. We characterized the supporting soil as medium dense coarse grained material.

We used simple analytical models to estimate the response of the foundation in a drop test. A conservation of momentum approach that models the test as a plastic impact provides an upper bound estimate of the kinetic energy taken by the foundation. This approach predicts that 6 percent of the kinetic energy of the Model 676 Projector is taken by the foundation upon impact.

Arya et al present a relevant method of analysis in "Design of Structures & Foundations For Vibrating Machines." The approach accounts for the participation of an effective soil mass in resisting a dynamic loading. This method predicts less than 1 percent of the kinetic energy is taken by the foundation. Arya el al also present a method of estimating the foundation deflection. We computed a deflection upon impact of 0.014 in.

We estimated the flexibility of the concrete foundation as a plate on an elastic foundation using a method presented in "Theory of Plates and Shells" by Timoshenko & Woinowsky-Krieger. This approach shows that the foundation is rigid relative to the soil, and virtually all of the foundation deflection is the result of soil response.

Discussion

The plastic impact approach provides an upper bound estimate of the energy transmitted to the foundation. In an actual test, energy is absorbed in the device being tested in both plastic deformation and rebound energy that is not accounted for in this analysis.

The Arya approach is fully applicable to foundations that support vibrating equipment. This approach may somewhat overstate the participation of the soil in a single impact loading. However, we expect the influence of the participating soil mass will be significant and, therefore, we expect the percent of kinetic energy taken by the foundation is closer to 1 percent than 6 percent.

The four cracks near the corners of the foundation intersect corners of the embedded steel plate. This suggests that the plate restrained the free shrinkage of the foundation and caused these cracks. The cracks are obviously old, yet they remain tight and there is no sign of recent movement at the cracks. This strongly indicates that the cracks have not compromised the monolithic behavior of the foundation. Any loss of stiffness in the foundation related to these cracks is insignificant within the limits of our simple analytical models.

Conclusion

Based on the study described above, we conclude that the existing test foundation absorbs between 1 and 6 percent of the kinetic energy at impact during a 30 ft drop test of a Model 676 Projector. In our opinion the foundation provides an essentially unyielding horizontal surface for the purpose of this test. For items of lesser mass, the foundation also provides an essentially unyielding horiozntal surface.

Sincerely yours,

Joseph J. Zona, P.E.
Principal
JJZ32-97.ras

Atis A. Liepins, P.E.
Senior Associate

OMEGA ENGINEERING, INC.
An OMEGA Technologies Company

Certificate of Conformance

for

AEA TECHNOLOGY

40 NORTH AVE

BURLINGTON MA 01803

Cust. P.O. #: 3291 OMEGA W.O. # 812995304

CAL-1

OMEGA Engineering, Inc. certifies that the items comprising the above order have been manufactured in accordance with all applicable instructions and specifications as published in the OMEGA TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA®. OMEGA Engineering Inc. further certifies that all thermocouple base and noble metal materials conform to ANSI Limits of Error (ANSI Standard MC96.1)

Certified by: Stephen Cardone Date: 12-04-98

Quality Assurance Inspector

Omega Engineering, Inc., One Omega Drive, Box 4047, Stamford, CT 06907
Telephone: (203) 359-1660 · FAX: (203) 359-7811
Internet Address: http://www.omega.com E-Mail: info@omega.com

OMEGA ENGINEERING, INC.
An OMEGA Technologies Company

Certificate of Conformance

for

AEA TECHNOLOGY

40 NORTH AVE

BURLINGTON MA 01803

Cust. P.O. #: 3226 OMEGA W.O. # 811973359

CAL-1

OMEGA Engineering, Inc. certifies that the items comprising the above order have been manufactured in accordance with all applicable instructions and specifications as published in the OMEGA TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA ®. OMEGA Engineering Inc. further certifies that all thermocouple base and noble metal materials conform to **ANSI Limits of Error** (ANSI Standard MC96.1)

Certified by: Stephen Cardone Date: 11-04-98

Quality Assurance Inspector

Omega Engineering, Inc., One Omega Drive, Box 4047, Stamford, CT 06907
Telephone: (203) 359-1660 · FAX: (203) 359-7811
Internet Address: http://www.omega.com E-Mail: info@omega.com

INSPECTION INSTRUCTION AND RECORD

T10119 | C | PERIODIC MAINTENANCE

DESCRIPTION: PUNCTURE TEST BILLET | CM - NA

CHARACTERISTICS	TOLERANCE	AQL	1	2	3	4	5	6	7	8	9	10	11	12
GENERAL VISUAL	N/A	C/100%	0/1	0/1										

ORIGINATOR DATE: Dave Linn 3 SEPT 97	P.O. / W.O. FREQ. DAYS	365												
ENGINEERING APPROVAL DATE: N/A	RECEIVING RECORD # DUE DATE	3 SEPT 98	3 Sep 99											
REGULATORY APPROVAL DATE: N/A	LOT / SERIAL NO.	01	01											
Q A APPROVAL DATE: 3Sep 97	LOT QTY.	1	1											
COMMENTS:	QTY REJ / NCR NO.	0 / N/A	0 / NA											
	QTY ACC.	1	1											
	INSP / DATE	DW 3 SEPT 97	DW 3 Sep 98											

OMEGA ENGINEERING, INC.
An OMEGA Technologies Company

Certificate of Conformance

for

MPR ASSOCIATES

320 KING ST

ALEXANDRIA VA 22314

Cust. P.O. #: 420002BRB OMEGA W.O. # 901934179

CAL-1

OMEGA Engineering, Inc. certifies that the items comprising the above order have been manufactured in accordance with all applicable instructions and specifications as published in the OMEGA TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA®. OMEGA Engineering Inc. further certifies that all thermocouple base and noble metal materials conform to ANSI Limits of Error (ANSI Standard MC96.1)

Certified by: Stephen Cardone Date: 01-28-99

Quality Assurance Inspector

Omega Engineering, Inc., One Omega Drive, Box 4047, Stamford, CT 06907
Telephone: (203) 359-1660 · FAX: (203) 359-7811
Internet Address: http://www.omega.com E-Mail: info@omega.com

Dd 1 Dec 98

TEKSERV
127 Riverneck Rd.
Chelmsford, MA 01824
Telephone: 978-459-9480

Calibration Report

Customer ID	Cust. P.O.	Serial Number
A51106	AEA	SN269

Date Received	Cal. Number	Technician
11/23/98	3303	ENG-21

AEA
40 NORTH AVENUE

BURLINGTON MA 01803-

Manufacturer
COLE PARMER

Model Number	Serial Number
92000-00	L98003314

Item Description
12 CHANNEL THERMOCOUPLE SCANNER

Quantity	Humidity	Cal Interval	Cal Interval	Date Calibrated	Due Date
21	30	12	Monthly	11/23/98	11/23/99

Work Requested	Service Rendered	Remarks
CALIBRATE/CERTIFY	CALIBRATED/CERTIFIED	IN TOLERANCE AS RECEIVED

Procedure Used	Customer Test Numbers	Technician
Manufacturer	413348-433349-259071-LRAN	POULIN

Calibration Checked To: Manufacturer *Spec* *Adjusted To:* Manufacturer *Spec*

Manufacturer Name	Model Number	Serial Number	Accuracy	Calibration Date	Cal Due Date
ANALOGIC	AN6520	8904010	MFG	7/3/98	7/3/99

TEKSERV CERTIFIES THAT ALL CALIBRATION EQUIPMENT USED IN THE TEST IS TRACEABLE TO N.I.S.T. AND THE TEST WAS PERFORMED IN ACCORDANCE TO ANSI/NCSL-Z540-1994, ISO-10012-1, IS09002 AND MIL-STD-45662A

ISO 9002 ISO 9002

Certified By:

IN TOLERANCE
AS RECEIVED

TEKSERV
CALIBRATION DATA

CP 92000-00
Serial Number: L98 V0 3314
Date of test: 11-23-98
Prior Cal: —
Technician: MP.

Data as Received ✓
Data After Adjustment
Data After Repair
Asset Number: ENG-21

Thermocouple Scanner
Type "K"

Channel	Standard Input (Deg F)			Tolerance
	32.0	1000	2000	
1	31.9	1000	2000	+/-(0.1%+0.8F)
2	31.7	999.4	2001	"
3	31.5	999.7	1999	"
4	32.0	999.6	2002	"
5	31.7	1000	2001	"
6	31.6	999.8	2001	"
7	32.0	999.7	2000	"
8	31.8	999.8	2000	"
9	31.8	1000	2000	"
10	31.9	999.7	1999	"
11	32.1	999.7	2000	"
12	31.7	999.9	2000	"

TEKSERV 127 Riverneck Rd. Chelmsford, MA 01824 Telephone: 978-459-9480 Fax: 978-453-6336

Bill To: AEA
40 NORTH AVENUE
ATTN ACCT PAYABLE
BURLINGTON MA 01803-

Ship To: AEA
40 NORTH AVENUE
BURLINGTON MA 01803-

Service Report Invoice

Invoice Number INV143

Item ID A51106

PO Number	Ship Via	Urgent	Call Back	Invoice Date	Contact	Phone Number	Technician
3303	TEKSERV	Yes	No	11/23/98			

Model Number	Manufacturer	Serial Number	Accessories Received With Equipment
92000-00	COLE PARMER	L98003314	ENG-21 W/MANUAL SOFTCASE AN AC ADAPTER

Work Requested	Quantity	Part No.	Description	Unit Price	Total Price	Tax Amt
CALIBRATE/CERTIFY						

Service Performed

Remarks
IN TOLERANCE AS RECEIVED

TEKSERV
127 Riverneck Road
Chelmsford, MA 01824
Telephone: 978 - 459-9480
FAX # 978 - 453-6336
WEB SITE: http://www.tekserv.com

Calibration Regular Hours:	0	*Charge:*	$45.00	*Material:*	$0.00
Calibration Overtime Hours:	0	*Labor:*	$0.00	*% Discount:*	0
Repair Regular Hours:	0	*Cost:*	$0.00	*% Tax:*	0
Repair Overtime Hours:	0	*Labor/Hour:*	$0.00	*Shipping:*	$0.00
Contract #: AEA		*Sub Total:*	$45.00		
Warranty:				*Total Due:*	**$45.00**

APPENDIX B

MANUFACTURING ROUTE CARDS AND PRE-TEST RADIATION PROFILE DATA SHEETS

SENTINEL

TP80 (A)

ROUTE CARD

QC Lot# 10352 Complete Lot:_____ Total WO Qty.: 3 Serial No: 2243

CM: A Split Lot : ✓ Rte. Cd. Qty.: 1 Lot No: NA

Part # TP80		Description 650L SOURCE CHANGER TEST UNITS		Dwg C TP80			Rev A	WO Q89650
Oper. Seq.	Department	Operation Description	By	Date	Qty Acc	Qty Rej	Reference	Comments
0010	ASSY	MODIFY PER NOTES 3-11	RWC	15 Mar 99			TP80	QC VERIFY NOTE 6
			DW	15 MAR 99	0	1		
0020	QC	INSPECTION	DW	15 MAR 99	1	0	SOP-Q015	SEE DISPOSITION BACK
								80 lbs
0030	QA	QA REVIEW	F	15 Mar 99			SOP-Q025 & TP80	
0040	IC	STOCKROOM PROCESSING	QC	15 MAR 99			SOP-M002	
		DELIVER TO QC FOR						
		TESTING						

VI–Step	Checklist	Initials	WI–Step	Checklist	Initials	WI–Step	Checklist	Initials

NGINEERING: S. Grimi 15 Mar 99 REGULATORY: C. Lenfant 15 Mar 99 MATERIALS: Alan Cain 15 MAR 99

RODUCTION: R W Evans 15 Mar 99 QUALITY ASSURANCE: D. W. Kentz 15 MAR 99 ISSUE NUMBER: 1

NO	DESCRIPTION OF NONCONFORMANCE	DISPOSITION	INDIV/ DATE	INSP/DATE
1	THRU BOLT TORQUE	*	RWE 15MAR99	DW 15 MAR 99
	135 IN LBS (4PL)			
	*USE AS IS - TORQUE OF 135 in-lbs			
	ENSURES TOP AND BOTTOM PLATES ARE			
	PROPERLY SEATED - ECO WILL BE			
	ISSUED TO CHANGE SPECIFIED TORQUE			
	ON DRAWING TO 135 ±5 in-lbs			
	MM 15MAR99			
	~~BWK~~ 15MAR99			
	16 March 99			
	MZ 16 March 99			

PART NUMBER	DESCRIPTION	CM	SERIAL/ LOT NO.	INITIALS	DATE
650L	SOURCE CHANGER	A	2243	RWE	15 Mar 99
* SCR200	5/16-18 HEX BOLT	A	99072-1	RWE	15 Mar 99
* BOLT #4					
#5				RWE	15 Mar 99
#6					
#7					

MTE SN	MTE DESCRIPTION	CAL DUE DATE	INITIALS	DATE
112613 1	SCALE	16 MAY 99	DW	15 MAR 99
171	TORQUE WRENCH	8/7/99	RWE	15 Mar 99

CHANGE VERIFICATION

PART NUMBER	DESCRIPTION	REV	ECO	INDIVIDUAL	VERIFIED

Security-Related Information
Figure Withheld Under 10 CFR 2.390

ITEM	QTY	NAME	DESCRIPTION

MATERIALS: C65009 & PARTS LIST ABOVE

PROTECTIVE FINISH: NONE

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES.
2. MIN SURFACE TEXTURE
3. TOLERANCES APPLY AFTER PLATING.
4. REMOVE BURRS AND SHARP EDGES.
5. DO NOT SCALE DRAWING.
6. TOLERANCES:
FRACTIONS ± 1/64 .XX ± 0.01
ANGULAR ± 1°

USED ON:

DRAWN		15 Mar 97
CHECKED		15 MAR 97
APPR.		15 Mar 97

SAFETY CLASS: A

AEATECHNOLOGY QSA
40 NORTH AVE, BURLINGTON, MA 01803

TITLE: MODEL 650L TEST SPECIMEN

SIZE	DWG. NO.	REV
C	TP80	A

SCALE: NA SHEET 1 OF 1

SENTINEL

TP80(A)

ROUTE CARD

QC Lot# 10243 Complete Lot:_____ Total WO Qty.: 3 Serial No: 2243

CM: A Split Lot: ✓ Rte. Cd. Qty.: 1 Lot No: NA

Part# TP80	Description 650L SOURCE CHANGER TEST UNITS	Dwg TP80	Rev B	WO Q89650

Oper. Seq.	Department	Operation Description	By	Date	Qty Acc	Qty Rej	Reference	Comments
0010	ASSY	MODIFY PER NOTES 2-4	RWE	25Feb99			TP80	
0020	QC	INSPECTION	DX	25Feb99	1	0	SOP-Q015	
0030	QC	FINAL PROFILE	DW FOR MRB	25Feb99	1	0	WI-Q09	TOTAL WEIGHT 800 #
0040	QA	QA REVIEW	F	25Feb99			SOP-Q025 & TP80	
0050	IC	STOCKROOM PROCESSING DELIVER TO QC FOR TESTING	AC	25Feb99			SOP-M002	

WI-Step	Checklist	Initials	WI-Step	Checklist	Initials	WI-Step	Checklist	Initials

ENGINEERING: [signature] REGULATORY: C. Ronfeldt 25Feb99 MATERIALS: Alan Cain 25Feb

PRODUCTION: RW Evans 25Feb99 QUALITY ASSURANCE: D.W. Kurtz 25Feb99 ISSUE NUMBER: 1

INEL

14T CORR

DESCRIPTION OF NONCONFORMANCE	DISPOSITION	INDIV/ DATE	INSP/DATE

PART NUMBER	DESCRIPTION	CM	SERIAL/ LOT NO.	INITIALS	DATE
650L	SOURCE CHANGER	A	2243	RWE	25 Feb 99
SCR200	5/16-18 HEX BOLT	A	99054-1	RWE	25 Feb 99

MTE SN	MTE DESCRIPTION	CAL DUE DATE	INITIALS	DATE
112613	SCALE	16 May 99	RWE	25 Feb 99

CHANGE VERIFICATION

PART NUMBER	DESCRIPTION	REV	ECO	INDIVIDUAL	VERIFIED

Security-Related Information
Figure Withheld Under 10 CFR 2.390

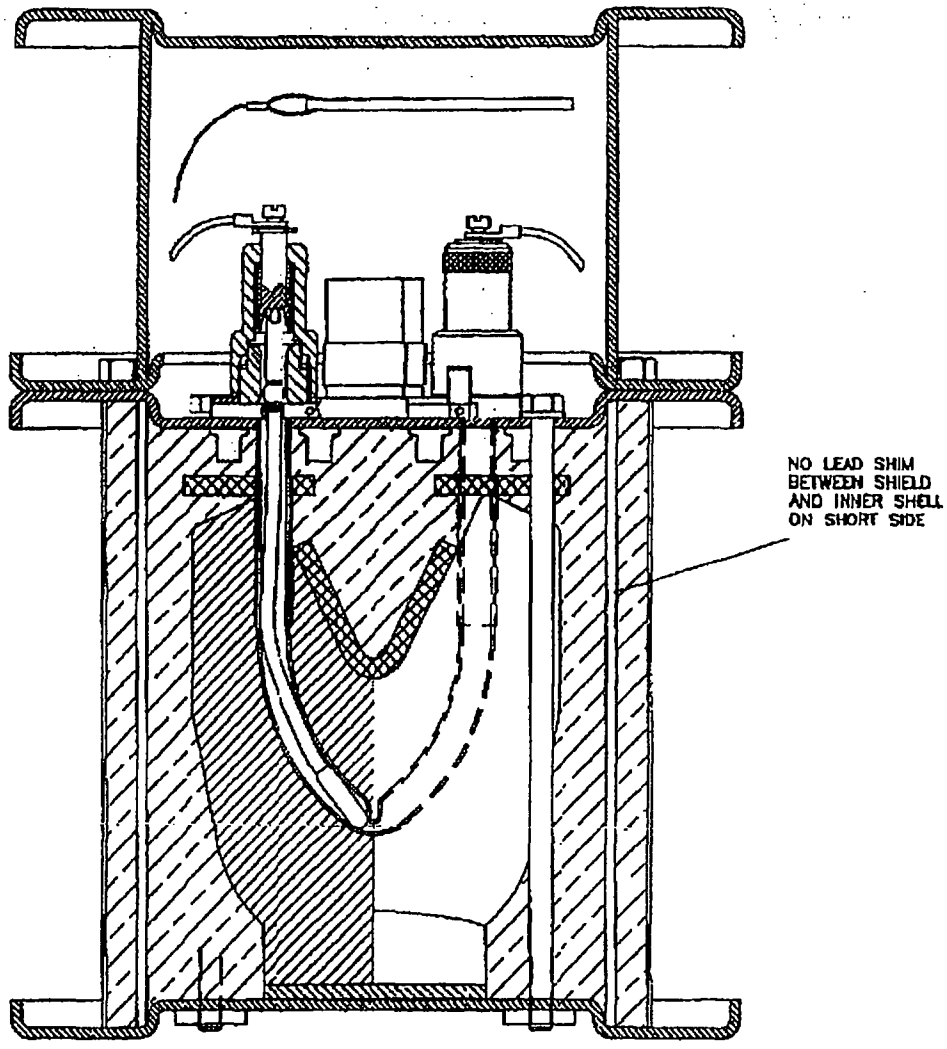
FORMAT CORRECTED DDCO#31			B		
DESCRIPTION	APPROVALS	DATE	LTR	SIZE A	DWG. NO. R-TP80
REVISIONS					SCALE: NONE SHEET 1 OF 2

UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE INCHES AND REFERENCE

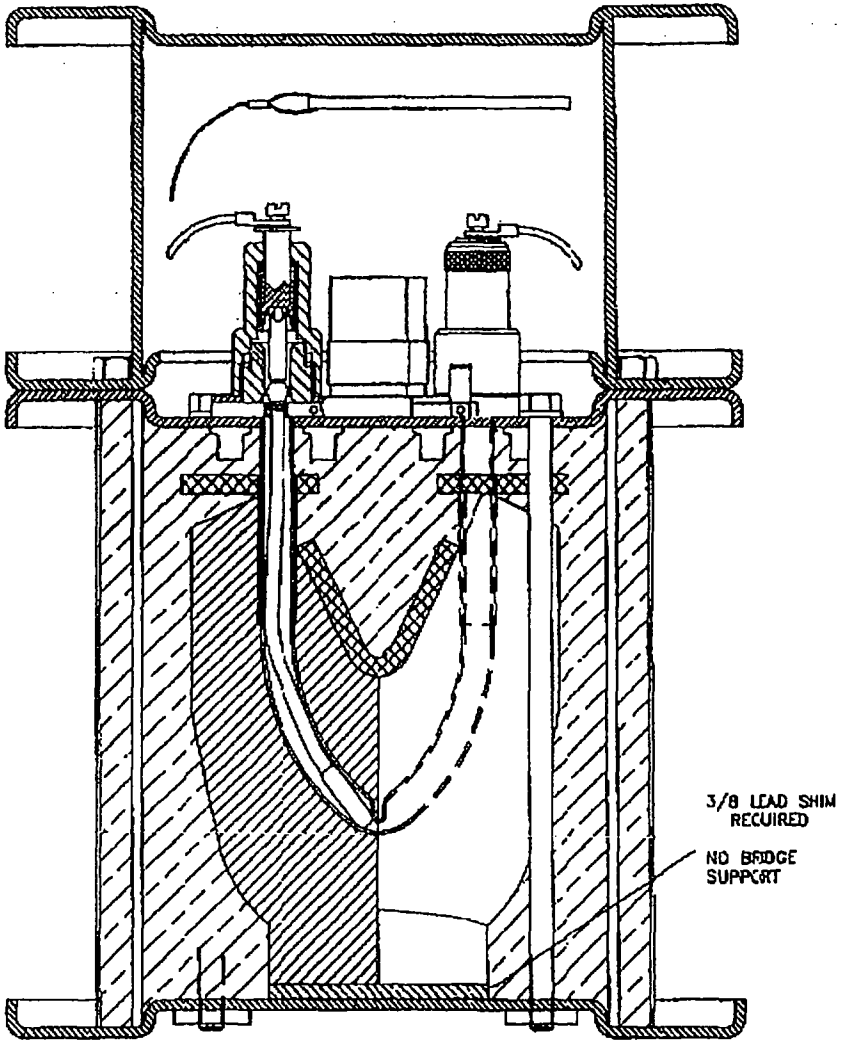
AEATECHNOLOGY QSA
40 NORTH AVE, BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE 650L SOURCE CHANGER TEST UNITS



TP 80 (A)



TP 80 (B)

NOTE:
NO SPECIAL REQUIREMENTS
FOR
LEAD LOCATION N TP80(C)

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE REFERENCE			
SIZE A	DWG. NO. R—TP80		REV B
	SCALE: NONE	SHEET 2 OF 2	

SENTINEL TP80 (B)

ROUTE CARD

QC Lot# 10352 Complete Lot:_____ Total WO Qty.: 3 Serial No: ~~2243~~ 182 Dw 15 MAR 99

CM: A Split Lot : ✓ Rte. Cd. Qty.: 1 Lot No: NA

Part # TP80	Description 650L SOURCE CHANGER TEST UNITS	Dwg C TP80	Rev A	WO Q89650

Oper. Seq.	Department	Operation Description	By	Date	Qty Acc	Qty Rej	Reference	Comments
0010	ASSY	MODIFY PER NOTES 3-11	RWE	15 Mar 99			TP80	QC VERIFY NOTE 6
			~~Dw~~	15 MAR 99	~~0~~	1		
0020	QC	INSPECTION	Dw	15 MAR 99	1	~~0~~	SOP-Q015	SEE DISPOSITION BACK
								83.6 lbs
0030	QA	QA REVIEW		15 MAR 99			SOP-Q025 & TP80	
0040	IC	STOCKROOM PROCESSING	QC	15 MAR 99			SOP-M002	
		DELIVER TO QC FOR						
		TESTING						

WI–Step	Checklist	Initials	WI–Step	Checklist	Initials	WI–Step	Checklist	Initials

ENGINEERING: S. Gr 15 Mar 99 REGULATORY: C. Lenfant 15 Mar 99 MATERIALS: Alan Cain 15 MAR 99

PRODUCTION: RWE 15 Mar 99 QUALITY ASSURANCE: D.W. Kurtz 15 MAR 99 ISSUE NUMBER: 1

QP25-1/2

NO	DESCRIPTION OF NONCONFORMANCE	DISPOSITION	INDIV/ DATE	INSP/DATE
1	THRU BOLT TORQUE	*	RWE 15 Mar 99	DW 15 MAR 99
	135 IN LBS (4 PL)			
	*USE AS IS - Torque of 135 in-lbs			
	ENSURES TOP AND BOTTOM PLATES ARE			
	PROPERLY SEATED - ECO will be			
	issued to change specified torque			
	on drawing to 135 ± 5 lbs			
	NAM 15MAR99			
	BWK 15MAR99			
	LDC 16 Mar 99			
	MJS 16 MAR 99			

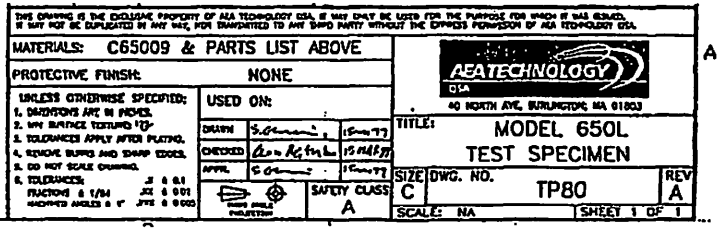
PART NUMBER	DESCRIPTION	CM	SERIAL/ LOT NO.	INITIALS	DATE
650L	SOURCE CHANGER	A	182	RWE	15 Mar 99
* SCR200	5/16-18 HEX BOLT	A	99072-1	RWE	15 Mar 99
* Bolt #8					
#9					
#10				RWE	15 Mar 99
#11					

MTE SN	MTE DESCRIPTION	CAL DUE DATE	INITIALS	DATE
1126131	SCALE	16 MAY 99	DW	15 MAR 99
171	TORQUE WRENCH	8/7/99	RWE	15 Mar 99

CHANGE VERIFICATION

PART NUMBER	DESCRIPTION	REV	ECO	INDIVIDUAL	VERIFIED

Security-Related Information
Figure Withheld Under 10 CFR 2.390



SENTINEL

TP80 CB) Mon 2 Mar 99

ROUTE CARD

QC Lot# 10243 | Complete Lot: | Total WO Qty.: 3 | Serial No: 182

EM: A | Split Lot: ✓ | Rte. Cd. Qty.: 1 | Lot No: NA

Q 2 Mar 99

Part # TP80	Description 650L SOURCE CHANGER TEST UNITS	Dwg # TP80	Rev B	WO Q89650

Oper. Seq.	Department	Operation Description	By	Date	Qty Acc	Qty Rej	Reference	Comments
0010	ASSY	MODIFY PER NOTES 2-4	RWE	25 Feb 99			TP80	
0020	QC	INSPECTION	[illegible]	25 Feb 99	1	0	SOP-Q015	
0030	QC	FINAL PROFILE	DC FOR MRB	25 Feb 99	1	0	WI-Q09	TOTAL WEIGHT 83.6 #
0040	QA	QA REVIEW	[illegible]	25 Feb 99			SOP-Q025 & TP80	
0050	IC	STOCKROOM PROCESSING	DC	25 Feb 99			SOP-M002	
		DELIVER TO QC FOR TESTING						

WI-Step	Checklist	Initials	WI-Step	Checklist	Initials	WI-Step	Checklist	Initials

ENGINEERING: [signature] 25 Feb 99 | REGULATORY: C. Rowman 25 Feb 99 | MATERIALS: [signature] 25 Feb

PRODUCTION: RW Crowe 25 Feb 99 | QUALITY ASSURANCE: D.W. Kurtz 25 Feb 99 | ISSUE NUMBER: 1

QI

SENTINEL

DESCRIPTION OF NONCONFORMANCE	DISPOSITION	INDIV/ DATE	INSP/DATE

PART NUMBER	DESCRIPTION	CM	SERIAL/ LOT NO.	INITIALS	DATE
650L	SOURCE CHANGER	A	182	KWE	25 Feb 99
SCR200	5/16-18 HEX BOLT	A	99054-1	KWE	25 Feb 99

MTE SN	MTE DESCRIPTION	CAL DUE DATE	INITIALS	DATE
1126131	SCALE	16 May 99	KWE	25 Feb 99

CHANGE VERIFICATION

PART NUMBER	DESCRIPTION	REV	ECO	INDIVIDUAL	VERIFIED

Security-Related Information
Figure Withheld Under 10 CFR 2.390

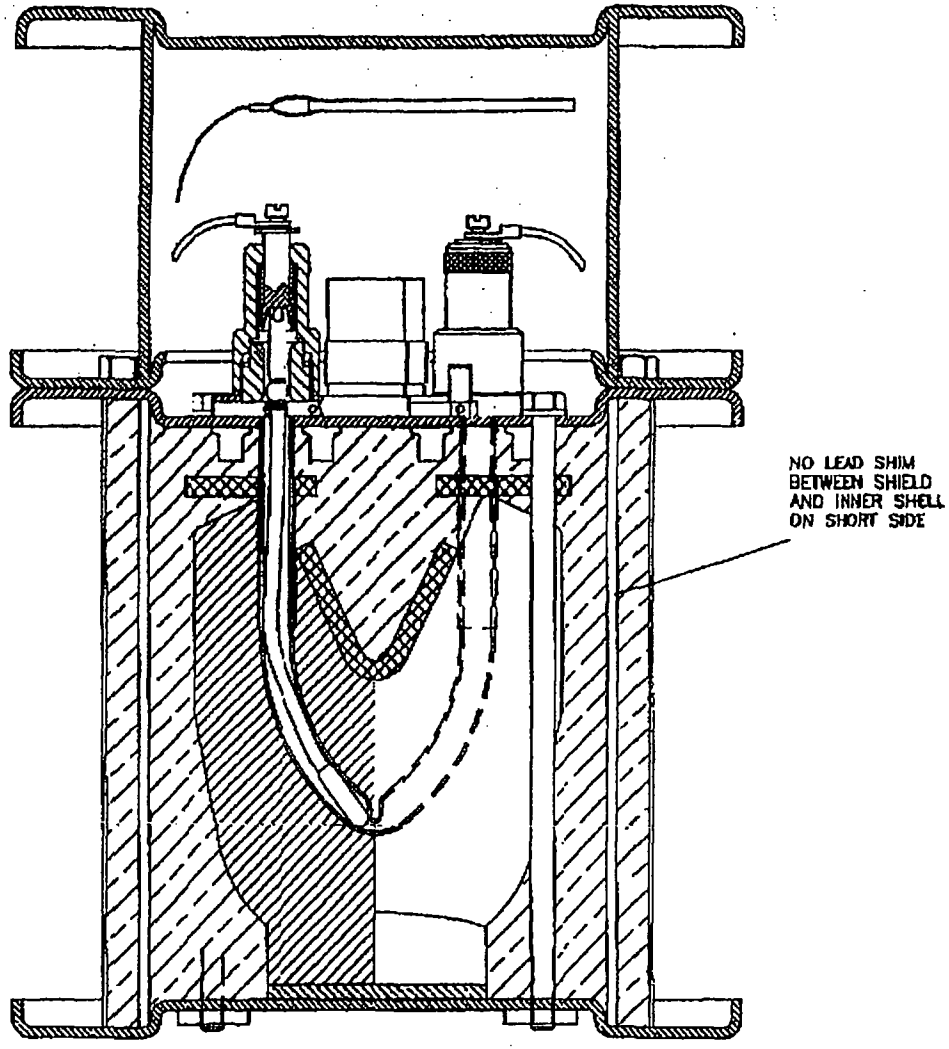
UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE INCHES AND REFERENCE

AEATECHNOLOGY
QSA
40 NORTH AVE, BURLINGTON, MA 01803

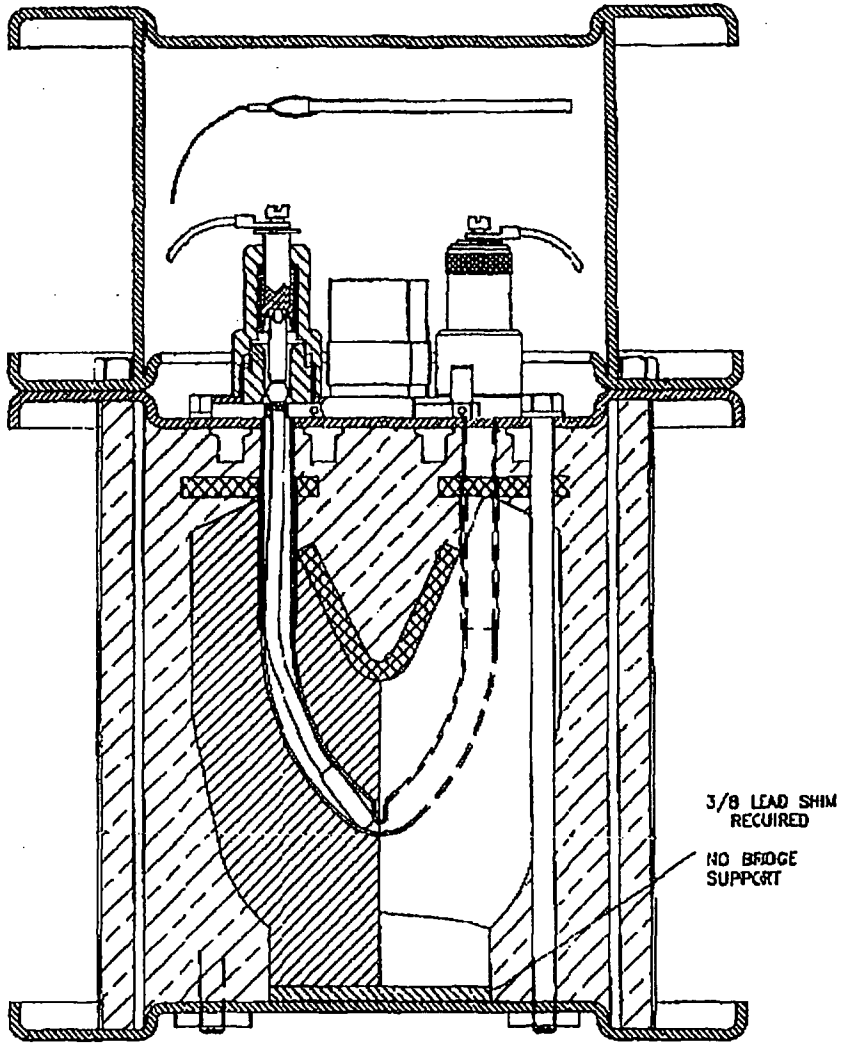
DESCRIPTIVE DRAWING

TITLE 650L SOURCE CHANGER TEST UNITS

SIZE	DWG. NO.		RE
A	SCALE: NONE	SHEET 1 OF 2	B



TP 80 (A)



TP 80 (B)

NOTE:
NO SPECIAL REQUIREMENTS
FOR
LEAD LOCATION N TP80(C)

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE REFERENCE			
SIZE A	DWG. NO. R—TP80		REV B
	SCALE: NONE	SHEET 2 OF 2	

SENTINEL TP80 (c)

ROUTE CARD

QC Lot# 10352 Complete Lot: ✓ 15 MAR 99 Total WO Qty.: 3 Serial No: 195

CM: A Split Lot: ✓ Rte. Cd. Qty.: 1 Lot No: NA

Part # TP80	Description 650L SOURCE CHANGER TEST UNITS	Dwg C TP80	Rev A	WO Q89650

Oper. Seq.	Department	Operation Description	By	Date	Qty Acc	Qty Rej	Reference	Comments
0010	ASSY	MODIFY PER NOTES 3-11	RWE	15 Mar 99			TP80	QC VERIFY NOTE (DW) 15 MAR 99
			DW	15 MAR 99	0	1		
0020	QC	INSPECTION	DW	15 MAR 99	1	0	SOP-Q015	SEE DISPOSITION BACK
								89 lbs
0030	QA	QA REVIEW	$	15 MAR 99			SOP-Q025 & TP80	
0040	IC	STOCKROOM PROCESSING	IC	15 MAR 99			SOP-M002	
		DELIVER TO QC FOR						
		TESTING						

WI–Step	Checklist	Initials	WI–Step	Checklist	Initials	WI–Step	Checklist	Initials

ENGINEERING: S. Gruni 15 MAR 99 REGULATORY: C. Kenyon 15 MAR 99 MATERIALS: Alan Cain 15 MAR 99

PRODUCTION: RW Erwin 15 Mar 99 QUALITY ASSURANCE: D.W. Kentz 15 MAR 99 ISSUE NUMBER: 1

SENTINEL

QP25-1/2

NO	DESCRIPTION OF NONCONFORMANCE	DISPOSITION	INDIV/ DATE	INSP/DATE
1	THRU BOLT TORQUE	*	RDE 15 Mar 99	DW 15 MAR 99
	135 IN LBS (4PC)			
	*USE AS IS - Torque of 135 in-lbs			
	ensures top and bottom plates are			
	properly seated - ECO will be			
	issued to change specified torque			
	on drawing to 135 ± 5 in-lbs			
	MM 15MAR99			
	BWK 15 MAR 99			
	LAP 16 MAR 99			
	MJS 16 Mar 99			

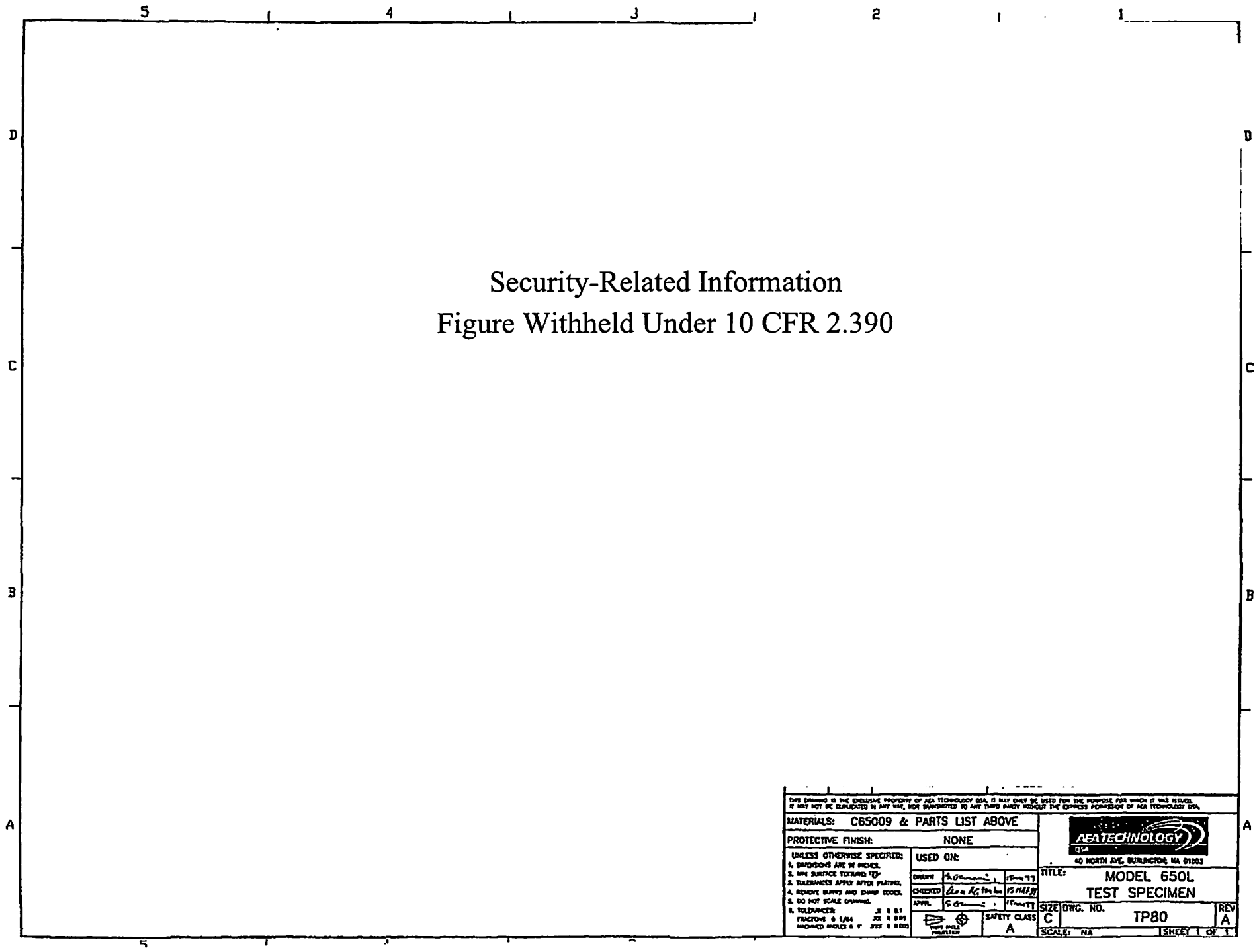
PART NUMBER	DESCRIPTION	CM	SERIAL/ LOT NO.	INITIALS	DATE
650L	SOURCE CHANGER	A	195	RDE	15 Mar 99
* SCR200	5/16-18 HEX BOLT	A	99072-1	RDE	15 Mar 99
* BOLT # 12					
# 13				RDE	15 Mar 99
# 14					
# 15					

MTE SN	MTE DESCRIPTION	CAL DUE DATE	INITIALS	DATE
F16383	SCALE	16 MAY 99	DW	15 MAR 99
171	TORQUE WRENCH	8/7/99	RDE	15 Mar 99

CHANGE VERIFICATION

PART NUMBER	DESCRIPTION	REV	ECO	INDIVIDUAL	VERIFIED

Security-Related Information
Figure Withheld Under 10 CFR 2.390



SENTINEL

ROUTE CARD

QC Lot# 10283 | Complete Lot: N/A | Total WO Qty.: 3 4 @ 3 MAR 99 | Serial No: 195

CM: A | Split Lot: ✓ | Rte. Cd. Qty.: 1 | Lot No: NA

Part # TP80	Description 650L SOURCE CHANGER TEST UNITS	Dwg # TP80 R-	Rev B	WO Q89650

Oper. Seq.	Department	Operation Description	By	Date	Qty Acc	Qty Rej	Reference	Comments
0010	ASSY	MODIFY PER NOTES 2-4	REVE	3Mar99			TP80	
0020	QC	INSPECTION	DVe	3 MAR 99	1	0	SOP-Q015	
0030	QC	FINAL PROFILE	MMB	4 March 99	1	0	WI-Q09	TOTAL WEIGHT 89 #26
0040	QA	QA REVIEW	[illegible]	4 Mar 99			SOP-Q025 & TP80	
0050	IC	STOCKROOM PROCESSING	QC	4MAR99			SOP-M002	
		DELIVER TO QC FOR TESTING						

WI–Step	Checklist	Initials	WI–Step	Checklist	Initials	WI–Step	Checklist	Initials

ENGINEERING: [signature] 25 Feb 99 | REGULATORY: [signature] 25Feb99 | MATERIALS: [signature] 25Feb

PRODUCTION: [signature] 25 Feb 99 | QUALITY ASSURANCE: D.W. Kurtz 25Feb99 | ISSUE NUMBER: 1

QP2

RMAT COR

DESCRIPTION OF NONCONFORMANCE	DISPOSITION	INDIV/ DATE	INSP/DATE

PART NUMBER	DESCRIPTION	CM	SERIAL/ LOT NO.	INITIALS	DATE
650L	SOURCE CHANGER	A	195	RJOE	3 Mar 99
SCR200	5/16-18 HEX BOLT	A	99054-1	RJOE	3 Mar 99

MTE SN	MTE DESCRIPTION	CAL DUE DATE	INITIALS	DATE
F16383	SCALE	16 May 99	RJOE	3 Mar 99

CHANGE VERIFICATION

PART NUMBER	DESCRIPTION	REV	ECO	INDIVIDUAL	VERIFIED

Security-Related Information
Figure Withheld Under 10 CFR 2.390

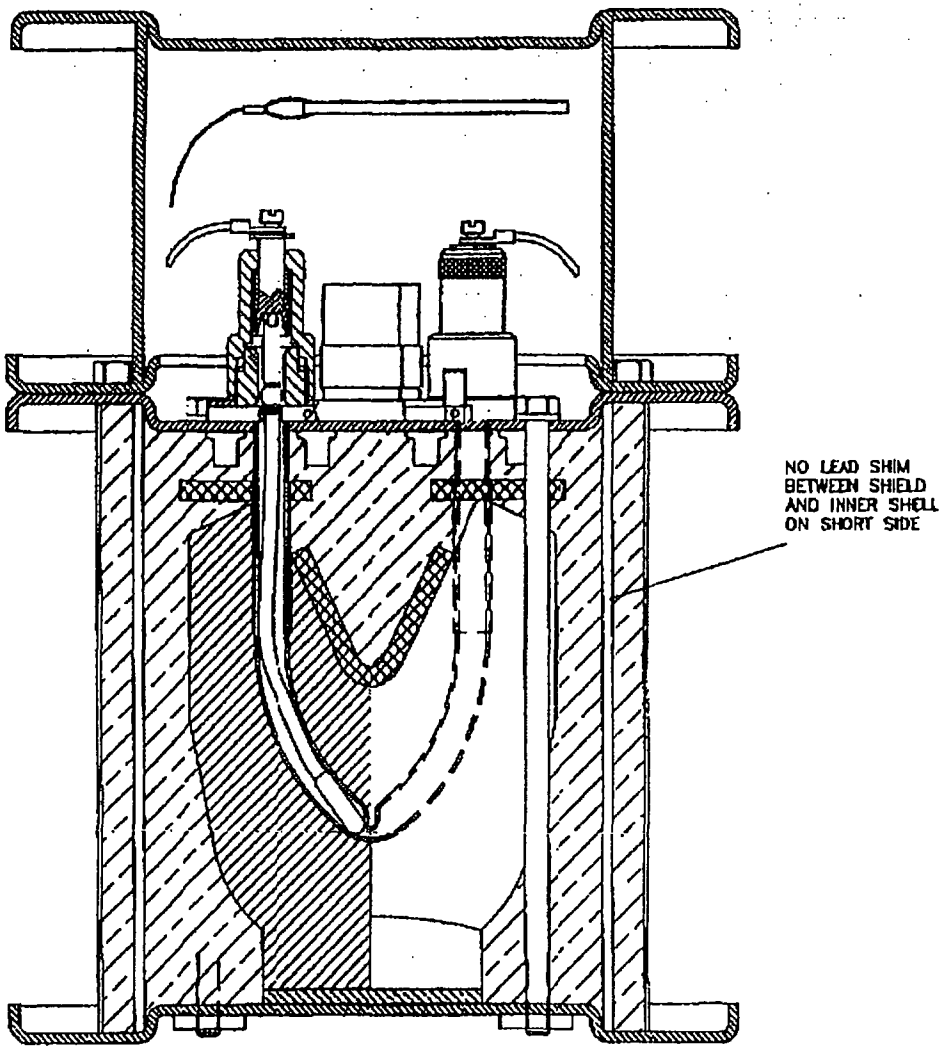
UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE INCHES AND REFERENCE

AEATECHNOLOGY
QSA
40 NORTH AVE, BURLINGTON, MA 01803

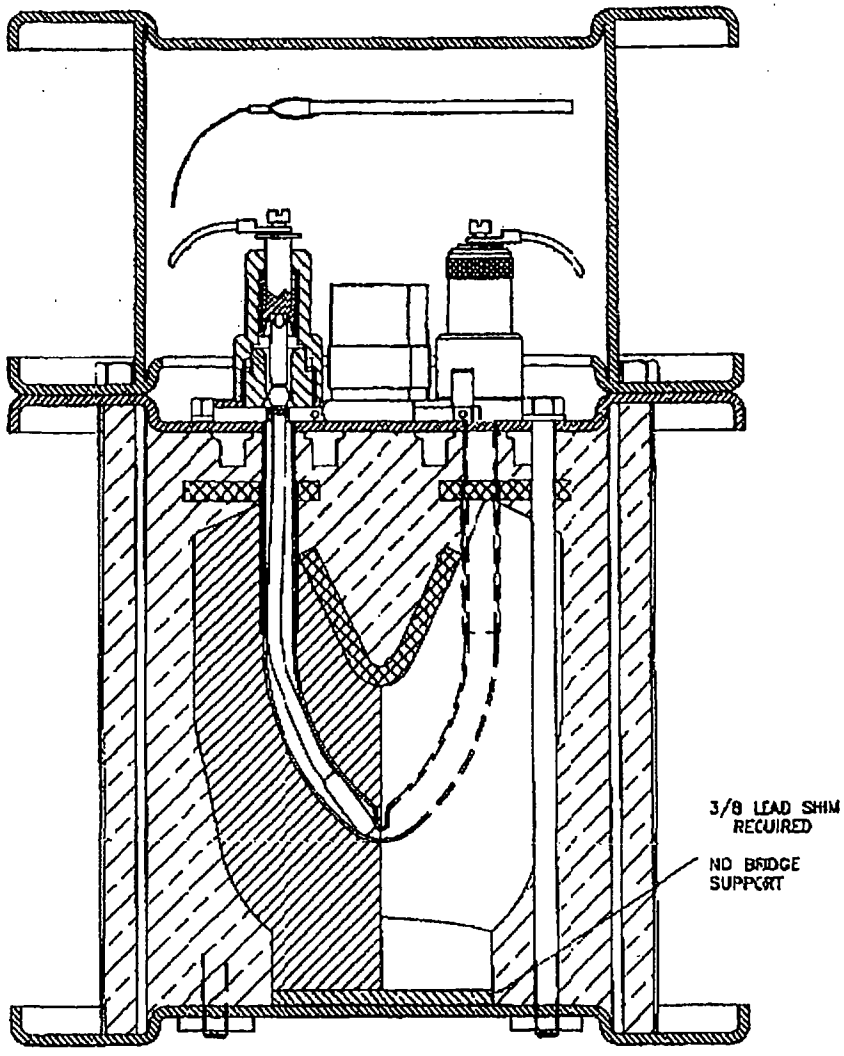
DESCRIPTIVE DRAWING

TITLE 650L SOURCE CHANGER TEST UNITS

SIZE	DWG. NO.		
A	R-TP80		E
	SCALE: NONE	SHEET 1 OF 2	



TP 80 (A)



TP 80 (B)

NOTE:
NO SPECIAL REQUIREMENTS
FOR
LEAD LOCATION N TP80(C)

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE REFERENCE			
SIZE A	DWG. NO. R-TP80		REV B
	SCALE: NONE	SHEET 2 OF 2	

SENTINEL

TP80 (A) - BEFORE TEST

SHIELDING PROFILE AND INSPECTION FORM

Model: 6506 Serial Number: 2243 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data		
Shield Heat#:	Mass of Shield: Lbs.	Lot #:

Initial Profile

Source Model: Source SN: Activity: Ci

Survey Inst.: SN: Date Cal.: Date Due:

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top			Capacity Correction Factor:	
Right				
Front				
Left				
Rear				
Bottom				

Inspector: Date: NCR #:

Final Profile

Source Model: 424-9 Source SN: C89311 131.2Ci. C9001 : 124.9Ci. Activity: 256.1 Ci Mass of Device: Lbs.

Survey Inst.: AN/PDR27T SN: 3924102 Date Cal.: 8 Oct 98 Date Due: 8 Oct 99

Surface	Observed Intensity mR/hr: At Surface	Surface Corr. Factor	Observed Intensity mR/hr: At One Meter		Adjusted Intensity mR/hr: At Surface	Adjusted Intensity mR/hr: At One Meter
Top	90	*N/A	3.5	Capacity Correction Factor: .93	84	3.2
Right	50		.7		47	.6
Front	95		.8		88	.7
Left	60		.7		56	.6
Rear	80		.8		74	.7
Bottom	55	↓	.5		51	.4

Inspector: MRB Date: 24 Feb 99 NCR #: N/A

QI6-1/1

Comments: * Per WI-Q09 Worksheet

Amersham QSA

SENTINEL

TP80(B) - BEFORE TEST

SHIELDING PROFILE AND INSPECTION FORM

Model: 6506 Serial Number: 182 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#:	Mass of Shield: Lbs.	Lot #:

Initial Profile

Source Model: Source SN: Activity: Ci

Survey Inst.: SN: Date Cal.: Date Due:

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top			Capacity Correction Factor:	
Right				
Front				
Left				
Rear				
Bottom				

Inspector: Date: NCR #:

Final Profile

Source Model: 424-9 Source SN: C8981-131.2Ci. C9001-124.9Ci Activity: 256.1 Ci Mass of Device: Lbs.

Survey Inst.: AN/PDR-27T SN: SM392402 Date Cal.: 8Oct98 Date Due: 8Oct99

Surface	Observed Intensity mR/hr: At Surface	Surface Corr. Factor	At One Meter		Adjusted Intensity mR/hr: At Surface	At One Meter
Top	65	*N/A	3.3	Capacity Correction Factor: .93	60	3.1
Right	60		.5		56	.4
Front	MRB 24 Feb 99 85-90		.9		84	.8
Left	95		.7		88	.6
Rear	85		.9		79	.8
Bottom	80		.6		74	.5

Inspector: MRBoyd Date: 24 Feb 99 NCR #: N/A

Q16-1/1

Comments: * Per WI-Q09 Worksheet

Amersham QSA

ENTINEL TP 80 (c) - BEFORE TEST

Drop Test Unit

SHIELDING PROFILE AND INSPECTION FORM

Model: 6506 Serial Number: 195 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#: _____ Mass of Shield: _____ Lbs. Lot #: _____

Initial Profile

Source Model: _____ Source SN: _____ Activity: _____ Ci

Survey Inst.: _____ SN: _____ Date Cal.: _____ Date Due: _____

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top				
Right			Capacity Correction Factor: _____	
Front				
Left				
Rear				
Bottom				

Inspector: _____ Date: _____ NCR #: _____

Final Profile

Source Model: 424-9 Source SN: C8931 = 121.7 Ci. C9113 = 105.0 Ci. Activity: 226.7 Ci Mass of Device: _____ Lbs.

Survey Inst.: AN/PDR77 SN: SM392402 Date Cal.: 8 Oct 98 Date Due: 8 Oct 99

Surface	Observed Intensity mR/hr: At Surface	Surface Corr. Factor	At One Meter		Adjusted Intensity mR/hr: At Surface	At One Meter
Top	65	*N/A	2.0		72	2.2
Right	95		.6		105	.7
Front	45		.5	Capacity Correction Factor: 1.10	50	.6
Left	115		.6		127	.7
Rear	45		.5		50	.6
Bottom	55	↓	.5		61	.6

Inspector: MABoyd Date: 4 March 99 NCR #: N/A

QI6-1/1

Comments: * Per WI-009 Worksheet
See Attached Doc.

Amersham QSA

APPENDIX C

TEST CHECKLISTS AND DATA SHEETS

Specimen Preparation List

Step		TP80(A)	TP80(B)	TP80(C)
1.	Serial Number:	2243	182	195
2.	Total weight of package (lb):	80.0 lb.	83.6 lb	89.0 lb
3.	Location of simulated source from top plate (in):	(A) 6.318 (B) 6.359	(A) 6.556 (B) 6.430	(A) 6.304 (B) 6.256
4.	Location of lead shielding:	SEE X-RAYS	SEE X-RAYS & ROUTE CARD PKG.	SEE X-RAYS
5.	All fabrication and inspection records documented in accordance with the AEAT QA Program?	(DW) 16 MAR 99	(DW) 16 MAR 99	(DW) 16 MAR 99
6.	Does the unit comply with the requirements of Drawing R-TP80, Revision D?	*	*	*
7.	Has the radiation profile been recorded in accordance with AEAT QSA Work Instruments WI-Q09?	YES (DW)	YES (DW)	YES (DW)
8.	Is the package prepared for transport?	yes (DW)	yes (DW)	yes (DW)

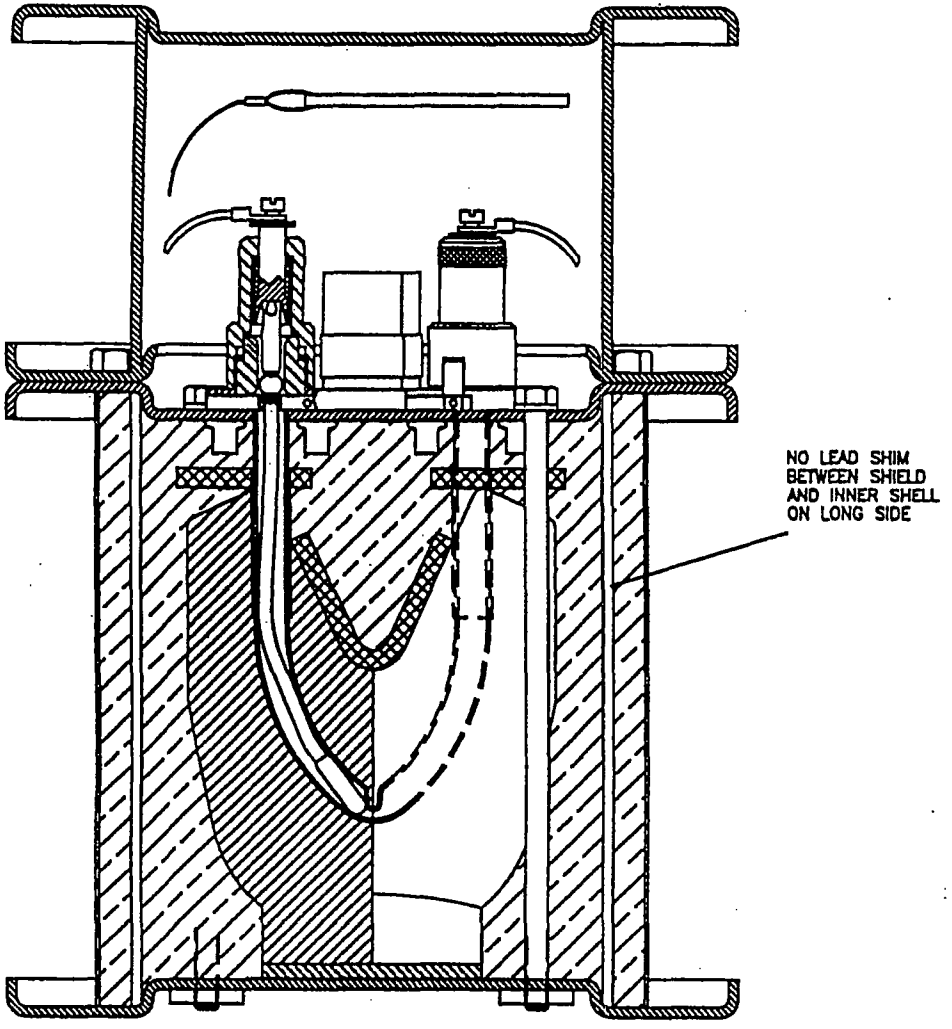
Verified by:	Print Name:	Signature:	Date:
Engineering	NICHOLAS J. MARRAINE		16 MAR 99
Regulatory Affairs	MARC S. NADEAU		16 MAR 99
Quality Assurance	Daniel W. Kuntz	Daniel W. Kuntz	16 MAR 99

* AS NOTED ON THE ROUTE CARDS FOR THE DEVICES, THE UNITS WERE ASSEMBLED WITH THROUGH BOLT torques of 135±5 in-lbs. INSTEAD OF THE 100±5 in-lb TORQUE SPECIFIED ON R-TP80, REV D. THIS CHANGE WAS APPROVED BY ENGINEERING, REGULATORY AND QA AND WAS IMPLEMENTED ON REV E of R-TP80.

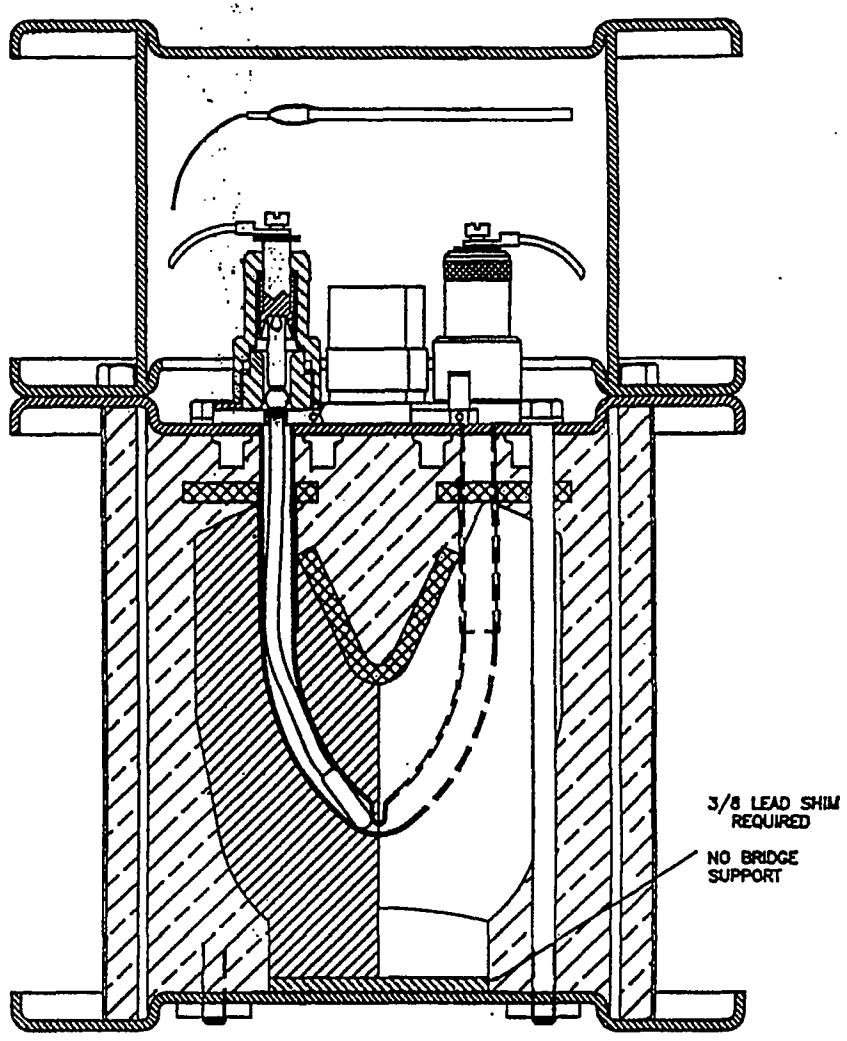
NJM 16MAR99
DWK 16MAR99
16 MAR 99

Security-Related Information
Figure Withheld Under 10 CFR 2.390

ABA TECHNOLOGY QSA 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE 650L SOURCE CHANGER TEST UNITS			
SIZE A	DWG. NO. R-TP80		REV D
	SCALE: NONE	SHEET 1 OF 2	



TP 80 (A)



TP 80 (B)

NOTE:
NO SPECIAL REQUIREMENTS
FOR
LEAD LOCATION IN TP80(C)

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE REFERENCE			
SIZE A	DWG. NO. R—TP80		REV D
	SCALE: NONE	SHEET 2 OF 2	

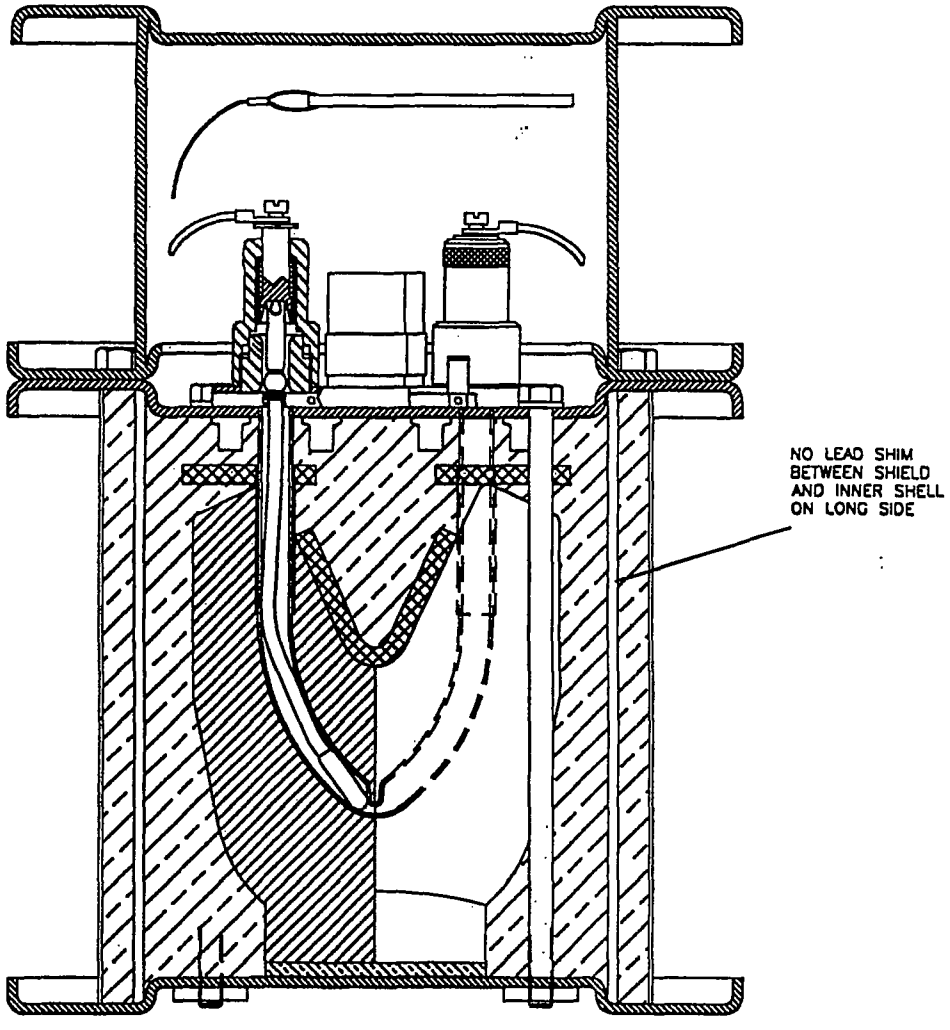
Security-Related Information
Figure Withheld Under 10 CFR 2.390

AEATECHNOLOGY
QSA
40 NORTH AVE, BURLINGTON, MA 01803

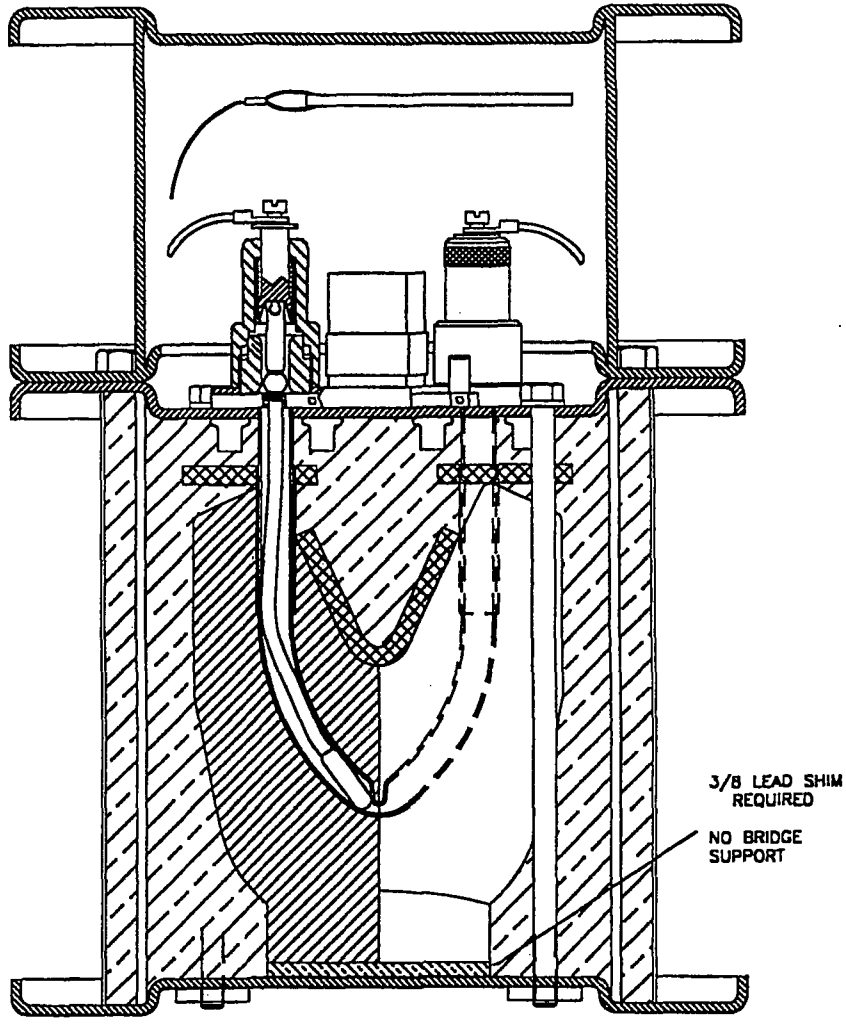
DESCRIPTIVE DRAWING

TITLE 650L SOURCE CHANGER TEST UNITS

SIZE	DWG. NO.	REV
A	R-TP80	E
	SCALE: NONE	SHEET 1 OF 2



TP 80 (A)



TP 80 (B)

NOTE:
NO SPECIAL REQUIREMENTS
FOR
LEAD LOCATION IN TP80(C)

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE REFERENCE			
SIZE A	DWG. NO. R-TP80		REV E
	SCALE: NONE	SHEET 2 OF 2	

Equipment List 1: Compression Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Weight Scale	ASSY-11	DUE 16 MAY 99
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		
THERMOCOUPLE READER	ENG-12	DUE 8 OCT 99
18" CALIPER	# 236	1 APR 99

	Print Name:	Signature:	Date:
Completed by:	DAVE ANNIS	Dave Annis	15 MAR 99
Verified by:	Nicholas J. Marone	Nicholas J. Marone	15 MAR 99

Checklist 1: Compression Test

Step	TP80(A)	TP80(B)	TP80(C)
1. Position the specimen on concrete surface, per the appropriate drawing.	Figure 2	Figure 2	Figure 2
2. Measure the ambient temperature.	20.5 °C	20.5°C	20.5°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
3. Apply a uniformly distributed weight of 455 to 465 pounds on the top of the lid for a period of 24 hours.	DW 15 MAR 99	DW 15 MAR 99	DW 15 MAR 99
Record the actual weight:	462 lb	458 lb	459 lb
Note the instrument used:	ASY-11	ASY-11	ASY-11
Record start time and date:	7:15 pm 15 MAR 99	7:15 pm 15 MAR 99	7:15 pm 15 MAR 99
4. After 24 hours, remove the weight.	DW 16 MAR 99 7:18 PM	DW	DW
Record end time and date:	16 MAR 99 7:18 PM	16 MAR 99 7:18 PM	16 MAR 99 7:18 PM
5. Measure the ambient temperature.	22°C	22°C	22°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
6. Photograph the test specimen and record any damage on Data Sheet 1.	DW	DW	DW
7. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record the assessment on Data Sheet 1. Determine what changes are necessary in package orientation for the penetration test to achieve maximum damage.	DW 16 MAR 99	DW 16 MAR 99	DW 16 MAR 99

Verified by:	Print Name:	Signature:	Date:
Engineering	Nicholas J. Marrone	Nicholas J. Marrone	16 MAR 99
Regulatory Affairs	Marc S. Nadeau	Marc S. Nadeau	16 MAR 99
Quality Assurance	Daniel W. Kurtz	Daniel W. Kurtz	16 MAR 99

SUPPLEMENTAL SHT. FOR TP80, REV. 1

650L COMPRESSION TEST

TEST WT.: 455 - 465 lb.

TP80(A)	TP80(B)	TP80(C)
PLATE WT. = 14 lb.	PLATE WT. = 13.8 lb.	PLATE WT. = 14 lb.
INGOT WT. = —	INGOT WT. = —	INGOT WT. = —
TOTAL WT. = 462 lb	TOTAL WT. = 458	TOTAL WT. = 459
DW 15 MAR 99	DW 15 MAR 99	DW 15 MAR 99
GAGE HEIGHT BEFORE COMPRESSION TEST:		
13.367	13.465 IN	13.620 IN
DW 15 MAR 99	DW 15 MAR 99	DW 15 MAR 99
GAGE HEIGHT AFTER COMPRESSION TEST:		
13.365	13.463	13.616
DW 16 MAR 99	DW 16 MAR 99	DW 16 MAR 99

Data Sheet 1: Compression Test

Test Unit Model and Serial Number: 650L S/N 2243 S/N 182 S/N 195		Test Specimen: TP80(A) TP80(B) TP80(C)
Test Date: 15-16MAR99	Test Time: 7:15PM - 7:15PM	Test Plan 80 Step No.: **8.5**

Describe test orientation and setup:
- Cask inserts stacked on top of each unit per Fig 2 of TP80

Describe on-site inspection (damage, broken parts, etc.):
No Damage to units

On-site assessment:
No DAMAGE

Engineering: 16MAR99 Regulatory: 16MAR99 QA: D.W. Kuntz 16MAR99

Describe any post-test disassembly and inspection:
NA

Describe any change in source position:
NA

Describe results of any pre- or post-test radiography:
NA

Completed by:	Date:
Nicholas J. Marrone	16 MAR 99

Equipment List 2: Penetration Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Penetration Bar	Drawing BT10129, Rev. B	See Attach
Drop Surface	Drawing AT10122, Rev. B	Da
Thermometer	OMEGA MODEL HH21 # ENG-12	
Thermocouple	OMEGA MODEL# 5TC-GG-K-20-36	
Thermocouple	OMEGA MODEL# WTK-10-36	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:	Dave Annis	Dave Annis	17 mar 99
Verified by:	Daniel W. Kurtz	D. W. Kurtz	17 mar 99

Checklist 2: Penetration Test

Step		TP80(A)	TP80(B)	TP80(C)
1.	Immerse the test specimen in dry ice or cool in freezer as needed to bring specimen temperature below –40°C.	DW	DW	DW
2.	Position the package as shown in the referenced figure, or by Step 7, Checklist 1.	Figure 3	Figure 3	Figure 3
3.	Begin video recording of the test.	DW	DW	DW
4.	Inspect the orientation setup and verify the bar height.	DW	DW	DW
5.	Photograph the set-up in at least two perpendicular planes.	DW	DW	DW
6.	Measure the ambient temperature and the specimen's internal and surface temperatures. Ensure that the specimen is at the specified temperature.	DW	DW	DW
	Record the ambient temperature:	"A" 10°C	9°C	10°C
	Note the instrument used:	ENG-12	ENG-12	ENG-12
	Record the specimen's internal temperature:	-95°C	-83°C	-90°C
	Note the instrument used:	ENG-12	ENG-12	ENG-12
	Record the specimen's surface temperature:	-96°C	-93°C	-90°C
	Note the instrument used:	ENG-12	ENG-12	ENG-12
7.	Drop the penetration bar.	DW	DW	DW
8.	Check to ensure that penetration bar hit the specified area.	DW	DW	DW
9.	Measure the specimen's surface temp. Ensure that specimen is at specified temp.	-74°C	-62°C	-71°C
	Note the instrument used:	ENG-12	ENG-12	ENG-12
10.	Photograph the test specimen and record any damage on Data Sheet 2.	DW	DW	DW
11.	**Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record the assessment on Data Sheet 2. Determine what changes are necessary in package orientation for the 1.2 meter (4 foot) free drop to achieve maximum damage.	DW	DW	DW

Verified by:	Print Name:	Signature:	Date:
Engineering	Nicholas S. Marone		17 MAR 99
Regulatory Affairs	Marc S. Nadolny		17 MAR 99
Quality Assurance	Daniel W. Kurtz	D.W. Kurtz	17 MAR 99

Data Sheet 2: Penetration Test

Test Unit Model and Serial Number: 650L SN 2243		Test Specimen: TP80(A)
Test Date: 17 MAR 99	Test Time: 9:40 am	Test Plan 80 Step No.: 8.6

Describe test orientation and setup:
- In accordance with Fig 3 OF test Plan

Describe impact (location, rotation, etc.):
- Impact on side of source changer

Describe on-site inspection (damage, broken parts, etc.):
- No damage - small indentation at point of impact

On-site assessment:
- CONTINUE WITH ~~TEST~~ PLANNED TEST SEQUENCE AND ORIENTATIONS

Engineering: 17MAR99 Regulatory: 17 MAR 99 QA: D.N. Kunz 17 MAR 99

Describe any post-test disassembly and inspection:
NP

Describe any change in source position:
NA

Describe results of any pre- or post-test radiography:
NA

Completed by:	Date: 17 MAR 99

Data Sheet 2: Penetration Test

Test Unit Model and Serial Number: 650L SN 182		Test Specimen: TP80(B)
Test Date: 17 MAR 99	Test Time: 9:50 AM	Test Plan 80 Step No.: 8.6

Describe test orientation and setup:
IN ACCORDANCE WITH FIGURE 3 OF TEST PLAN

Describe impact (location, rotation, etc.):
IMPACT ON SIDE OF SOURCE CHANGER

Describe on-site inspection (damage, broken parts, etc.):
NO DAMAGE- SMALL INDENTATION AT POINT OF CONTACT

On-site assessment:
CONTINUE WITH PLANNED TEST SEQUENCE AND ORIENTATIONS.

Engineering: [signature] 17MAR99 Regulatory: [signature] 17MAR99 QA: D.W. Kent 17MAR99

Describe any post-test disassembly and inspection:
NA

Describe any change in source position:
NA

Describe results of any pre- or post-test radiography:
NA

Completed by: [signature]	Date: 17 MAR 99

Data Sheet 2: Penetration Test

Test Unit Model and Serial Number: 650L SN 195		Test Specimen: TP80(C)
Test Date: 17 MAR 99	Test Time: 10:01	Test Plan 80 Step No.: 8.6

Describe test orientation and setup:

IN ACCORDANCE WITH FIGURE 3 OF TEST PLAN.

Describe impact (location, rotation, etc.):

IMPACT ON SIDE OF SOURCE CHANGER

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

NO DAMAGE - SMALL INDENTATION AT POINT OF CONTACT.

On-site assessment:

CONTINUE WITH PLANNED TEST SEQUENCE AND ORIENTATIONS.

Engineering: [signature] 17MAR99 Regulatory: [signature] 17MAR99 QA: D.N. Kurtz 17 MAR 99

Describe any post-test disassembly and inspection:

NA

Describe any change in source position:

NA

Describe results of any pre- or post-test radiography:

NA

Completed by: [signature]	Date: 17 MAR 99

Equipment List 3: 1.2 Meter (4 Foot) Free Drop

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Drop Surface	Drawing AT10122, Rev. B	SEE ATTACH
Thermometer	OMEGA EHG-12	↓
Thermocouple	OMEGA 5TC-GG-K-20-36	↓
Thermocouple	OMEGA WTK-10-36	↓
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:	DAVE ANNIS		17 MAR 99
Verified by:	Daniel N. Kurtz	D.W. Kurtz	17 MAR 99

Checklist 3: 1.2 Meter (4 Foot) Free Drop

Step	TP80(A)	TP80(B)	TP80(C)
1. Immerse specimen in dry ice or cool in freezer to bring specimen below –40°C.	DW	DW	DW
2. Measure the ambient temperature.	13°C	13°C	13°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
3. Attach the test specimen to the release mechanism.	DW	DW	DW
4. Begin video recording of the test.	DW	DW	DW
5. Measure specimen internal and surface temps. Ensure specimen is at specified temp.	DW	DW	DW
Record the specimen's internal temperature:	-90°C	-89°C	-92°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
Record the specimen's surface temperature:	-92°C	-87°C	-95°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
6. Lift and orient the test specimen as shown in the specified referenced figure.	Figure 4	Figure 5	Figure 6
7. Inspect the orientation setup and verify drop height.	DW	DW	DW
8. Photograph the set-up in at least two perpendicular planes.	DW	DW	DW
9. Release the test specimen.	DW	DW	DW
10. Measure specimen internal and surface temps. Ensure specimen is at specified temp.	DW	DW	DW
Record the specimen's internal temperature:	-71°C	-53°C	-90°C
Note the instrument used:	DW ENG-12	ENG-12	ENG-12
Record the specimen's surface temperature:	-76°C	-90°C	-61°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
11. Photograph the test specimen and record any damage on Data Sheet 3.	DW	DW	DW
12. Measure and record a radiation profile of the test specimen in accordance with AEAT/QSA Work Instruction WI-Q09.	DW	DW	DW
13. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71, and record on Data Sheet 3. Determine package orientation for the 9 meter free drop to achieve maximum damage.	DW	DW	DW

Verified by:	Print Name:	Signature:	Date:
Engineering	Nick Marrone	Nicholas J. Marrone	17 MAR 99
Regulatory Affairs	MARC D. NAHOUI		17 MAR 99
Quality Assurance	Daniel W. Kurtz	D.W. Kurtz	17 March 99

Data Sheet 3: 1.2 Meter (4 Foot) Free Drop

Test Unit Model and Serial Number: 650L SN 2243		Test Specimen: TP80 (A)
Test Date: 17 MAR 99	Test Time: 10:15 AM	Test Plan 80 Step No.: 8.7

Describe drop orientation and drop height:
HORIZONTAL - LONG SIDE DOWN. HEIGHT OF DROP WAS 1.2 m

Describe impact (location, rotation, etc.):
IMPACT FLAT AS SHOWN IN FIGURE 4

Describe on-site inspection (damage, broken parts, etc.):
IMPACT WITNESS MARKS ON BOTTOM PLATE, TOP PLATE AND BOTH LID FLANGES.
NO DAMAGED OR BROKEN PARTS.

On-site assessment:
CONTINUE WITH PLANNED TEST SEQUENCE AND ORIENTATIONS.

Engineering: 17 MAR 99 Regulatory: 17 MAR 99 QA: D.N. Kurk 17 MAR 99

Describe any post-test disassembly and inspection:
- LID REMOVED TO ALLOW FOR PROFILING OF DEVICE, NO DAMAGE TO TOP PLATE/LOCKING ASSEMBLIES WAS OBSERVED
- LOCK ASSEMBLIES REMAIN FUNCTIONAL

Describe any change in source position:
(A) 6.295" after drop vs. 6.318 before drop } No change within the accuracy of
(B) 6.375" after drop vs. 6.359 before drop } the measurement

Describe results of any pre- or post-test radiography:
NA

Completed by:	Date:
	17 MAR 99

Data Sheet 3: 1.2 Meter (4 Foot) Free Drop

Test Unit Model and Serial Number: 650L SN 182		Test Specimen: TP80(B)
Test Date: 17 MAR 99	Test Time: 10:30 AM	Test Plan 80 Step No.: 8.7

Describe drop orientation and drop height:
~~HORIZONTAL - LONG SIDE DOWN~~ - HEIGHT OF DROP WAS 1.2 m
FLAT ON TOP DWK 17MAR99

Describe impact (location, rotation, etc.):
IMPACT FLAT ON TOP OF LID - VERTICAL UPSIDE DOWN AS SHOWN IN FIGURE 5

Describe on-site inspection (damage, broken parts, etc.):
IMPACT WITNESS MARKS ON TOP OF LID. NO DAMAGE OBSERVED.

On-site assessment:
CONTINUE WITH PLANNED TEST SEQUENCE AND ORIENTATIONS.

Engineering: NJ Maggard 17MAR99 Regulatory: [signature] 17MAR99 QA: D.N. Kreitz 17MAR99

Describe any post-test disassembly and inspection:
- LID REMOVED TO ALLOW FOR PAPERING OF DEVICE - NO DAMAGE TO TOP PLATE/LOCKING ASSEMBLY WAS OBSERVED
- LOCK ASSEMBLIES REMAIN FUNCTIONAL

Describe any change in source position:
(A) 6.533 after drop vs 6.556 before drop
(B) 6.348 after drop vs 6.430 before drop
} NO CHANGE - Measurements unchanged within the accuracy of the measurement technique

Describe results of any pre- or post-test radiography:
NA

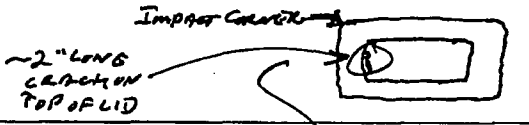
Completed by: NJ Maggard	Date: 17 MAR 99

Data Sheet 3: 1.2 Meter (4 Foot) Free Drop

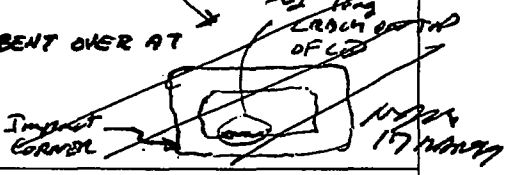
Test Unit Model and Serial Number: 650L SN 195		Test Specimen: TP80(C)
Test Date: 17MAR99	Test Time: 10:45	Test Plan 80 Step No.: 8.7

Describe drop orientation and drop height:
TOP CORNER DOWN - HEIGHT OF DROP WAS 1.2 m

Describe impact (location, rotation, etc.):
IMPACT ON CORNER OF LID TOP.



Describe on-site inspection (damage, broken parts, etc.):
IMPACT WITNESS MARKS ON TOP CORNER OF CID. FLANGE BENT OVER AT IMPACT POINT. APPROX. 2" CRACK OBSERVED ON TOP OF CID AS SHOWN IN SKETCH. No damage observed on lidbolts OR RIVNUTS.



On-site assessment:
CONTINUE WITH PLANNED TEST SEQUENCE AND ORIENTATIONS

Engineering: [signature] 17MAR99 Regulatory: [signature] 17MAR99 QA: D.N. Kurtz 17MAR99

Describe any post-test disassembly and inspection:
- LID REMOVED TO ALLOW FOR PADDICING OF DEVICE - NO DAMAGE TO TOP PLATE/LOCKING ASSEMBLIES WAS OBSERVED
- Lock Assemblies Remain Functional

Describe any change in source position:
(A) 6.328 after drop vs 6.304 before drop
(B) 6.291 after drop vs 6.256 before drop
} No change - Measurements unchanged within the accuracy of the measurment technique

Describe results of any pre- or post-test radiography:
NA

Completed by: [signature]	Date: 17 MAR 99

SENTINEL TP80(A) - AFTER 1.2M (4 FOOT) DROP TEST

DROP TEST UNIT

SHIELDING PROFILE AND INSPECTION FORM

odel: 650L Serial Number: 2243 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

hield Heat#: _____ Mass of Shield: _____ Lbs. Lot #: _____

Initial Profile

ource Model: _____ Source SN: _____ Activity: _____ Ci

urvey Inst.: _____ SN: _____ Date Cal.: _____ Date Due: _____

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
op				
ight			Capacity Correction Factor: _____	
ront				
eft				
ear				
ottom				

spector: _____ Date: _____ NCR #: _____

Final Profile

ource Model: 424-9 Source SN: C9232 – 94.8 Ci, C8931 – 107.8 Ci Activity: 202.6 Ci Mass of Device: _____ Lbs.

urvey Inst.: AN/PDR27T SN: ~~SM39204~~ 392402 Date Cal.: 8Oct98 Date Due: 8Oct99

MDB 13 Apr. 99

Surface	Observed Intensity mR/hr At Surface	Surface Corr. Factor	Observed Intensity mR/hr At One Meter		Adjusted Intensity mR/hr At Surface	Adjusted Intensity mR/hr At One Meter
op	80	*N/A	2.0		94	2.4
ight	40		.6		47	.7
ront	75		.7	Capacity Correction Factor: 1.18	89	.8
eft	55		.6		65	.7
ear	75		.7		89	.8
ottom	80	↓	.6		94	.7

spector: MDBoyd Date: 17March99 NCR #: N/A

Q16-1/1

mments: * Per WI-Q09 worksheet

Amersham QSA

SENTINEL TP80(B) - AFTER 1.2M (4 FOOT) DROP TEST

DROP TEST UNIT

SHIELDING PROFILE AND INSPECTION FORM

Model: 650L Serial Number: 182 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#: _____ Mass of Shield: _____ Lbs. Lot #: _____

Initial Profile

Source Model: _____ Source SN: _____ Activity: _____ Ci

Survey Inst.: _____ SN: _____ Date Cal.: _____ Date Due: _____

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top			Capacity Correction Factor: _____	
Right				
Front				
Left				
Rear				
Bottom				

Inspector: _____ Date: _____ NCR #: _____

Final Profile

Source Model: 424-9 Source SN: C9252 – 94.8 Ci, C8931 – 107.8 Ci Activity: 202.6 Ci Mass of Device: _____ Lbs.

Survey Inst.: AN/PDR27T SN: SIM 392402, 392404 MDB 13 Apr 99 Date Cal.: 8Oct98 Date Due: 8Oct99

Surface	Observed Intensity mR/hr: At Surface	Surface Corr. Factor	Observed Intensity mR/hr: At One Meter		Adjusted Intensity mR/hr: At Surface	Adjusted Intensity mR/hr: At One Meter
Top	60	*N/A	1.7	Capacity Correction Factor: 1.18	71	2.0
Right	45		.5		53	.6
Front	70		.7		83	.8
Left	70		.5		83	.6
Rear	65		.7		77	.8
Bottom	70	↓	.6		83	.7

Inspector: MDBoyd Date: 17March99 NCR #: N/A

QI6-1/1

Comments: * Per WI-009 Worksheet

Amersham QSA

SENTINEL TP80(c) - AFTER 1.2M (4 FOOT) DROP TEST

DROP TEST UNIT

SHIELDING PROFILE AND INSPECTION FORM

odel: 6506 Serial Number: 195 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#: | Mass of Shield: ____ Lbs. | Lot #:

Initial Profile

Source Model: ____ Source SN: ____ Activity: ____ Ci

Survey Inst.: ____ SN: ____ Date Cal.: ____ Date Due: ____

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top				
Right			Capacity Correction Factor:	
Front				
Left				
Rear				
Bottom				

Inspector: ____ Date: ____ NCR #: ____

Final Profile

Source Model: 424-9 Source SN: C9232 - 94.8 ci. C8991 - 107.8 Activity: 202.6 Ci | Mass of Device: ____ Lbs.

Survey Inst.: AN/PDR27T SN: SIM 392402 Date Cal.: 80ct98 Date Due: 80ct99

MDB 13 Apr 99

Surface	Observed Intensity mR/hr At Surface	Surface Corr. Factor	Observed Intensity mR/hr At One Meter		Adjusted Intensity mR/hr At Surface	Adjusted Intensity mR/hr At One Meter
Top	50	*N/A	1.7		59	2.0
Right	60		.6		71	.7
Front	40		.4	Capacity Correction Factor: 1.18	47	.5
Left	90		.7		106 53	.8
Rear	45		.5		MDB 17 March 99 53	.6
Bottom	50	↓	.4		59	.5

Inspector: MDBgd Date: 17March99 NCR #: N/A

Comments: * Per WI-QQ9 worksheet

QI6-1/1

Amersham QSA

Equipment List 4: 9 Meter (30 Foot) Free Drop

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Drop Surface	Drawing AT10122, Rev. B	SEE ATTACH (DW)
Thermometer	OMEGA HH21 ENG-12	
Thermocouple	OMEGA 5TC-GG-K-20-36	
Thermocouple	OMEGA WTK-10-36	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:	DAVE ANNIS	Dave Annis	18 Mar 99
Verified by:	Daniel W. Kurtz	D.W. Kurtz	18 Mar 99

Checklist 4: 9 Meter (30 Foot) Free Drop

Step	TP80(A)	TP80(B)	TP80(C)
1. Immerse test specimen in dry ice or cool in freezer to bring specimen temperature below –40°C.	DW	DW	DW
2. Measure the ambient temperature.	11°C	13°C	15°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
3. Attach the test specimen to the release mechanism.	DW	DW	DW
4. Begin Video Recording of the test.	DW	DW	DW
5. Measure specimen's internal and surface temps. Ensure specimen is at the specified temperature.	DW	DW	DW
Record the specimen's internal temperature:	NOTE ①	-94°C	-97°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
Record the specimen's surface temperature:	-92°C	-93°C	-98°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
6. Lift and orient the test specimen as shown in the specified referenced figure.	Figure 7	Figure 8	Figure 9
7. Inspect the orientation setup and verify drop height.	DW	DW	DW
8. Photograph the setup in at least two perpendicular planes.	DW	DW	DW
9. Release the test specimen.	DW	DW	DW
10. Measure specimen's internal and surface temps. Ensure specimen is at specified temperature.	DW	DW	DW
Record the specimen's internal temperature:	-92°C	-94°C	-94°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
Record the specimen's surface temperature:	-54°C	-69°C	-64°C
Note the instrument used:	ENG-12	ENG-12	ENG-12
11. Photograph the test specimen and record any damage on Data Sheet 4.	DW	DW	DW
12. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record assessment on Data Sheet 4. Determine what changes are necessary in package orientation for the puncture test to achieve maximum damage.	DW	DW	DW

Verified by:	Print Name:	Signature:	Date:
Engineering	Nick Marroni		18 MAR99
Regulatory Affairs	Marc S. Nadeau		18 MAR99
Quality Assurance	Daniel W. Kurtz	D.W. Kurtz	18 March 99

① ATC UUT READING -93°C

Data Sheet 4: 9 Meter (30 Foot) Free Drop

Test Unit Model and Serial Number: 650L SN 2243		Test Specimen: TP80(A)
Test Date: 18 MAR 99	Test Time: 9:45	Test Plan 80 Step No.: 8.9

Describe drop orientation and drop height:
HORIZONTAL LONG SIDE DOWN FROM 30 ft

Describe impact (location, rotation, etc.):
- PACKAGE ROTATED SLIGHTLY DURING DROP - EDGE OF BOTTOM PLATE STRUCK FIRST (IMPACT ON LONG EDGE OF PLATE)

Describe on-site inspection (damage, broken parts, etc.):
- LONG EDGE OF BOTTOM PLATE DEFORMED (NO CRACKING OBSERVED); WITNESS MARKS ON EDGE OF TOP PLATE AND BOTTOM CLO FLANGE - SMALL DEFORMATION OF CLO TOP FLANGE
- DEFORMATION OF OUTER SHELL AT INTERFACE WITH BOTTOM FLANGE PLATE (WHERE BOTTOM PLATE DEFORMED)

On-site assessment:
- CONTINUE WITH PLANNED DRIP SEQUENCE AND ORIENTATION

Engineering: 18MAR99 Regulatory: BMM99 QA: D.W. Kuntz 18MAR99

Describe any post-test disassembly and inspection:
NA

Describe any change in source position:
NA

Describe results of any pre- or post-test radiography:
NA

Completed by:	Date:
	18 MAR 99

Data Sheet 4: 9 Meter (30 Foot) Free Drop

Test Unit Model and Serial Number: 650L SN 182		Test Specimen: TP80(B)
Test Date: 18 MAR 99	Test Time: 10:30	Test Plan 80 Step No.: 8.9

Describe drop orientation and drop height:
- VERTICAL INSIDE DOWN FROM 30 ft

Describe impact (location, rotation, etc.):
- Impact was flat on top

Describe on-site inspection (damage, broken parts, etc.):
- One mount broken - Lid bolt still holding - No other ~~damage~~ MM damage to lid bolts
- No damage to lid (Only witness marks on top
- SS over wrap (i.e. label) unzipped and opened up
- CS Outer shell (18 gage) unzipped along seat weld line and opened up ~15"

On-site assessment:
- FOAM CRACKED SEVERAL SMALL PIECES CAME OUT
- CS Inner shell (10 gage) (in middle of short side) FAILED (BRITTLE FRACTURE) - Opened CRACK ~ 3" High; ~ ½ WIDE; ~~ALSO~~ MM AT THIS CRACK STARTS AT TOP END - AT BOTTOM OF THIS OPENING THE CRACK TURNS AND CONTINUES BEHIND FOAM
- FOAM BEHIND INNER SHELL CRACKED

* SEE BELOW
Engineering: [signature] 19 MAR 99 Regulatory: [signature] 18MAR99 QA: D. W. Kurtz 18 MAR 99

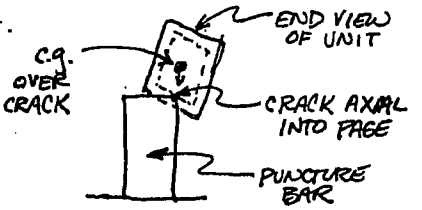
Describe any post-test disassembly and inspection:
NA

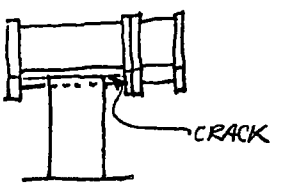
Describe any change in source position:
NA

Describe results of any pre- or post-test radiography:
NA

Completed by: [signature]	Date: 18 MAR 99

* CHANGE PUNCTURE BAR DROP ORIENTATION FROM UNDERSIDE OF TOP PLATE TO HORIZONTAL WITH IMPACT TO OPEN AXIAL CRACK.
- PROCEED WITH PUNCTURE BAR DROP





Data Sheet 4: 9 Meter (30 Foot) Free Drop

Test Unit Model and Serial Number: 650L SN 195		Test Specimen: TP 80 (C)
Test Date: 18 MAR 99	Test Time: 11:20	Test Plan 80 Step No.: 8.9

Describe drop orientation and drop height:
TOP CORNER DOWN FROM 30 ft

Describe impact (location, rotation, etc.):
IMPACT ON TOP CORNER OF LID

Describe on-site inspection (damage, broken parts, etc.):
- TOP PLATE OF LID CRACKED (BRITTLE FAILURE) IN VICINITY OF IMPACT POINT. TOP SURFACE LID DEFLECTED INTO "COLUMN" SECTION OF LID ~½" - COLUMN SECTION AND BOTTOM PLATE OF LID INTACT
-NO DAMAGE TO LID BOLTS OR RIVNUTS - BOTTOM PLATE DEFORMED AT CORNER (HIT ON BOUNCE)

On-site assessment:
- CHANGE PUNCTURE BAR DROP ORIENTATION FROM HIT ON BOTTOM PLATE TO IMPACT ON TOP OF LID TO TRY TO GET TO LOCKS.
-PROCEED W/ PUNCTURE BAR DROP

Engineering: [signature] 18MAR99 Regulatory: [signature] 18MAR99 QA: D.W. Kuntz 18MAR99

Describe any post-test disassembly and inspection:
NA

Describe any change in source position:
NA

Describe results of any pre- or post-test radiography:
NA

Completed by: [signature]	Date: 18 MAR 99

Equipment List 5: Puncture Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Drop Surface	Drawing AT10122, Rev. B	DW SEE ATTACH
Puncture Billet	Drawing CT10119, Rev. C	
Thermometer	OMEGA HH21 ENG-12	
Thermocouple	OMEGA 5TC-GG-K-20-36	
Thermocouple	OMEGA WTK-10-36	
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		

	Print Name:	Signature:	Date:
Completed by:	DAVE ANNIS		18 MAR 99
Verified by:	Daniel W. Kurtz	D.W. Kurtz	18 MAR 99

Checklist 5: Puncture Test

Step	TP80(A)	TP80(B)	TP80(C)	TP80(C) 2ND ORIENTATION
1. Immerse specimen in dry ice or cool in freezer to bring specimen temp. below –40°C.	Dw	Dw	Dw	Dw
2. Measure the ambient temperature.	15°C / 15c ②	18°C	15°C	15°C
Note the instrument used:	ENG-12	ENG-12	ENG-12	ENG-12
3. Attach the test specimen to the release mechanism.	Dw	Dw	Dw	Dw
4. Begin Video Recording of the test.	Dw	Dw	Dw NOTE *	Dw
5. Measure specimen's internal and surface temps. Ensure that specimen is at specified temp.	Dw	Dw	Dw	Dw
Record the specimen's internal temperature: ② –81°C	-87°C / -81	-83°C	-83°C	-80°C
Note the instrument used:	ENG-12	ENG-12	ENG-12	ENG-12
Record the specimen's surface temperature: ② –46°C	-69°C /	-57°C	-53°C	-47°C
Note the instrument used:	ENG-12	ENG-12	ENG-12	ENG-12
6. Lift and orient the test specimen as shown in the specified referenced figure, or as determined during the assessment of the 9 Meter (30 Foot) Drop Test.	Figure 10	Figure 11	Figure 12 Dw	Dw
7. Inspect the orientation setup and verify drop height.	Dw	Dw	Dw	Dw
8. Photograph the set-up in at least two perpendicular planes.	Dw	Dw	Dw	Dw
9. Release the test specimen.	Dw	Dw	Dw	Dw
10. Measure the specimen's internal and surface temperatures.	Dw	Dw	Dw	Dw
Record the specimen's internal temperature: ② –79°C	-88°C	-82°C	-81°C	-70°C
Note the instrument used:	ENG-12	ENG-12	ENG-12	ENG-12
Record the specimen's surface temperature: ② –42°C	-26°C	-44°C	-50°C	-37°C
Note the instrument used:	ENG-12	ENG-12	ENG-12	ENG-12
11. Photograph the test specimen and record any damage on Data Sheet 5.	Dw	Dw	Dw	
12. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record assessment on Data Sheet 5. Determine what changes are necessary in package orientation for thermal test to achieve maximum damage.	Dw	Dw	Dw	

Verified by:	Print Name:	Signature:	Date:
Engineering	Mick Maraone	Michael J. Maraone	18 Mar 99
Regulatory Affairs	Marie S. Nadeau		18 MAR 99
Quality Assurance	Daniel W. Kurtz	D.W. Kurtz	18 March 99

* TEST SIGN WAS FOR "B" UNIT, NOT "C"

Data Sheet 5: Puncture Test

Test Unit Model and Serial Number: 650L SN 2243		Test Specimen: TP80(A)
Test Date: 19 MAR 99	Test Time: 12:05	Test Plan 80 Step No.: **8.10**

Describe drop orientation and drop height:
HORIZONTAL LONG SIDE ONTO PUNCTURE BAR FROM 4ft

Describe impact (location, rotation, etc.):
IMPACT ON LONG SIDE OF PACKAGE

Describe on-site inspection (damage, broken parts, etc.):
-WITNESS MARK ON TOP PLATE FLANGE
- SMALL DENT ON SIDE JUST ABOVE BOTTOM PLATE
-NO DAMAGE TO LID BOLTS OR RIVNUTS

On-site assessment:
-PACKAGE INTACT -NO DAMAGE TO LID
-NOTE: LID TEMP AFTER DROP ~~26°C~~ 18MAR99 (i.e. below 40°C) - Therefore drop 2nd TIME IN SAME ORIENTATION
- 2nd DROP HIT ON LONG SIDE - IMPACT ~~AREA~~ (CORNER) RESULTED IN DENT ON SIDE OF PACKAGE - NO OTHER DAMAGE
- PROCEED WITH DISASSEMBLY INSPECTION OF TOP PLATE AND LOCK AND SOURCE POSITION Therefore there is no need to change the plan to NOT PERFORM A THERMAL TEST ON THE PACKAGE
- There are NO OPENINGS IN THE PACKAGE
Engineering: [signature] 18MAR99 Regulatory: [signature] 18MAR99 QA: D.W. Kurtz 18 MAR 99

Describe any post-test disassembly and inspection:
SEE ATTACHED SHEETS

Describe any change in source position:

	Before	After	Δ
(A)	6.318	6.303	- 0.015
(B)	6.359	6.378	+ 0.019

Describe results of any pre- or post-test radiography:
NO change in shield position - No damage to internal structure identified in radiographs

Completed by: [signature]	Date: 22 MAR 99

650L - TEST SPECIMEN TP80(A)

18 MAR 99

- REMOVED COVER - BOLTS & RIVNUTS OK
- SOURCE LOCATION
  - (A) 6.303
  - (B) 6.378
- SOURCES SECURED IN LOCKED POSITION
- NO DAMAGE TO LOCKS, LOCK SCREWS OR THROUGH BOLTS
- NO DEFLECTION OF TOP PLATE

18 MAR 99

Data Sheet 5: Puncture Test

Test Unit Model and Serial Number: 650L SN 182		Test Specimen: TP80(B)
Test Date: 18 MAR 99	Test Time: 1:20	Test Plan 80 Step No.: 8.10

Describe drop orientation and drop height:
4 ft DROP ON PUNCTURE BAR - TARGET ~~ER~~ MJM 18MAR99 AXIAL CRACK

Describe impact (location, rotation, etc.):
Impact Point directly on axial crack ~~AT~~ MJM 18MAR99

Describe on-site inspection (damage, broken parts, etc.):
- SMALL INDENTATION ON EITHER SIDE OF CRACK WHERE BAR IMPACTED
- NO FURTHER OPENING OF CRACK WAS OBSERVED

On-site assessment:
- Radiograph device to further assess cracking and determine how to proceed.
- Radiographs were taken which showed cracking of inner sleeve only on the one side.
- Based on above it was determined that it is appropriate to proceed with inspection of top plate, locking mechanism and source position. IN ADDITION IT WAS DETERMINED THAT THE THERMAL TEST OF THE UNIT SHOULD BE PERFORMED WITH THE CRACK SIDE DOWN AND THE UNIT ROTATED FROM HORIZONTAL TO ALLOW THE SHIELD TO MOVE AS MUCH AS POSSIBLE CJ

Engineering: MJ Mooney 18MAR99 TMT Regulatory: BMARR QA: D.W. Keuch, 18MAR99 MJM 18 MAR 99

Describe any post-test disassembly and inspection:
SEE ATTACHED SHEET

Describe any change in source position:
- Deflection of top plate resulted in a very small change in source position as follows
  - (A) Δ is 0.027 in
  - (B) Δ is 0.064 in

Describe results of any pre- or post-test radiography:
SEE ABOVE

The crack ~~BAR~~ MJM appears to run the ENTIRE 18MAR99 LENGTH OF THE INNER SHELL. TMT

Completed by:	Date:
	18 MAR 99

18 MAR 99

650L - TEST SPECIMEN TP80(B) - SN 182
DISASSEMBLY NOTES (POST PUNTURE BAR DROP)

- PART OF RIVNUT - ADJACENT TO SEAM - BROKEN OFF
- LID BOLTS UNDAMAGED, BUT RIVNUTS TURNED OUT
- LOCK B BROKEN OUT; SOURCE STILL LOCKED IN PLACE
- NO SIGNIFICANT DEFLECTION OF THROUGH-BOLT HEADS
- LOCK SCREWS INTACT; SOURCES LOCKED IN POSITION
- LOCKS ARE STILL FUNCTIONAL
- SOURCE POSITION:

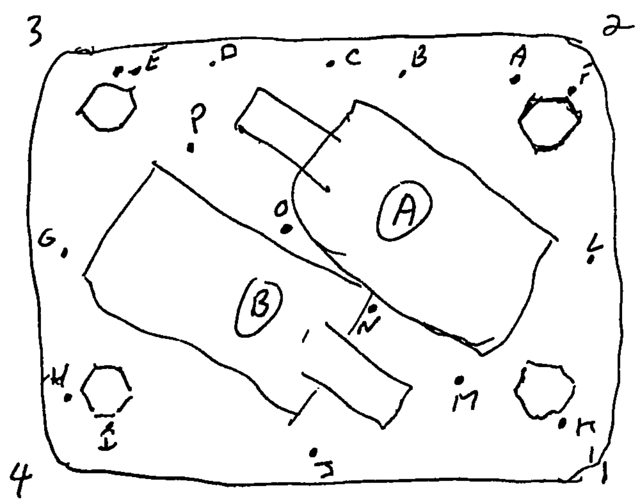
		ORIG. SOURCE POS.	Δ
(A)	6.583	6.556	0.027
(B)	6.494	6.430	0.064

18 MAR 99

TP 8U(13)
Post-9in Drop

18 MAR 99

Dave Annis



PT	
A	0.000
B	.032
C	.032
D	.019
E	-.005
F	-.005
G	.023
H	.013
I	.012
J	.019
K	.020
L	.003
M	.034
N	.154
O	.162
P	.070

Data Sheet 5: Puncture Test

Test Unit Model and Serial Number: 650L SN 195		Test Specimen: TP80(C)
Test Date: 18 MAR 99	Test Time: 12:45p	Test Plan 80 Step No.: **8.10**

Describe drop orientation and drop height:
(1) - UPSIDE DOWN ON LID CENTER, AT A SLIGHT ANGLE.

(2ND) DROP ORIENTATION TARGET UNDERNEATH CORNER OF TOP PLATE PER Fig 11

Describe impact (location, rotation, etc.):
(1) - EDGE OF PUNCTURE BAR HIT TOP PLATE OF LID WITHIN THE TUBE/COLUMN OF THE LID.

(2) Impact on ~~CORNER~~ CORNER ON 2ND ATTEMPT

Describe on-site inspection (damage, broken parts, etc.):
(1) - DAMAGE TO LID INCREASED ONLY SLIGHTLY

(2ND) DROP ORIENTATION
SMALL DEFORMATION OF TOP PLATE AT IMPACT POINT - NO DAMAGE TO BOLTS - NO GAPS WERE CREATED BY TOP plate/SHELL INTERFACE

On-site assessment:
(1) - LOCK MECHANISMS NOT EXPOSED OR DIRECTLY IMPACTED IN DROP SEQUENCE
- LID BOLTS REMAINED INTACT
- PACKAGING REMAINED INTACT. NO OPENINGS IN PACKAGE* CREATED IN ANY OF THE DROPS.

(2) NOTE: IT WAS DECIDED ON-SITE TO PERFORM AN ADDITIONAL PUNCTURE BAR DROP USING THE TP80(C) TEST SPECIMEN. THE 2ND DROP ORIENTATION WILL TARGET UNDERNEATH CORNER OF TOP PLATE AS SHOWN IN FIGURE 11 OF THE TEST PLAN. [THIS DROP ORIENTATION WAS PLANNED FOR ITEM TP 80(A)]

* SEE BELOW

Engineering: NJ Mayo 18 March Regulatory: 18 MAR 99 QA: D.W. Kuntz 18 MAR 99

Describe any post-test disassembly and inspection:
SEE ATTACHED SHEET

Describe any change in source position:

	BEFORE	AFTER	Δ
A	6.304	6.342	+0.038
B	6.256	6.259	+0.003

Describe results of any pre- or post-test radiography:
No damage to internals identified in radiography

Completed by:	Date:
Richard J. Mayo	22 MAR 99

* THERE ARE NO OPENING IN THE PACKAGES THEREFORE THERMAL TESTING OF THE UNIT IS NOT REQUIRED (PER THE TEST PLAN) NJM 18 MAR 99

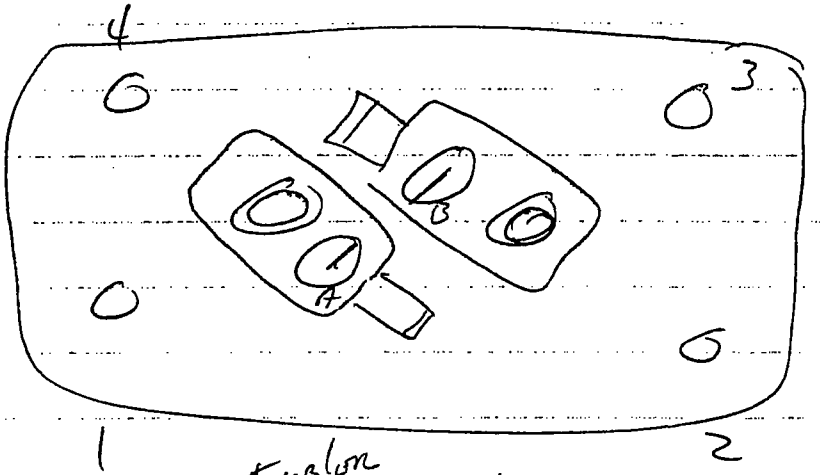
HANDWRITTEN MARGIN NOTE: 1 MISSION, 1 MISSION

650L TEST

1635
18 MARCH 99

TP80(C) - TOP CORNER DROP
#195

REMOVED COVER → BOLTS & RIVNUTS OK
→ TOP PLATE SLIGHTLY WARPED DUE TO PUNCTURE IMPACT ON CORNER #2
(i.e. SLIGHT UPWARD BEND IN PLATE AT CORNER #2)



→ LOCK "B" SLIGHTLY HIGHER THAN NORMAL (TUMBLER)
(LOCK B WORKS)
→ LOCKS & LOCK SLIDES WORK PROPERLY THOUGH DIFFICULT TO MOVE (DUE POSSIBLE TO ICE)

SOURCES → 6.342 SIDE A
6.259 SIDE B
→ SOURCES SECURED IN LOCKED POSITION
→ THROUGH BOLTS & LOCK HOLDDOWN SCREWS SHOW NO SIGN OF ANY DEFORMATION
→ NO DEFLECTION OR DISHING OF TOP PLATE

18 March 99

SENTINEL TP80(A) - AFTER 9M (30 FOOT) DROP TEST & PUNCTURE TEST

SHIELDING PROFILE AND INSPECTION FORM

Model: 6506 Serial Number: 2243 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#: _____ Mass of Shield: _____ Lbs. Lot #: _____

Initial Profile

Source Model: _____ Source SN: _____ Activity: _____ Ci

Survey Inst.: _____ SN: _____ Date Cal.: _____ Date Due: _____

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top			N/A	
Right			Capacity Correction Factor: _____	
Front				
Left				
Rear				
Bottom				

Inspector: _____ Date: _____ NCR #: _____

Final Profile

Source Model: 424-9 Source SN: C9274-112.9 Ci. C9232-93.1 Ci Activity: 205.4 Ci Mass of Device: _____ Lbs.

Survey Inst.: AN/PDR27T SN: SM382402 Date Cal.: 8 Oct 98 Date Due: 8 Oct 99

Surface	Observed Intensity mR/hr: At Surface	Surface Corr. Factor	Observed Intensity mR/hr: At One Meter		Adjusted Intensity mR/hr: At Surface	Adjusted Intensity mR/hr: At One Meter
Top	80	*N/A	2.3	Capacity Correction Factor: 1.16	93	2.7
Right	55		1.7		64	1.8
Front	80		1.9		93	1.0
Left	50		.6		58	.7
Rear	70		.8		81	.9
Bottom	80	↓	.5		93	.6

Inspector: MDBoyd Date: 19 March 99 NCR #: N/A

Comments: * Per WT-Q09 Worksheet

QI6-1/1

Amersham QSA

SENTINEL TP80(C) - AFTER 9M (30 FOOT) DROP TEST & PUNCTURE TEST

SHIELDING PROFILE AND INSPECTION FORM

lodel: 650L Serial Number: 195 Radionuclide: IR192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#: Mass of Shield: Lbs. Lot #:

Initial Profile

Source Model: Source SN: Activity: Ci

Survey Inst.: SN: Date Cal.: Date Due:

Surface	Observed Intensity mR/hr	Surface Correction Factor		Adjusted Intensity mR/hr
Top			N/A	
Right			Capacity Correction Factor:	
Front				
Left				
Rear				
Bottom				

Inspector: Date: NCR #:

Final Profile

ource Model: 424-9 Source SN: C9274-112.3 ci. C9232-99.1ci Activity: 205.4 Ci Mass of Device: Lbs.

urvey Inst.: AMPDR27T SN: SM3922402 Mar 13 Apr 99 Date Cal.: 8 Oct 98 Date Due: 8 Oct 99

Surface	Observed Intensity mR/hr: At Surface	Surface Corr. Factor	At One Meter		Adjusted Intensity mR/hr: At Surface	At One Meter
op	60	*N/A	1.9		70	2.2
ight	85		.8		99	.9
ront	45		.5	Capacity Correction Factor: 1.16	52	.6
eft	100		.9		116	1.0
ear	50		.5		58	.6
ottom	60	↓	.4		70	.5

spector: MR Boyd Date: 19 March 99 NCR #: N/A

QI6-1/1

mments: * Per WI-Q09 Worksheet

Amersham QSA

Equipment List 6: Thermal Test

Description	Enter the Model and Serial Number	Attach Inspection Report or Calibration Certificate
Bottom Surface Thermocouple 1	XCIB-K OMEGA	DW
Top Surface Thermocouple 2	OMEGA XCIB-K	DW
Side Surface Facing Oven Front Thermocouple 3	OMEGA XCIB-K	DW
Side Surface Facing Oven Rear Thermocouple 4	XCIB-K	DW
Source Tube Thermocouple 5/8 DW 19 MAR99	XCIB-K	DW
Oven	GE 60KW RESISTANT HEATED BOX FURNACE	DW N/A
Oven thermostat	OMEGA#XCIB-K-	DW
Record any additional tools used to facilitate the test and attach the appropriate inspection report or calibration certificate.		
SIDE SURFACE FACING LEFT TC 5	XCIB-K	DW
SIDE SURFACE FACING RIGHT TC 6	XCIB-K	DW
SIDE OF UNIT FACING OVEN FRONT TC 7	XCIB-K	DW
AMBIENT THERMOCOUPLE 9	XCIB-K	DW
THERMOCOUPLE THERMOMETER DW 19 MAR 99	Cole-Parmer #ENG-21 (12 CH)	DW

	Print Name:	Signature:	Date:
Completed by:	Dave Annis	Dave Annis	19 mar 99
Verified by:	Daniel W. Kurtz	D.W. Kurtz	19 Mar 99

Checklist 6: Thermal Test

Step	TP80(A)	TP80(B)	TP80(C)
1. Record Test Specimen Serial Number.		182	
2. Preheat the oven to 810°C.		DW	
3. Attach the thermocouples as described in Equipment List 6. Ensure the recording devices are active, and that the external thermocouples are shielded.		DW	
4. Place the package in the oven in the worst case orientation and partially close the oven door such that a 1 inch by 36 inch opening is provided. Record the time.		DW 19 MAR 99 7:35 PM	
5. When all of the test specimen's surface temperatures exceed 810°C, begin the 30-minute time interval. Record the time.		DW 19 MAR 99 8:05 PM	
6. Monitor and record the test specimen and the oven temperatures throughout the 30-minute period to ensure that they are above 810°C		DW	
7. At the end of the 30-minute test period, shut off the oven and open the door. Record the time. (AND REMOVE THE TEST SPECIMEN) NJM 19 MAR 99 DWK 19 MAR 99		DW 19 MAR 99 8:37 PM	
8. Describe combustion when door is opened.		CHERRY RED NO FLAME	
9. Allow the specimen to cool, ~~then remove the specimen from the oven~~. Record the time. NJM 19 MAR 99 DWK 19 MAR 99		8:37 PM	
NOTE: If specimen continues to burn, let it self-extinguish and cool naturally.			
10. Measure and record the ambient temperature.		DW 25°C	
11. Photograph the test specimen and record any damage on data sheet 6.		DW	
12. Radiograph the unit to determine the shield location.		DW	
13. Measure and record the source location.		DW 24 MAR 99	
14. **Engineering, Regulatory Affairs and Quality Assurance** make a preliminary assessment relative to 10 CFR 71. Record assessment on Data Sheet 6.		DW	

Verified by:	Print Name:	Signature:	Date:
Engineering	*NICHOLAS MARRONE CAROLINE S. SCHLASEMAN	Nicholas J. Marrone Caroline S. Schlaseman	~~19 MAR 99~~ 24 MAR 99
Regulatory Affairs	* MARC J. NARDONE Cathleen Rawlins	Cathleen Rawlins	~~20 MAR 99~~ 24 mar 99
Quality Assurance	*Daniel W. Kurtz ~~Daniel W. Kurtz~~	D.W. Kurtz ~~D.W. Kurtz~~	20 MAR 99 ~~26 MAR 99~~

*COMPLETION OF ALL STEPS EXCEPT STEP 13 (Source location). Source location will be determined at the time of profiling NJM 20MAR99

Data Sheet 6: Thermal Test

Test Unit Model and Serial Number: 650L SN 182		Test Specimen: TP80(B)
Test Date: 19 MAR 99	Test Time: 7:35 PM	Test Plan 80 Step No.: 8.12

Describe test orientation and setup:
PACKAGE ON JIG TO RAISE SIDE FACE OF UNIT TO AN ANGLE 53° ABOVE HORIZONTAL. SIDE WITH CRACK FACING DOWN (@ 53° ANGLE). SEE FIGURE – ATTACHED.

Describe package during testing:
POLYURETHANE FOAM BURNED OFF, CAUSING SOME RED FLAMES TO SHOOT OUT ABOVE OVEN DOOR. FLAMES DIMINISHED AND STOPPED COMPLETELY BEFORE 30 MINUTE INTERVAL COMPLETED.

Describe on-site inspection (damage, broken parts, etc.): WHEN OVEN DOOR FIRST OPENED, UNIT GLOWED BRIGHT RED (INCLUDING JIG). AFTER EXTERIOR HAD COOLED TO GREY COLOR, INSPECTION SHOWED: (1) NO CHANGE IN CONFIGURATION OF PACKAGE EXTERIOR, INCLUDING INNER SHELL -- e.g., CRACK WIDTH DID NOT CHANGE, (2) ALL FOAM IN TOP OF UNIT WAS GONE, SO DU SHIELD AND SOURCE TUBE CLOSEST TO CRACK WERE VISIBLE THROUGH CRACK OPENING, (3) DU SHIELD WAS GLOWING RED IN A FEW SPOTS AND OXIDE (BLACK POWDER) WAS BUILDING UP ON SHIELD SURFACE, (4) DU OXIDE WAS FALLING OUT OF UNIT PERIODICALLY AND FORMING A SMALL PILE BELOW FACE OF CRACK ON JIG'S BASE. NEXT MORNING (~10 HOURS LATER), INSPECTION SHOWED: (1) A CRACKED PIECE OF INNER SHELL HAD DROPPED OUT OF POSITION, ~~AND PARTIALLY COVERED CRACK OPENING~~, (2) PILE OF DU OXIDE BELOW CRACK WAS MUCH LARGER – AT LEAST 2" TALL, 3"Ø. ~~(3) DU OXIDE FILLING IN CRACK OPENING.~~ CLA 20MAR99 CLA 20 MAR 99

On-site assessment: – CONTINUE WITH PROFILE & SOURCE POSITION MEASUREMENTS

Engineering: W.J. Marvin 20MAR99 Regulatory: 20MAR99 QA: D.W. Kurtz 20MAR99

Describe any post-test disassembly and inspection:
SEE ATTACHED SHEETS.

Describe any change in source position:
~~LATER~~ SEE ATTACHED SHEETS. CLA 24MAR99

Describe results of any pre- or post-test radiography: POST-TEST RADIOGRAPHS TAKEN FROM LONG SIDE & SHORT SIDE SHOWED SOURCE TUBES ~~ENGAGE OR AT LEAST TOUCHING~~ PULLED OUT FROM IN POSITION. CLA 20 MAR99 TOP PLATE. DU SHIELD WAS SHIFTED DOWN (TOWARD CRACK FACE) & SOURCE TUBE CLOSEST TO CRACK HAD BENT SLIGHTLY TO FOLLOW SHIELD. SHIELD DID NOT PASS BEYOND INTERFERANCE WITH THROUGH BOLTS. THE D.U. SHIELD "EAR" (MATERIAL AROUND SOURCE TUBE) CLOSEST TO CRACK WAS MISSING MATERIAL, DUE TO OXIDATION. THE SOURCE TUBE PULLOUT AND SHIELD SHIFT CAUSED THE TOP OF THE SOURCE TUBES TO BE MISALIGNED WITH THE LOCK ASSEMBLIES. THE GAP BETWEEN THE TOP OF THE SOURCE TUBE AND THE BOTTOM OF THE TOP PLATE IS LARGER FOR THE TUBE FURTHER FROM THE CRACK. CLA 20MAR99 CLA MAR 99

Completed by: CLA 20MAR99	Date: 24MAR99

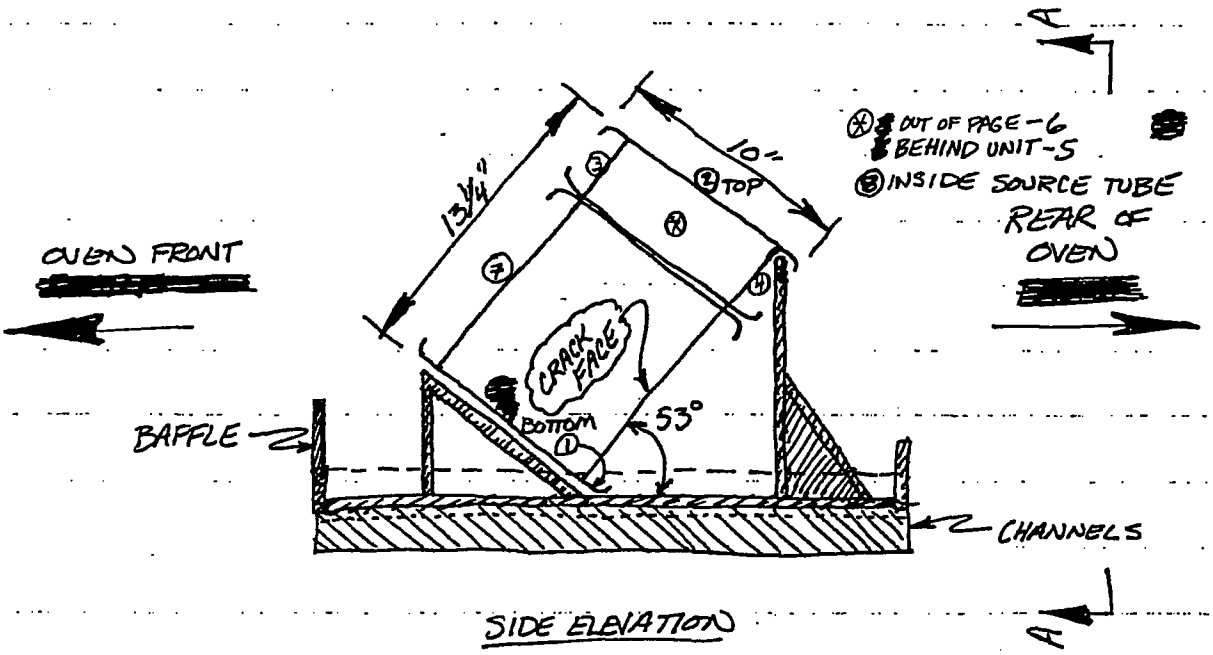
(54/A1)

19MAR99
CSCHUSSMAN

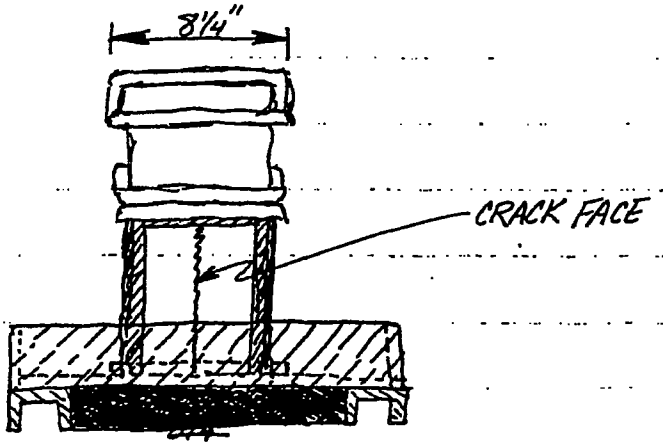
650L TP80(B) SN 182
THERMAL TEST ORIENTATION

(SUPPORT FIXTURE SHOWN CROSS-HATCHED)

○ TC NUMBER



SIDE ELEVATION



VIEW A-A
(FACING FRONT OF OVEN)

23MAR 99 @ MSC, OAK RIDGE, TN

INSPECTION & SET-UP FOR RADIATION PROFILE

(1) SOURCE TUBE & SHELL TEMP'S AMBIENT (~16 °C)

(2) PHOTO 1 CRACKED PIECE OF INNER SHELL

(3) PHOTO 2 CRACKED PIECE OF INNER SHELL REMOVED

(4) PHOTO 3 " " " " " OUTSIDE UNIT

(5) VACUUMED DU. OXIDE VIA CRACK OPENING.

(6) PHOTO 4 MELTED LEAD AT BASE OF UNIT

(7) ~~TUBES~~ & ~~SHELL~~ SHIELD OD SEEM OD 24MAR99 FAIRLY FIXED, i.e., CAN'T MOVE.

(8) CRACKED OFF REMAINING RIVETS FOR SS OVERWRAP.

(9) DRILLED HOLE IN LOWER HALF OF SHELL OPPOSITE CRACK FACE — PHOTOS 5 & 6

(10) VACUUMED D.U. OXIDE VIA HOLE; BASE AREA OF D.U. SHIELD LOOKED GOOD, COPPER SHIM AT BASE VISIBLE UNDER EDGE OF BASE, NO SIGN OF ANY REMAINING LEAD FROM THIS (THE UPPER) SIDE.

(11) FOAMED W/ 20# VULTAFOAM FROM NEW HOLE; FOAM SURROUNDS SHIELD UP ABOUT 2/3 — i.e., TOPS OF DU "EARS" & SOURCE TUBES ARE STILL ACCESSIBLE.

(12) DRILLED 3 ACCESS HOLES IN TOP SECTION OF UNIT SIDES, 90° APART, TO GET ACCESS TO DUMMY SOURCE WIRE IN "B" LOCK (FURTHER FROM CRACK).

(13) REMOVED LID - PHOTO 7 - "A" LOCK CYLINDER MELTED ("B" LOCK CYLINDER HAD BROKEN OUT DURING 9 M DROP.)

[CON'T]

23 MAR 99 – CON'T

(14) PHOTO 8: VIEW THROUGH CRACK: FOAM BELOW, RIVNUT ABOVE IN FOREGROUND, TOP OF "A" SOURCE TUBE (GREY) VISIBLE BELOW BOTTOM OF TOP PLATE, THERMOCOUPLE WIRE (SAME GREY COLOR AS TUBE) IS VISIBLE IN GAP BETWEEN TOP OF TUBE & BOTTOM OF TOP PLATE.

(15) DUMMY SOURCE WIRE MARKED W/ "WHITE OUT" @ TOP OF TUBE (VIA NEW HOLES)

(16) LOCK UNSCREWED, BUT SLIDE LEFT IN PLACE TO HOLD WIRE POSITION TEMPORARILY – PHOTO 9

(17) PHOTOS 10 & 11: SLIDE REMOVED ("B" SIDE), SOURCE WIRE STICKING UP.

(18) PHOTO 12: DUMMY SOURCE WIRE REMOVED; BRIGHT WHITE MARK ON 2ND BEND BELOW BALL IS TOP OF SOURCE TUBE POSITION; LIGHT GREY MARK BETWEEN BALL & WHITE MARK IS LIKELY ORIGINAL TOP OF TUBE MARK – GREY/DISCOLORATION IS DUE TO RUBBING OR SCUFFING.

(19) REMOVED "A" LOCK ASSEMBLY (WHICH HAD CONTAINED A TC WIRE & IS CLOSEST TO CRACK).

(20) PHOTOS 13 & 14: SOURCE TUBES VISIBLE BELOW TOP PLATE – SEE SKETCH FOR DIMENSIONS

(A) 0.436"

Δ = 6.992 - 6.556 =

FOR 24 MAR 99: PHOTO 15

7.002 - .010 = 6.992" 2 NEW LOCK Δ

"A" OLD LOCK .768 NEW LOCK .780 Δ = .010"

① → CHECK "A" SOURCE TUBE DEPTH W/ NYLON & NEW LOCK

③ → ENLARGE HOLES IN TOP PLATE → PHOTO 16 PHOTOS 17 & 18

④ → PRACTICE SOURCE TRANSFER W/ DUMMY SOURCE

⑤ → PERFORM PROFILE → SEE PROFILE SHEET

6.947 - 6.430 = 0.517" (B)

② → RE-CHECK "B" SOURCE TUBE DEPTH W/ NYLON ~~USE Δ = 0.517" (WHICH IS SLIGHTLY HIGHER THAN NUMBER BACKED OUT FROM MARK MADE AT TOP OF SOURCE TUBE BY ~28 MILS)~~ SEE NEXT SHEET FOR DETERMINATION OF SOURCE PULLOUT DISTANCE.

24 MAR 99 CAS

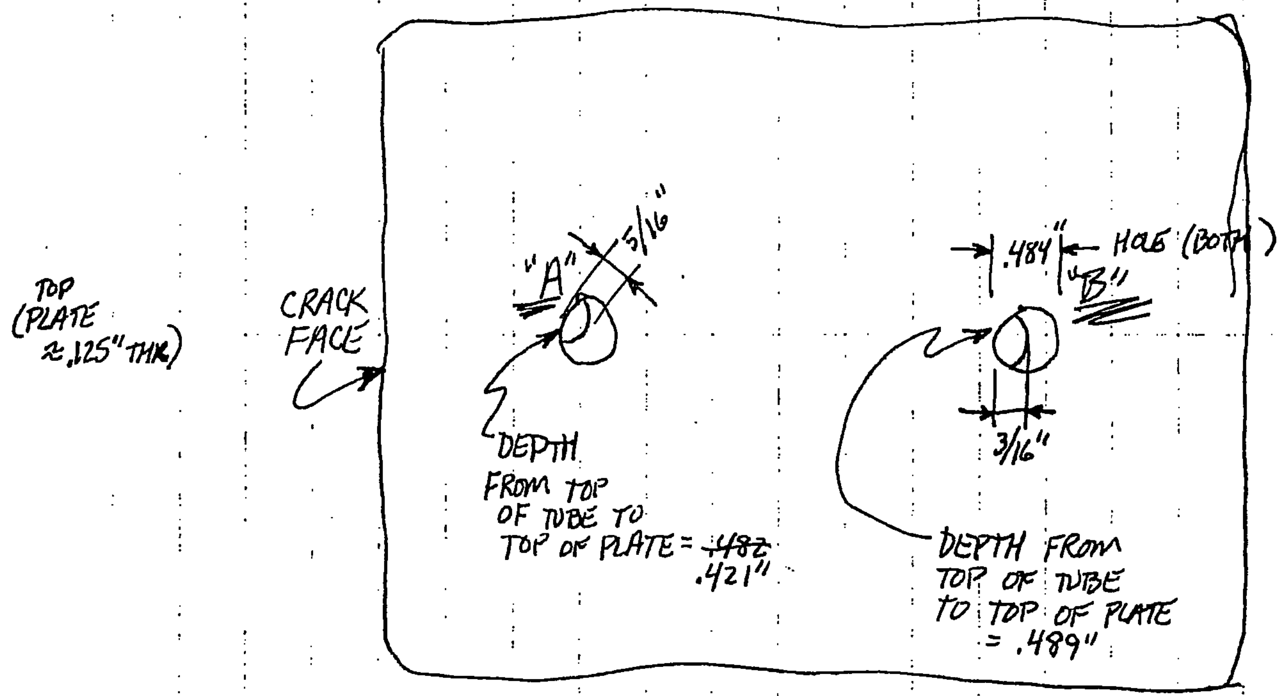
REF. DISTANCES:	A	B
HT. ABOVE TOP PLATE TO TOP OF SOURCE	0.954"	0.925"
WITHDRAWAL HEIGHT	0.436"	24MAR99 CLA 0.517" (BASED ON NYLON PROBE) 0.480" (SEE BELOW)
HT. ABOVE TOP PLATE FOR PROFILE	1.390"	24MAR99 CLA 1.442" 1.405"

CROSS-CHECK ON "B" SIDE (NO LOCKS ON TOP PLATE):

1. MATCH MARK ON DUMMY SOURCE USED IN THERMAL & DROP TESTS WITH NEW DUMMY SOURCE.
2. INSERT NEW DUMMY SOURCE WIRE IN TO THE POINT WHERE MARK MATCHES TOP OF TUBE.
3. MEASURE DIST. BETWEEN TOP OF PLATE & TOP OF SOURCE. → 1.385"
4. PUSH NEW DUMMY SOURCE ALL THE WAY TO BOTTOM OF TUBE AND MEASURE DIST. BETWEEN TOP OF PLATE & TOP OF SOURCE. → 0.905"
5. SUBTRACT TO GET SOURCE PULLOUT. 0.480" ← USE THIS NUMBER WHICH IS A DIRECT MEASUREMENT USING A DUMMY SOURCE WIRE.

23MAR99 TP80(B) SN 182 AFTER THERMAL TEST

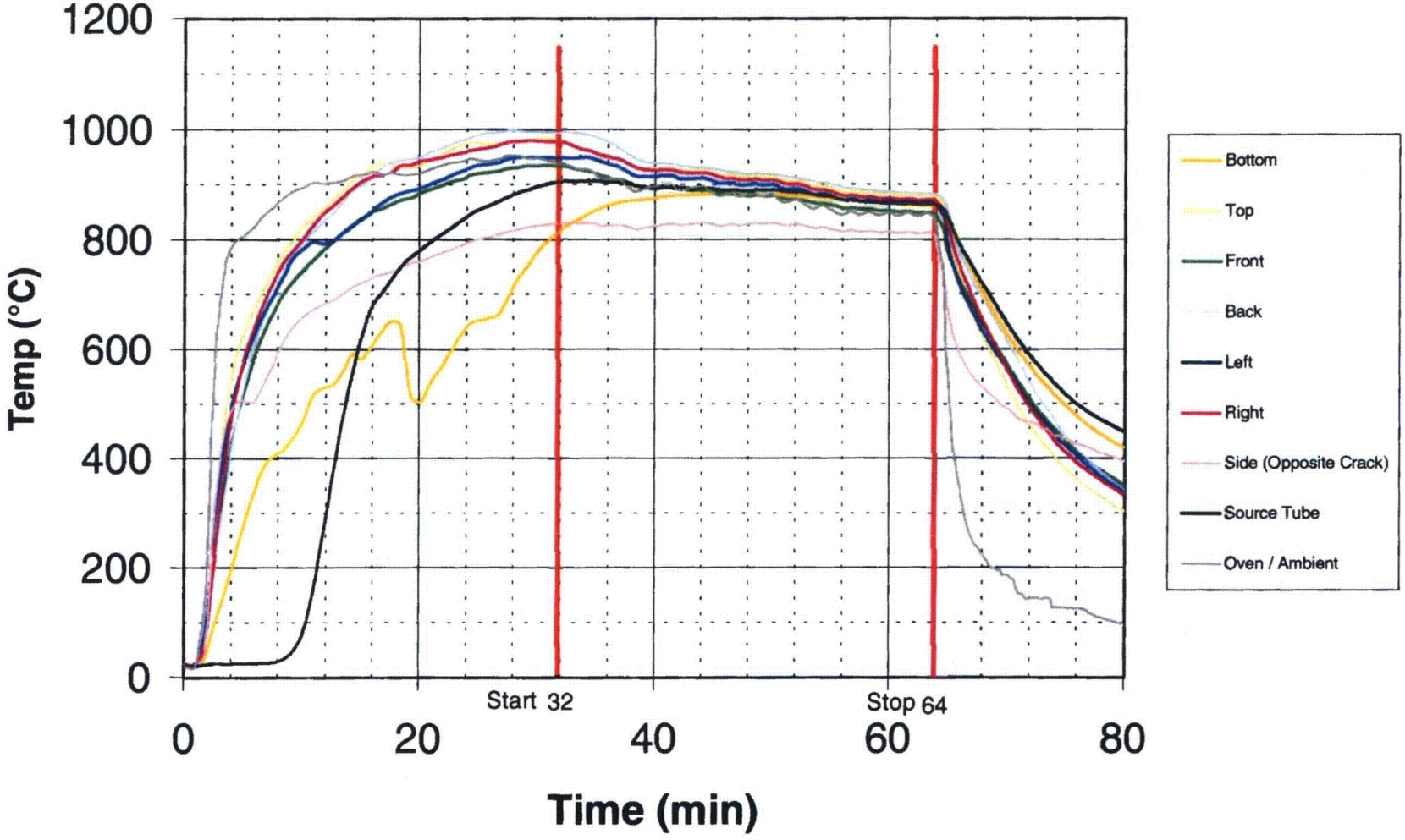
- LOCK ASSEMBLIES REMOVED
- SOURCE TUBE POSITION (TUBES BELOW TOP PLATE)

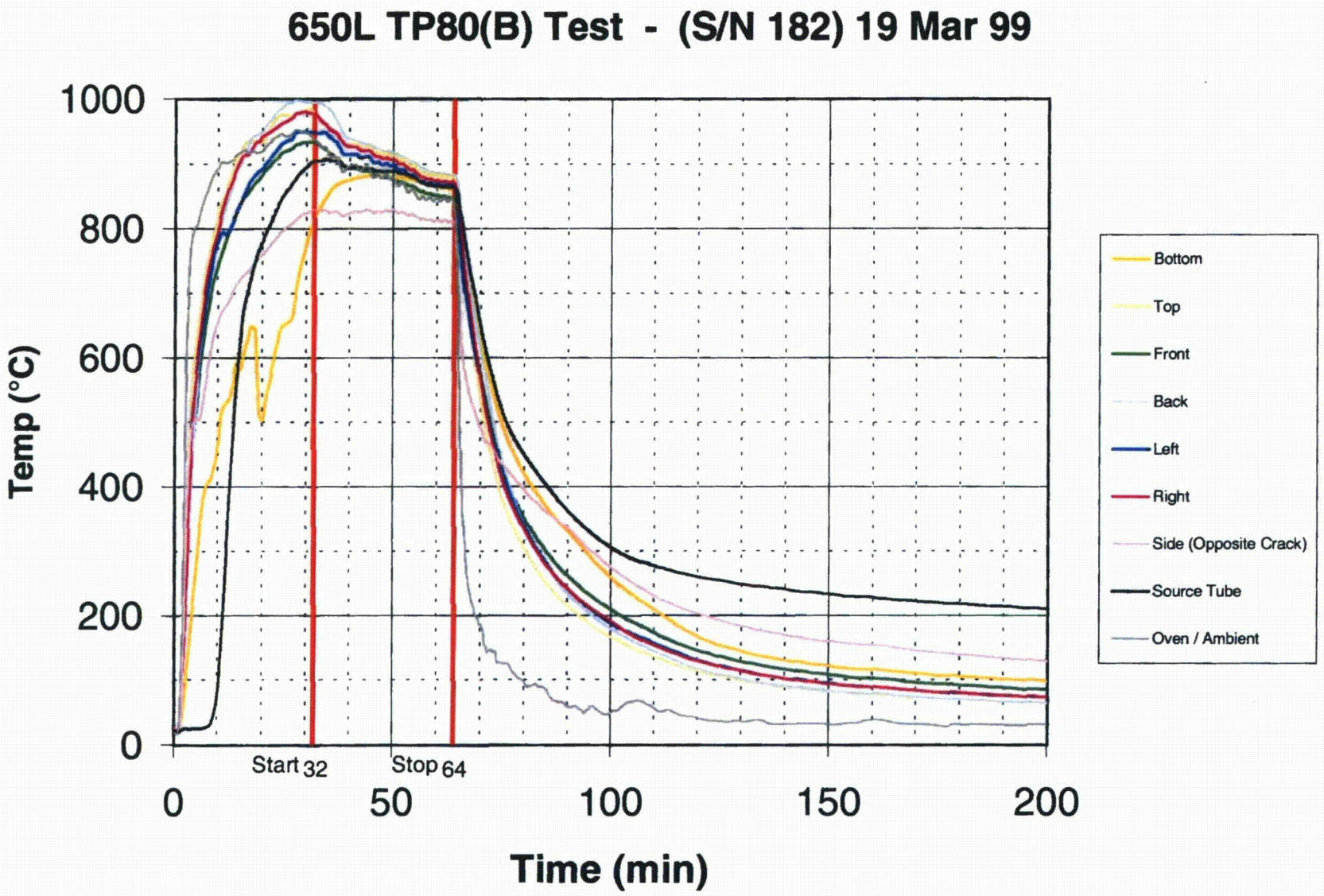


(54 A 1, 54 A 2 THRU 54 D)

24 MAR99

650L TP80(B) Test - (S/N 182) 19 Mar 99




650L TP80(B) Test - (S/N 182) 19 Mar 99
Temp (°C)
1000
800
600
400
200
0
Start 32
Stop 64
0
50
100
150
200
Time (min)
Bottom
Top
Front
Back
Left
Right
Side (Opposite Crack)
Source Tube
Oven / Ambient

SENTINEL TP 80(B) After Thermal Test

SHIELDING PROFILE AND INSPECTION FORM

odel: 650L Serial Number: 182 Radionuclide: I-192 Max.Capacity: 240 Ci

Shield Data

Shield Heat#: _____ Mass of Shield: _____ Lbs. Lot #: _____

Initial Profile

Source Model: _____ Source SN: _____ Activity: _____ Ci

Survey Inst.: _____ SN: _____ Date Cal.: _____ Date Due: _____

Surface	Observed Intensity mR/hr	Surface Correction Factor	NA	Adjusted Intensity mR/hr
Top				
Right			Capacity Correction Factor: _____	
Front				
Left				
Rear				
Bottom				

Inspector: _____ Date: _____ NCR #: _____

Final Profile total = 213.3

Source Model: 424-9 Source SN: C9313/C9312 Activity: 107.3/106 Ci Mass of Device: 83.6 Lbs.

Survey Inst.: Bicron Tech 50 SN: B-816-S Date Cal.: 8 Sep 98 Date Due: 8 Sep 99

	Observed Intensity mR/hr				Adjusted Intensity mR/hr	
Surface	At Surface	Surface Corr. Factor	At One Meter		At Surface	At One Meter
Top			25			28
Right	NA		5			5.6
Front			5	Capacity Correction Factor: 1.125		5.6
Left			7			7.9
Rear			7			7.9
Bottom			1			1.1

Inspector: Cathleen Rogers Date: 3-24-99 NCR #: NA

QI6-1/1

Comments: _____

source SN C9313 - 109.3 Ci on 3-22-99 - 107.3 on 3-24-99 cmn
C9312 108 Ci on 3-22-99 - 106 on 3-24-99

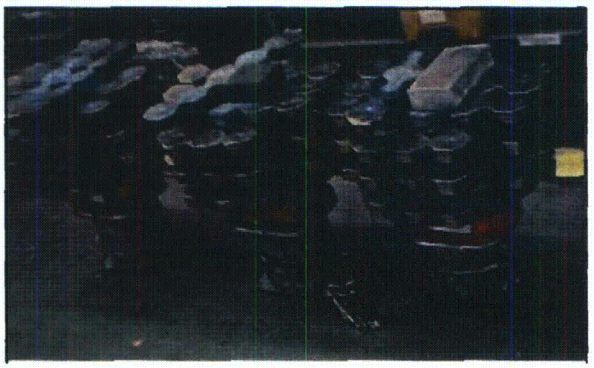
Amersham QSA

Total Activity 3-24-99 = 213.3

APPENDIX D

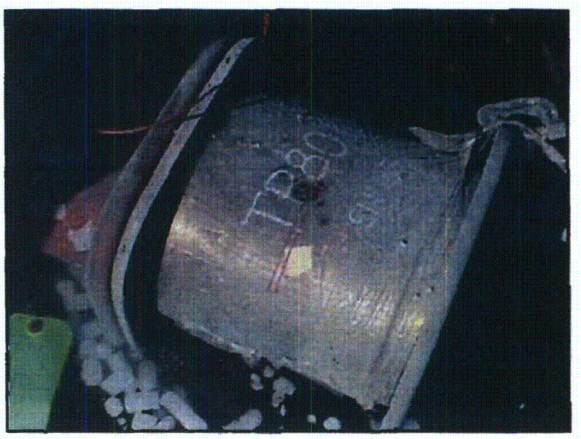
TEST PHOTOGRAPHS

Test Plan 80 Photographs



Compression Test

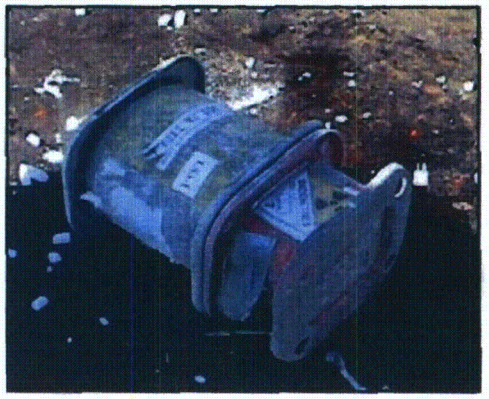
Typical Penetration Test Setup



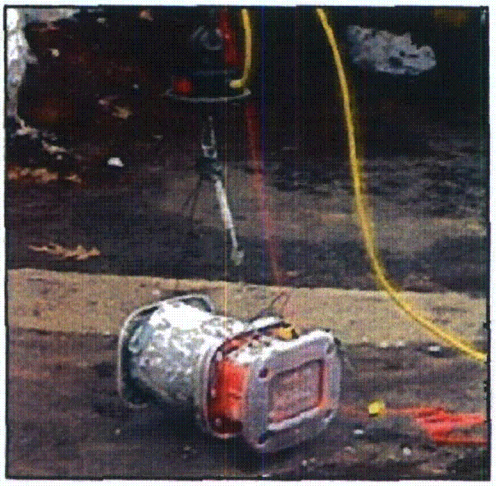
Typical Penetration Impact

Test Plan 80 Photographs

TP80(A) 4 Foot Drop Setup



TP80(A) 4 Foot Drop Results



TP80(A) 30 Foot Drop Setup

TP80(A) 30 Foot Drop Results

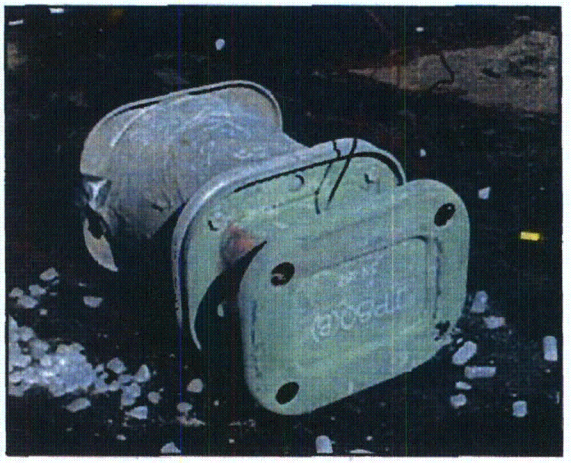
Test Plan 80 Photographs

TP80(A) Puncture Test Setup

TP80(A) Puncture Test Results

Test Plan 80 Photographs

TP80(B) 4 Foot Drop Setup

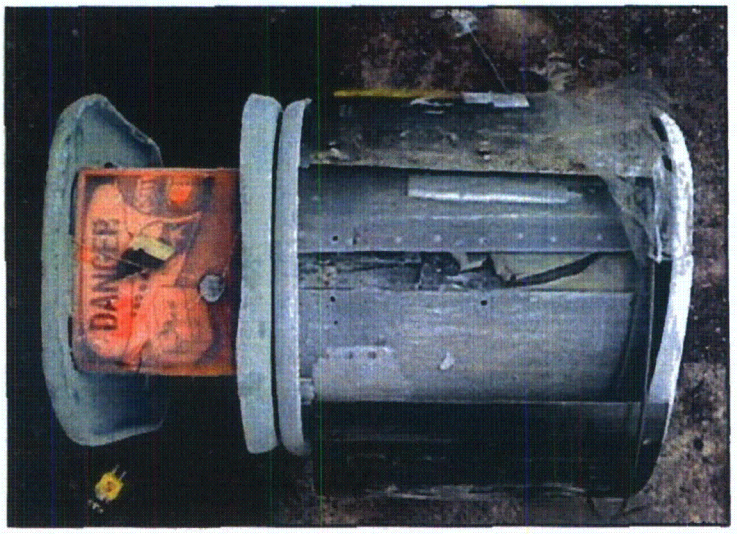


TP80(B) 4 Foot Drop Test Results

Test Plan 80 Photographs

TP80(B) 30 Foot Drop Setup

TP80(B) 30 Foot Drop Results



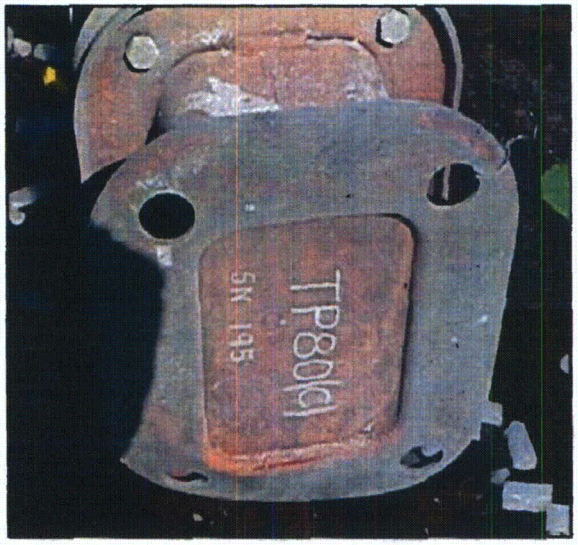
TP80(B) 30 Foot Drop Results

Test Plan 80 Photographs

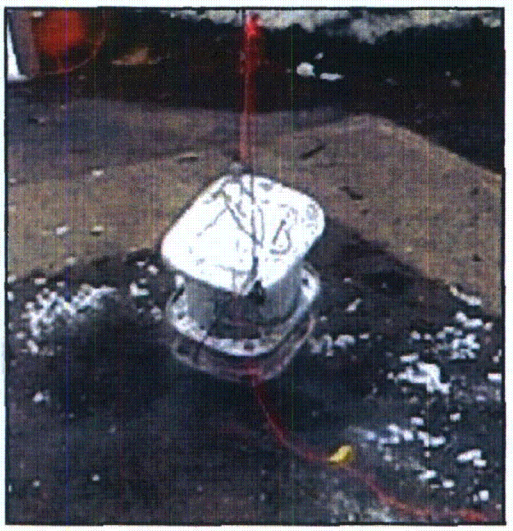
TP80(B) Puncture Test Setup

TP80(B) Puncture Test Results

Test Plan 80 Photographs



TP80(C) 4 Foot Drop Test Results



TP80(C) 30 Foot Drop Setup

TP80(C) 30 Foot Drop Results

TP80(C) 30 Foot Drop Results

Test Plan 80 Photographs

TP80(C) Puncture Drop 1 Setup

TP80(C) Puncture Drop 1 Results

TP80(C) Puncture Drop 2 Setup

TP80(C) Puncture Drop 2 Results Showing Closeup of Rivnut

Test Plan 80 Photographs

TP80(B) Thermal Test Setup

TP80(B) Thermal Test Setup

TP80(B) Thermal Test After Removal From Oven

TP80(B) Thermal Test After Removal From Oven

Test Plan 80 Photographs

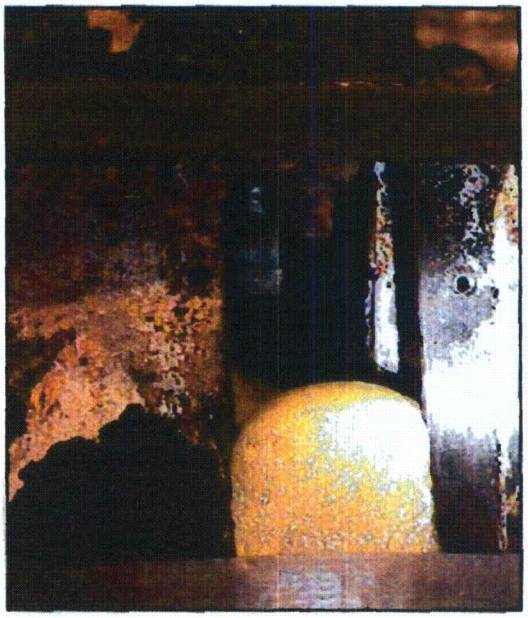
TP80(B) Thermal Test After Removal From Oven

TP80(B) Detail of Cracked Shell

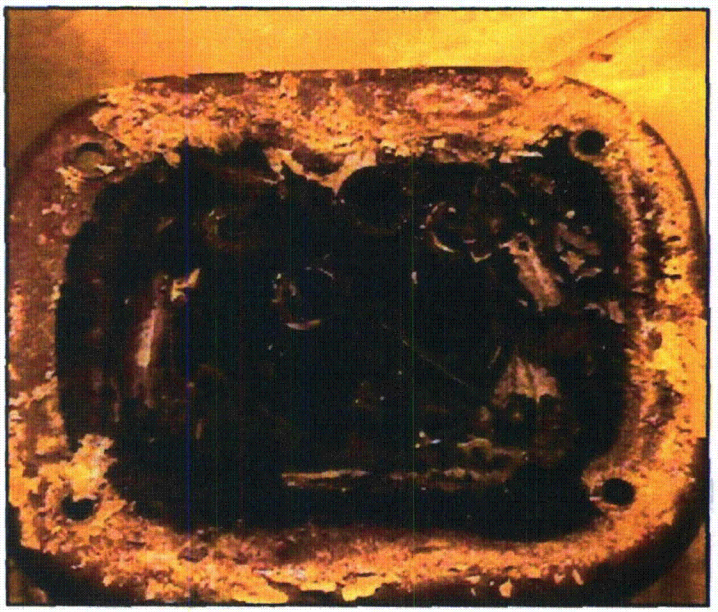
TP80(B) Detail of Uranium Oxide Residue

TP80(B) Detail of Uranium Oxide Residue

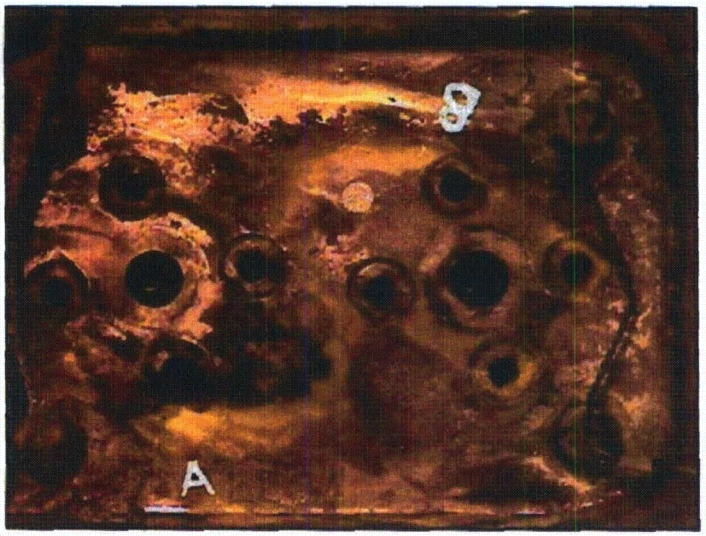
Test Plan 80 Photographs



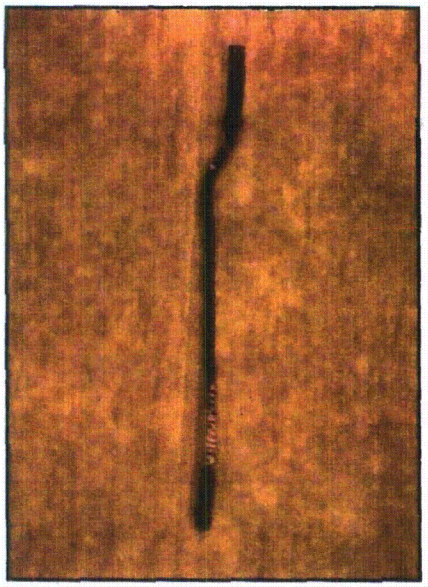
TP80(B) Thermal Test After Removal From Oven--Detail of Crack After Foaming to Stabilize Shield



TP80(B) Thermal Test After Removal From Oven—Lid Removed



TP80(B) Thermal Test After Removal From Oven--Detail of Source Tube Displacement After Removal of Lock Assemblies



TP80(B) Thermal Test After Removal From Oven--Dummy Source Wire--White Mark Shows Top of Source Tube Position

2.12.10 Test Report #1 for Test Plan 188 Rev 1 (minus Sections 7.3 – 7.5)

QSA GLOBAL	Document Number F-E-1808-2 Test Report Cover Sheet	Revision 1

TEST REPORT #1
FOR TEST PLAN 188

Model 880 Pipeliner
ISO 3999:2004(E)
Handle, Attachment Part or Lifting Mount Test

ISO 3999:2004(E)
Radiographic Protection – Apparatus for Industrial Gamma Radiography
Specifications for Performance, Design, and Tests
Sect 5.8.4.3 Tests for Exposure Containers, Handle, Attachment Part or Lifting Mount

Originator	Paul Rice	Date: 14 JUL 2010

APPROVALS		
Engineering		Date: 23 Jun 10
Regulatory		Date: 28 Jun 10
Quality Assurance	C. Roy	Date: 9 Jul 10

Contents Page

Section 1 Introduction

This document describes the mechanical tests and results for the Model 880 Pipeliner Projector to meet the requirements of the following standards

ISO 3999:2004(E), Radiographic protection – Apparatus for Industrial Gamma Radiography
Part 1: Specifications for Performance, Design, And Tests
Section 5.8.4.3 - Handle, attachment part or lifting mount

As part of this test plan the following ISO 3999:2004(E) tests were performed

Section 6.4.3 - Handle, attachment part or lifting mount test.

Section 2 Construction and Acceptance of Test Specimens

This Model 880 assembly used for this device was originally manufactured by QSA Global as a production Model 88015.

The assembly was retrofitted to a PipeLiner configuration by QSA Global production personnel under TMI279.

The PipeLiner retrofit components for this device were supplied and assembled by IRSS.

The device used for this test was previously used for;
Test Plan 187 Model 880 Pipeliner, ISO 3999:2004(E) / ANSI N432 (1980), Endurance Test

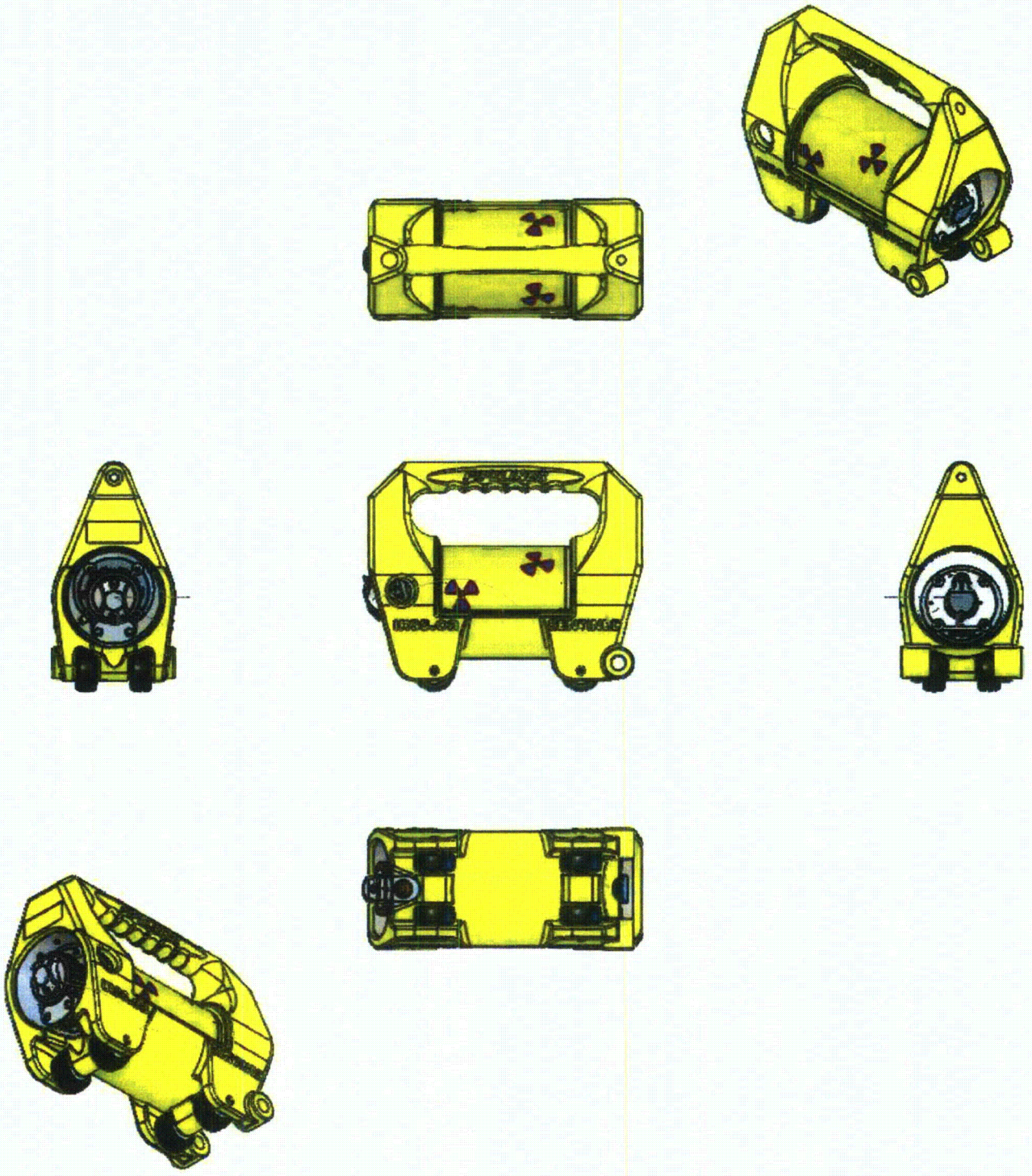


FIGURE 2.1 MODEL 880 PIPELINER PROJECTOR IN STANDARD CONFIGURATION.

Maximum Weight as Shown 55 lbs

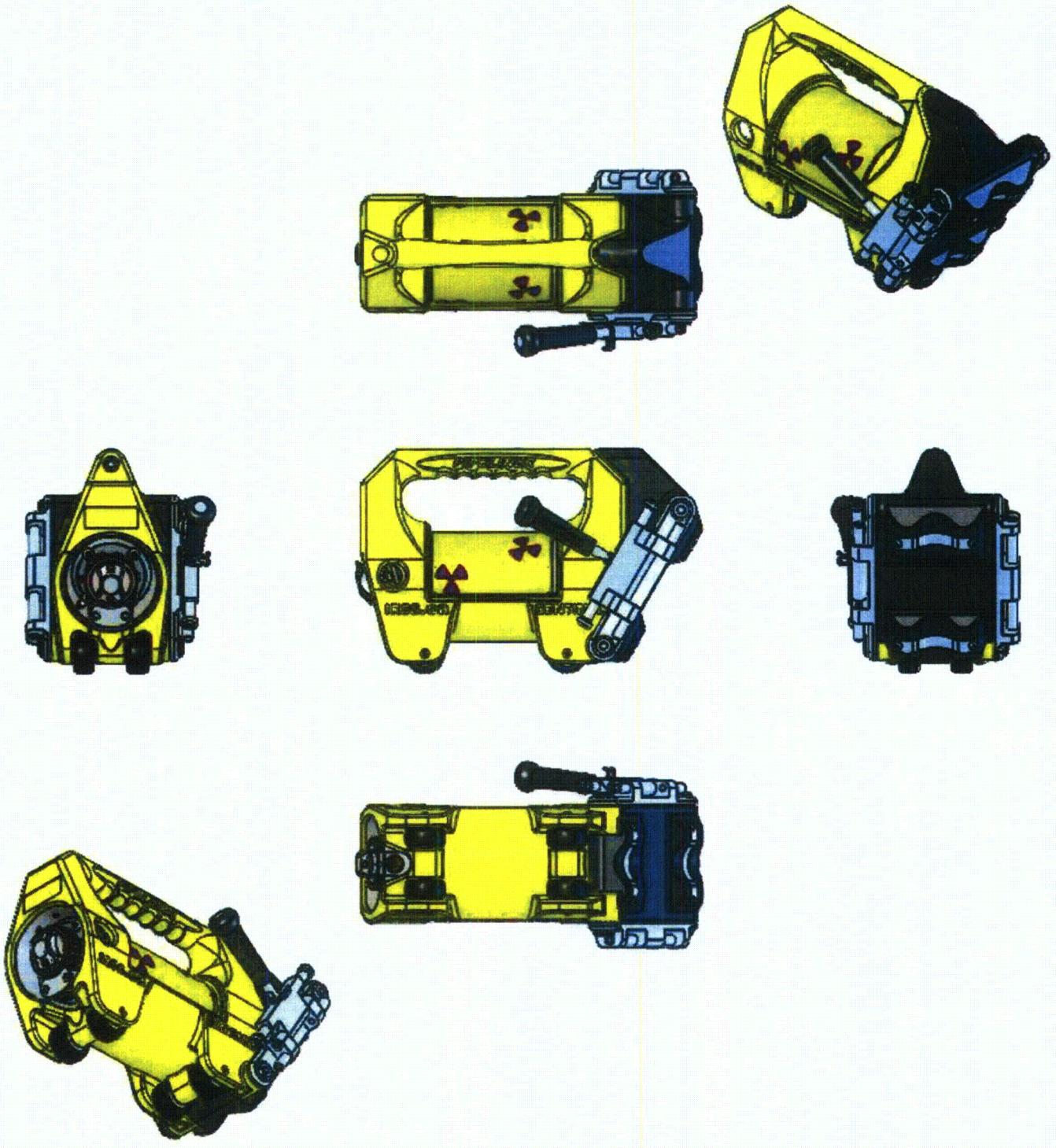


FIGURE 2.2 MODEL 880 PIPELINER PROJECTOR IN PIPELINER CONFIGURATION.

Maximum Weight as Shown 70 lbs

Section 3 Test Objectives

Objectives

The purpose of this test was to demonstrate that the Model 880 Pipeliner projector meets the requirements of;

ISO 3999:2004(E)
Radiographic Protection – Apparatus for Industrial Gamma Radiography
Part 1: Specifications for Performance, Design, and Tests
Sect 5.8.4.3 Tests for Exposure Containers, Handle, Attachment Part or Lifting Mount

Section 4 Test Setup

The test setup was modified from the original test plan.

1. The equipment used is shown in pictures 1 & 2.
2. The setup is shown in picture 3
3. The setup was the same for both configurations, Standard and Pipeliner.
4. The setup consisted of:
   - 4.1. A Walker Model CER.9 electro-magnet rated for 2400 lbs secured to the Drop Test Pad, T10740, S/N 001.
   - 4.2. The magnet was protected from damage by a cork enclosure topped with ½ plywood.
   - 4.3. The Pipeliner test device was secured to the magnet with a 2" wide ratchet strap.
   - 4.4. The load was applied by a fork-truck equipped with a lifting hook attachment.
   - 4.5. The load was measured by a Dillon Model Ed- Junior series digital crane scale rated for 2500 lbs
   - 4.6. The scale was attached to the device handle with a 2" wide lift strap.
   - 4.7. The device to be tested was cooled using dry ice to a temperature ≤ -40° F prior to each test.

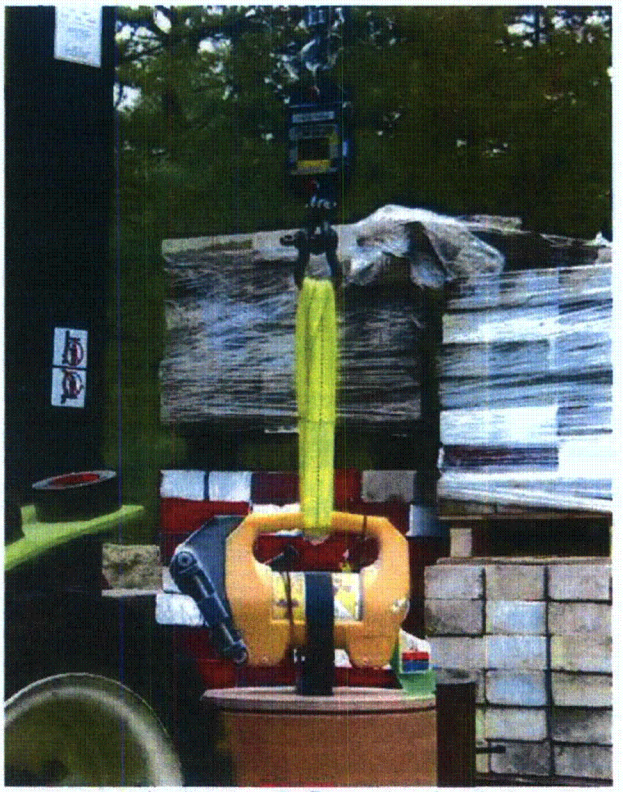
1 Test equipment and camera positions

2 Test equipment

3 Test setup

Section 4 Test Data

4 Standard configuration loaded



5 PipeLiner configuration loaded

The 'Standard' configuration was loaded to 1,568 lbs (25X 62.7 lbs)

The 'PipeLiner' configuration was loaded to 1,768 lbs (25X 70.7 lbs)

Section 5 Final Inspection and Assessment

The PipeLiner handle and jacket assembly was inspected after each test and no damage or permanent deformation was found.
The Pipeliner configuration is not intended for transport, but was tested due to the increased weight and possible affects of the Shoe Mounting Bolt that runs inside the handle in this configuration only. The bolt was removed after the test for inspection and was not bent or damaged.

Section 6 Conclusion

Both configurations evaluated in this report, Standard and PipeLiner, passed and exceeded the requirements of Test Plan 188 and ISO 3999:2004(E) Radiographic Protection – Apparatus for Industrial Gamma Radiography, Part 1: Specifications for Performance, Design, and Tests, Sect 5.8.4.3 Tests for Exposure Containers, Handle, Attachment Part or Lifting Mount.

In both configurations the handle showed no damage or deformation after a load in excess of the 25X requirement was applied. The same device was used for both test configurations and therefore was subjected to the load twice with no damage.

Additionally both configurations of the device were tested and passed at -40° F.

Section 7 Attachments

Section 7.1 Worksheets

Test Plan 188
Handle, Attachment Part or Lifting Mount

Material and Equipment:

Test device (Model 880) serial number: TP186-C Configuration: ☒ Standard ☐ Pipeliner

Weight of test device (Model 880): 53.24 lbs Total weight of test equipment: SCALE ZEROED

Scale: DILLON MODEL ED JR SERIAL # DED71300785

Unit complies with IRSS "Work instruction for performing Pipeliner Retro Fit" Rev 1 _____ Quality Control

Test Procedure:

1. Prepare test specimen as described in "Construction and Condition of Test Specimen".
2. Cool the device to -40° F
3. Secure device to plate and add weight to 25 times weight of test specimen as shown in Fig. 6.1. or 6.2
4. Record the device temperature. -45°F
5. Lift test specimen and weight from middle of handle with crane.
6. Record total weight. 1568 lbs MAX READING. REQUIRED LOAD WAS 1375 lbs
7. Inspect test handle for cracks or other visible damage.

Damage and/or operational malfunctions:

NO DAMAGE TO HANDLE

Test Assessment:

TEST SETUP WAS CHANGED FROM PLAN. THE HANDLE WAS LIFTED BY A FORK TRUCK WHILE SECURED TO THE DROP TEST PLATE. SEE ATTACHED SETUP

THE DEVICE PASSED WITH NO DAMAGE

Recorded by: _____ (PAUL RICE) Date: 11 MAR 2010

Witnessed by: _____ Karl Anderson Date: 16 April 2010

WORKSHEET 8.1 HANDLE, ATTACHMENT PART OR LIFTING MOUNT

Section 8 Test Worksheets

Test Plan 188
Handle, Attachment Part or Lifting Mount

Material and Equipment:

Test device (Model 880) serial number: TP186-C Configuration: ☐ Standard ☒ Pipeliner

Weight of test device (Model 880): 66.68 lbs Total weight of test equipment: Scale Was Zeroed

Scale: Dillon Model EQ-JR Serial # DEDJ1300785

Unit complies with IRSS "Work instruction for performing Pipeliner Retro Fit" Rev 1 _____ Quality Control

Test Procedure:

1. Prepare test specimen as described in "Construction and Condition of Test Specimen".
2. Cool the device to -40° F
3. Secure device to plate and add weight to 25 times weight of test specimen as shown in Fig. 6.1. or 6.2
4. Record the device temperature. -41 °F
5. Lift test specimen and weight from middle of handle with crane.
6. Record total weight. 1768 lbs Max Reading. Required Load Was 1746 lbs
7. Inspect test handle for cracks or other visible damage.

Damage and/or operational malfunctions:

No Damage To Handle

Test Assessment:

Test Setup Was Changed From Plan. The Handle Was Lifted By A Forklift While The Device Was Secured To The Drop Test Pad. See Attached. Setup

The Device Passed With No Damage.

Recorded by: _____ (Paul Ross) Date: 19 Mar 2010

Witnessed by: _____ Karl Anderson Date: 16 April 2010

WORKSHEET 8.1 HANDLE, ATTACHMENT PART OR LIFTING MOUNT

QSA GLOBAL	Document Number **TP188**	Revision **0**

TEST PLAN 188

Model 880 Pipeliner

ISO 3999-1:2004(E)
Handle, Attachment Part or Lifting Mount Test

ISO 3999-1:2004(E)
Radiographic Protection – Apparatus for Industrial Gamma Radiography
Part 1: Specifications for Performance, Design, and Tests
Sect 5.8.4.3 Tests for Exposure Containers, Handle, Attachment Part or Lifting Mount

Originator	Paul Rice	Date: 15 DEC 09

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

CONTENTS PAGE

Section 1 Introduction

This test plan is intended to evaluate only the Pipeliner Jacket Assembly produced by IRSS to the performance requirements of:

ISO 3999-1:2004(E), Radiographic protection – Apparatus for Industrial Gamma Radiography
Part 1: Specifications for Performance, Design, And Tests
Section 5.8.4.3 - Handle, attachment part or lifting mount

The test sequence to be used for the testing is listed in:

Section 6.4.3 - Handle, attachment part or lifting mount test.

This plan outlines the test procedure, describes the test specimen construction, identifies the test equipment, and provides worksheets for test data recording.

The QSA Global Model 880 Radiography Projector assembly and jacket has been tested and approved under previous AEA Technologies and QSA Global test plans

Section 2 Pipeliner Radiography Projector Description

The Model 880 Pipeliner projector, shown in Figure 2.1 & 2.2, is a portable (Class P), externally projecting source (Category II) device. The device consists of two major assemblies; the QSA Model 880 body assembly and the IRSS Pipeliner assembly.

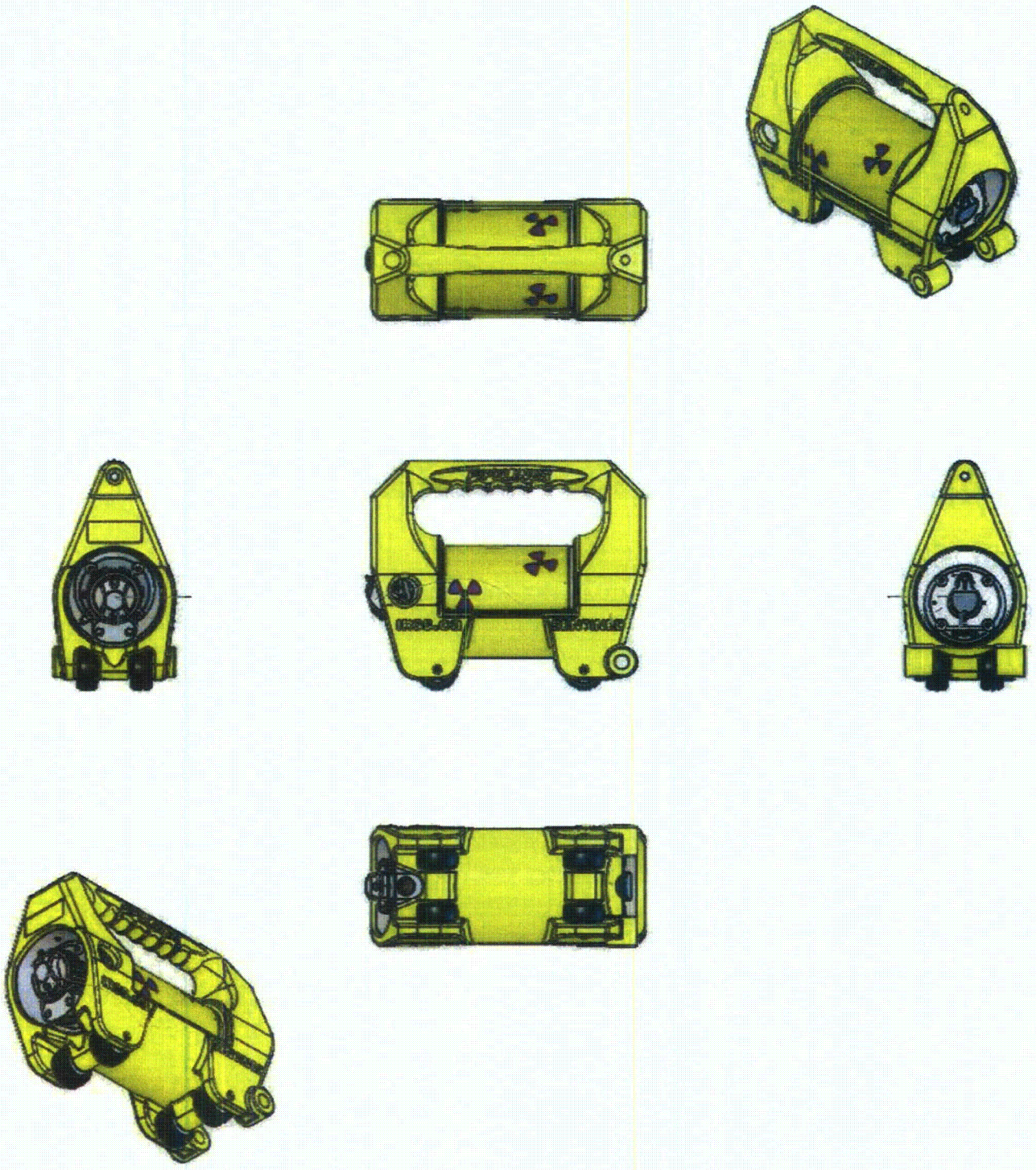


FIGURE 2.1 MODEL 880 PIPELINER PROJECTOR IN STANDARD CONFIGURATION.

Maximum Weight as Shown 55 lbs

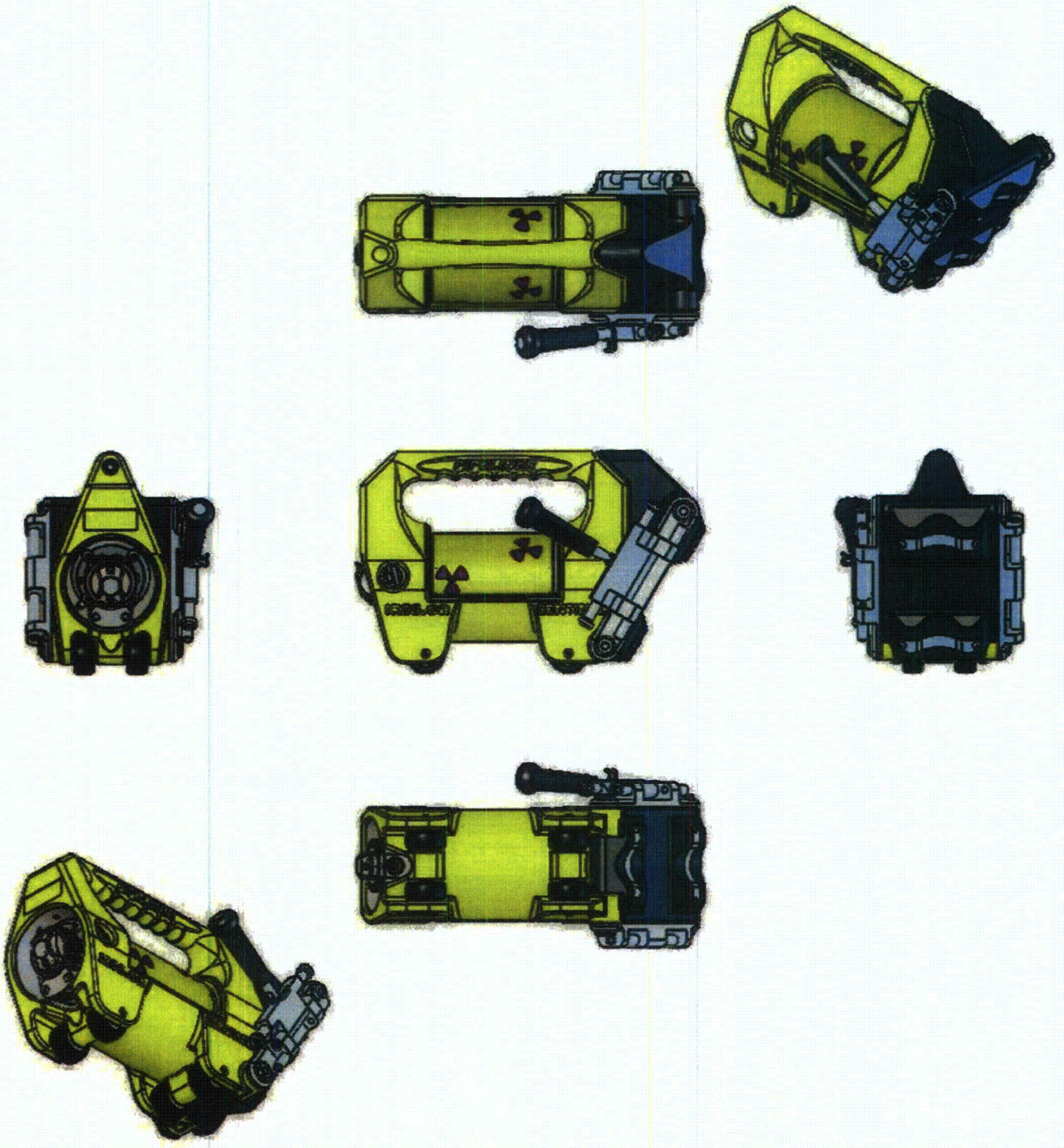


FIGURE 2.2 MODEL 880 PIPELINER PROJECTOR IN PIPELINER CONFIGURATION.

Maximum Weight as Shown 70 lbs

Section 3 Discussion on System Failure Modes of Interest

The Handle, Attachment Part or Lifting Mount Test is used to demonstrate that the handle of the exposure device is able to withstand forces that may be encountered during use.

A failure would be indicated by:

- The handle breaking.
- The handle becoming unattached from the device.

A failure could result in:

- The user not being able to use the handle to carry the device.
- The device being dropped.

The Pipeliner has two configurations:

- Standard, configured without the shoe and collimator assemblies for use with a standard guide tube and collimator.
- Pipeliner, configured with the shoe and collimator assemblies.

In the 'Standard' configuration the total system weight is approximately 55 lbs. In this configuration the handle has a hole, approximately ½" in diameter, extending along its centerline for the full length of the handle.

In the 'Pipeliner' configuration the total system weight is approximately 70 lbs. In this configuration the shoe mounting bolt, a 3/8" diameter stainless steel socket head cap screw, is inserted thru the hole in the handle giving additional support to the plastic jacket.

It is unclear which of these conditions puts the worse load on the handle, the lower load and less support of the 'Standard' configuration or the high load with added support of the 'Pipeliner' configuration.

Since both conditions will commonly be used, both configurations will be tested.

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 the intended area of use this series of tests will be performed with the test units cooled to -40°F.

Section 4 Construction and Condition of Test Specimens

All system components used in this test plan are manufactured in accordance with the QSA Global, Inc. (QSA) or Industrial Radiography Supplies and Services Inc. (IRSS) (as an approved supplier to QSA Global) Quality Assurance Programs

A Pipeliner Jacket, Part Number PL1013 Revision B, manufactured by Industrial Radiography Supplies and Services Inc. (IRSS) is the part to be evaluated.

The Pipeliner assembly 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 specimen used for this test 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 assembly 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.

Section 5 Test Specimen Preparation and Inspection

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

2. Mount the projector in the Pipeliner assembly, IRSS part number PL1000 revision 1, per IRSS instructions for conversion of a standard Model 880 projector titled "Work instruction for performing Pipeliner Retro Fit" Rev 1. This procedure will be done under TMI 279, one of the units built for testing under this TMI will be used for this test.

3. Measure and record the weight of the specimen and must be less than 55 pounds

4. Inspect the test specimen to ensure that:

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

   b. The test specimen complies with the requirements of the drawings and the IRSS assembly instructions.

5. This unit, in the 'Standard' configuration will be used for the first test.

6. After completion of the first test this unit will be reconfigured as specified in the IRSS Pipeliner Operations and Maintenance Manual to the 'Pipeliner' configuration. This involves the installation of the Pipeliner Shoe and Collimator assemblies. A copy of this manual will be included as part of the final test report.

7. Measure and record the weight of the specimen, and must be less than 70 pounds

8. Inspect the test specimen to ensure that:

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

   b. The test specimen complies with the requirements of the drawings and the IRSS assembly instructions.

Section 6 Test Procedures

Requirements

The Handle, Attachment Part or Lifting Mount Test demonstrates that the exposure container handle is able to withstand a static force equal to 25 times the maximum weight of the device. The force is to be applied to the most vulnerable part of the handle. The most vulnerable part of the handle is considered to be the middle of the handle where the most bending stresses will occur.
For the 'Standard' configuration the maximum device weight is 55 lbs requiring a test weight of 1375 lbs.
For the 'Pipeliner' configuration the maximum device weight is 70 lbs requiring a test weight of 1746 lbs.
The test weight is the total of the device weight, the weight of any fixturing and applied load.

Equipment

1. The test IRSS Pipeliner assembly installed on a Model 880 body.
2. A test plate that, when strapped to the device, achieves a total weight of at least 1746 lbs.
3. A scale to verify the weight of the test equipment.
4. Crane or forklift (Lifting Device)
5. Straps as required

Procedure

Preparation the Test Device

The test device is to be cooled to a temperature of -40° F prior to each test.

Test One

1. The test unit in the 'Standard' configuration will be secured to the weight assembly by a web strap or other device as shown in figure 6.1.
2. A two inch wide web strap will be positioned at the center of the handle as shown in the figure.
3. The strap will be connected to the scale and the scale will be connected to the lifting device.
4. The temperature of the device will be recorded.
5. The test assembly will be raised clear of all supports and a total weight reading will be recorded.
6. The weight will remain suspended for one minute.
7. The handle will be inspected for damage or failure.

8. If the handle has passed this test the device will be reconfigured for test two.

Test Two

9. The test unit in the 'Pipeliner' configuration will be secured to the weight assembly by a web strap or other device as shown in figure 6.2.
10. A two inch wide web strap will be positioned at the center of the handle as shown in the figure.
11. The strap will be connected to the scale and the scale will be connected to the lifting device.
12. The temperature of the device will be recorded.
13. The test assembly will be raised clear of all supports and a total weight reading will be recorded.
14. The weight will remain suspended for one minute.
15. The handle will be inspected for damage or failure.
16. If the handle has passed this test the device will be reconfigured for test two.
17.

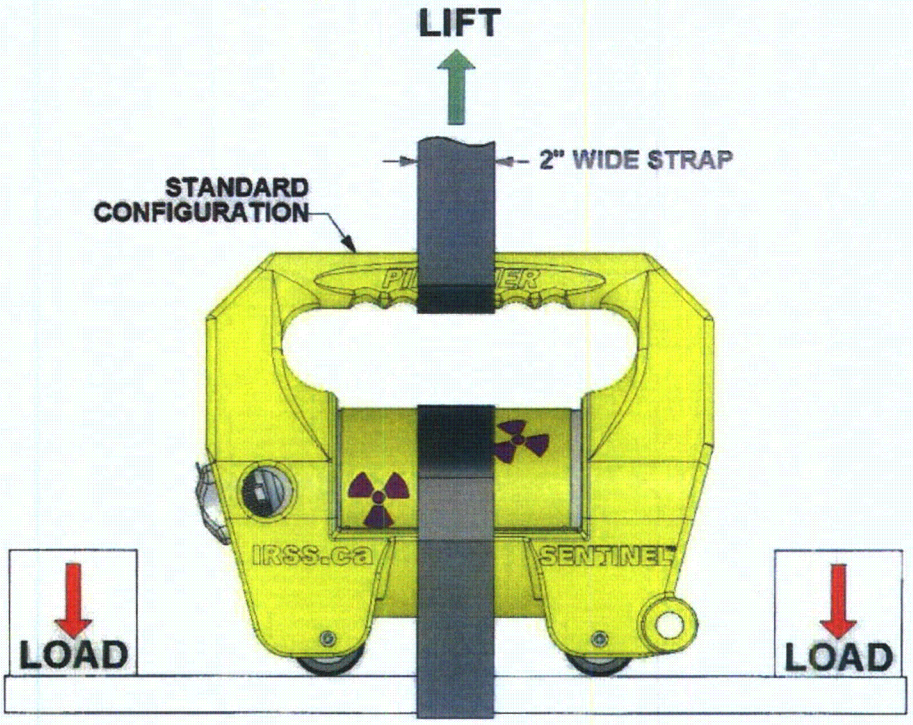


FIGURE 6.1 MODEL 880 PIPELINER - STANDARD CONFIGURATION TEST SETUP

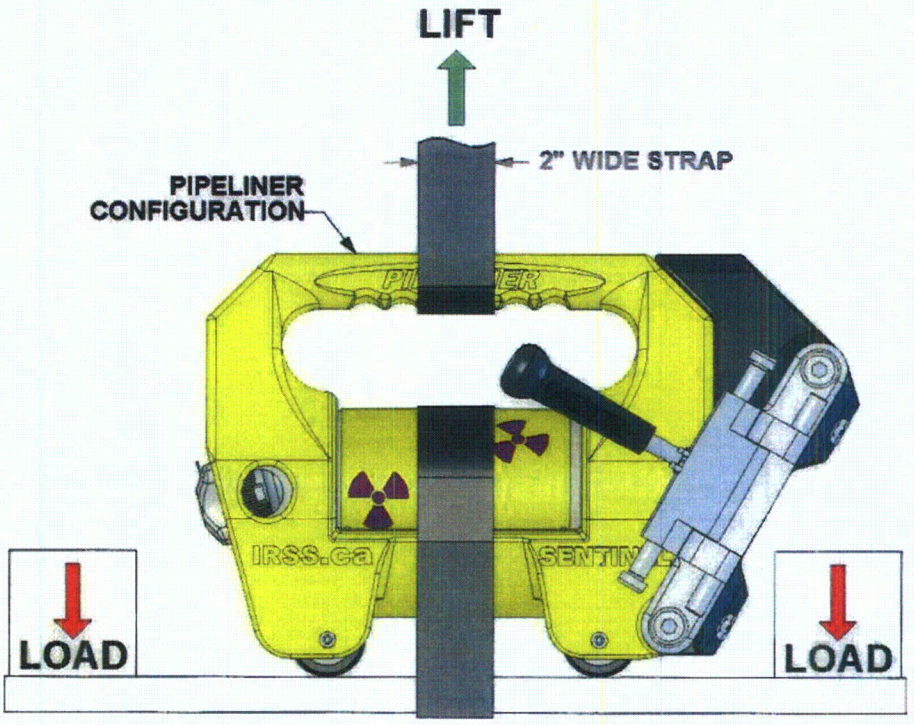


FIGURE 6.2 MODEL 880 PIPELINER - PIPELINER CONFIGURATION TEST SETUP

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 the requirements of ISO 3999-1:2004(E), Part 1: Section 5.8.4.3
- **Quality Control** is responsible for ensuring test and specimen data is measured and recorded throughout the test cycle.

Section 7 Final Test Assessment

After all the tests have been completed, evaluate the condition of the test specimen and assess its performance relative to the test requirements of standard:

ISO 3999-2004(E), Radiographic Protection – Apparatus for Industrial Gamma Radiography
Part 1: Specifications for Performance, Design, and Tests
Sect 5.8.4.3 Tests for Exposure Containers, Handle, Attachment Part or Lifting Mount

Test Plan 188
Handle, Attachment Part or Lifting Mount

Material and Equipment:

Test device (Model 880) serial number: _____ Configuration: ☐ Standard ☐ Pipeliner

Weight of test device (Model 880): _____ Total weight of test equipment: _____

Scale: _____

Unit complies with IRSS "Work instruction for performing Pipeliner Retro Fit" Rev 1 _____

Quality Control

Test Procedure:

1. Prepare test specimen as described in "Construction and Condition of Test Specimen".
2. Cool the device to -40° F
3. Secure device to plate and add weight to 25 times weight of test specimen as shown in Fig. 6.1. or 6.2
4. Record the device temperature. _____
5. Lift test specimen and weight from middle of handle with crane.
6. Record total weight. _____
7. Inspect test handle for cracks or other visible damage.

Damage and/or operational malfunctions:

_____

_____

_____

_____

Test Assessment:

_____

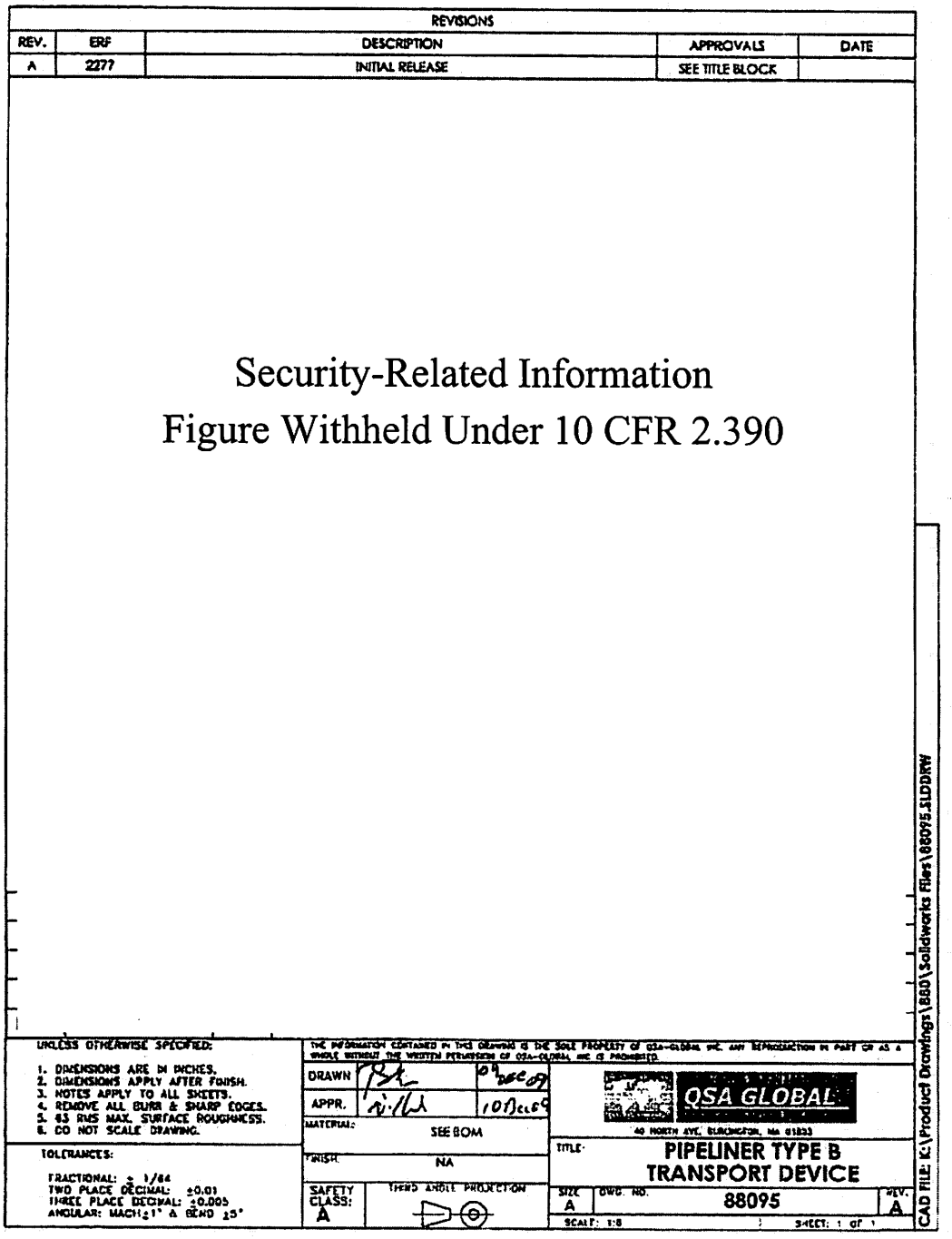
_____

_____

Recorded by: _____ Date: _____

Witnessed by: _____ Date: _____

WORKSHEET 8.1 HANDLE, ATTACHMENT PART OR LIFTING MOUNT



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

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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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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: 1:8 | SHEET: 1 OF 1

CAD FILE: K:\Product Drawings\8801\Solidworks Files\88095.SLDDRW

ATTACHMENT 9.1 DRAWING 88095 REV A, PIPELINER TYPE B TRANSPORT DEVICE

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

Security-Related Information
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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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APPR. [illegible] 10 Dec 09
MATERIAL: SEE BOM
FINISH: NA
SAFETY CLASS: A
THIRD ANGLE PROJECTION

QSA GLOBAL
43 NORTH AVE, BURLINGTON, MA 01803

TITLE: PIPELINER ASSEMBLY
SIZE A | DWG NO 88095-1 | REV. A
SCALE: 1:8 | SHEET: 1 OF 1

CAD FILE: K:\Product Drawings\880\Solidworks Files\88095-1.SLDDRW

ATTACHMENT 9.2 DRAWING 88095-1 REV A, PIPELINER ASSEMBLY