8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 ACCEPTANCE TESTS

Prior to the first use of the 3-60B package, the following tests and evaluations will be performed:

8.1.1 Visual Inspections and Measurements

Throughout the fabrication process, confirmation by visual examination and measurement are required to be performed to verify that the 3-60B packaging dimensionally conforms to drawing C-002-165024-001 in Appendix 1.3.

The packaging is also required to be visually examined for any adverse conditions in materials or fabrication that would not allow the packaging to be assembled and operated per Section 7.0 or tested in accordance with the requirements of Section 8.0.

8.1.2 Weld Examinations

8.1.2.1 Containment boundary welds identified on drawing C-002-165024-001 are required to be inspected and are required to meet the acceptance requirements of ASME Code, Section III, Div. I, Subsection ND, Article ND-5000.

8.1.2.2 The Containment boundary welds listed below are required to be inspected by radiographic examination (RT) and are required to meet the acceptance requirements of ASME Code, Section III, Div. I, Subsection ND, Article ND-5320. On drawing C-002-165024-001, the welds to be examined by RT are:

a. Weld between Item 6, Bolting Ring and Item 13, Inner Cask Shell (3/4").
b. Weld between Item 13, Inner Cask Shell and Item 14, Cask Cavity Bottom Plate (3/4")
c. Any seam welds on Item 13, Inner Cask Shell

8.1.2.3 Non-containment boundary welds identified on drawing C-002-165024-001 are required to be inspected and are required to meet the acceptance requirements of ASME Code, Section III, Div. I, Subsection ND, Article ND-5000 or NF, Article NF-5000.

8.1.2.4 The Non-containment boundary welds listed below are required to be inspected by ultrasonic examination (UT) and are required to meet the acceptance requirements of ASME Code, Section III, Div. I, Subsection ND, Article ND-5330 or NF, Article NF-5330. On drawing C-002-165024-001, the welds to be examined by UT are:

a. Weld between Item 6, Bolting Ring and Item 7, Outer Cask Shell (1¼").
b. Weld between Item 7 and Item 10, Cask Bottom Forging
c. Weld between Item 10 and Item 11, Cask Bottom Plate (3")

8.1.2.5 Welds on lifting and tiedown trunnions identified on drawing C-002-165024-001 are required to be inspected by liquid penetrant examination (PT) and are required to meet the acceptance requirements of ASME Code, Section III, Div. I, Subsection ND, Article NF-5350. Inspection shall be before and after 150% load test.

8.1.3 Structural and Pressure Tests

A pressure test of the containment system will be performed as required by 10CFR71.85. As determined in Section 3.4.4, the maximum normal operating pressure for the cask cavity is 35 psig, therefore the minimum test pressure will be 1.5 x 35 = 52.5 psig. The hydrostatic test pressure will be held for a minimum of 10 minutes prior to initiation of any examinations. Following the 10 minute hold time, the cask body, lid and lid/body closure shall be examined for leakage. Any leaks, except from temporary

connections, will be remedied and the test and inspection will be repeated. After depressurization and draining, the cask cavity and seal areas will be visually inspected for cracks and deformation. Any cracks or deformation will be remedied and the test and inspection will be repeated.

8.1.4 Leakage Tests

This test shall be performed prior to acceptance and operation of a newly fabricated package, in accordance with ASTM E-427 using a halogen leak detector or ASTM E-499 using a helium leak detector depending on the test gas used; and capable of meeting the appropriate sensitivity requirements specified in Figures 4.7, 4.11 or 4.14 in Section 4.0. Calibration of the leak detector shall be performed using a leak rate standard traceable to NIST. The leak standard's setting shall correspond to the approved leak test rate (see Section 4.0). Referring to Fig. 4.1, the cavity of the 3-60B will be evacuated to a minimum vacuum of 20"Hg, and then be pressurized to a minimum pressure of 25 psig with pure dichlorodifluoromethane (R-12) or 1,1,1,2 – tetrafluoroethane (R-134a). If helium is used, the cavity of the 3-60B will be evacuated to a minimum vacuum of 20"Hg, and then be pressurized to a minimum pressure of 1 psig. Check for leakage of the inner (containment) O-ring via the test port in the lid.

The vent and drain penetrations will be similarly tested as above by evacuating and pressurizing the inlet (cavity) side of the penetration and checking for leaks at the outlet side. Refer to Figures 4.2 and 4.3.

The maximum allowable leak rate (which is temperature dependent) is specified in Section 4.6, 4.10, or 4.13 (depending on the test gas used). Any condition, which results in leakage in excess of this value, shall be corrected and re-tested.

The requirements for Periodic Leak Testing of the 3-60B are summarized in Table 8.1.

8.1.5 Component and Material Tests

Energy*Solutions* will apply its USNRC approved 10CFR71 Appendix B Quality Assurance Program, which implements a graded approach to quality based on a component's or material's importance to safety consistent with the guidance provided in NUREG/CR-6407 (Reference 4-23) to assure all materials used to fabricate and maintain the 3-60B are procured with appropriate documentation which meet the appropriate tests and acceptance criteria for packaging materials.

This includes as example:
ASTM steel material used for shells, lids, bolts, etc. will comply with and meet ASTM manufacturing requirements.
O-rings will meet GSA spec AA-595588 or equal.
The impact limiter foam will meet the requirements of ES-M-172, which is included in Appendix 8.3.1.

Table 8.1
Periodic Leak Test of 3-60B

Component	Test Gas	Max. Leak Rate	Min. Sensitivity	Test Pressure	Procedure
Lid	R-12	Fig. 4.6	Fig. 4.7	Evacuate cask cavity to 20" Hg then pressurize to 25 psig.	After pressurizing the cask cavity with the test gas, check for gas leakage from the cask Lid inner O-ring using the cask Lid test port (See Fig. 4.1).
	R-134a	Fig. 4.10	Fig. 4.11		
	Helium	Fig. 4.13	Fig. 4.14	Evacuate cask cavity to 20" Hg then pressurize to 1 psig.	
Vent Port	R-12	Fig. 4.6	Fig. 4.7	Evacuate cask cavity to 20" Hg then pressurize to 25 psig.	After pressurizing the cask cavity with the test gas, check for gas leakage from the Vent Port Plug inner O-ring using the test port in Vent Port Plug (See Fig. 4.2).
	R-134a	Fig. 4.10	Fig. 4.11		
	Helium	Fig. 4.13	Fig. 4.14	Evacuate cask cavity to 20" Hg then pressurize to 1 psig.	
Drain Port	R-12	Fig. 4.6	Fig. 4.7	Evacuate cask cavity to 20" Hg then pressurize to 25 psig.	After pressurizing the cask cavity or Drain Port inlet with the test gas, check for gas leakage from the Drain Port seal at the Drain Port outlet (See Fig. 4.3).
	R-134a	Fig. 4.10	Fig. 4.11		
	Helium	Fig. 4.13	Fig. 4.14	Evacuate cask cavity to 20" Hg then pressurize to 1 psig.	

8.1.6 Shielding Tests

Shielding integrity of the packaging will be verified by gamma scan or gamma probe methods to assure the packaging is free of significant voids in the poured shield annulus. All gamma scanning will be performed on a 4-inch square or less grid system. The acceptance criteria will be that voids resulting in shield loss in excess of 10% of the normal lead thickness in the direction measured shall not be acceptable. Any results not meeting this requirement will be remedied and the test and inspection will be repeated.

8.1.7 Thermal Tests

No thermal acceptance testing will be performed on the 3-60B packaging. Refer to the Thermal Evaluation, Section 3.0 of this report.

8.1.8 Miscellaneous Tests

No other testing is required on the 3-60B.

8.2 MAINTENANCE PROGRAM

Energy*Solutions* operates an ongoing preventative maintenance program for all shipping packages. The 3-60B package will be subjected to routine and periodic inspection and tests as outlined in this section and the approved procedure based on these requirements. Defective items are replaced or remedied, including testing, as appropriate.

Examples of inspections performed prior to each use of the cask include:

Cask Seal Areas: O-rings are inspected for any cracks, tears, cuts, or discontinuities that may prevent the o-ring from sealing properly. O-ring seal seating surfaces are inspected to ensure they are free of scratches, gouges, nicks, cracks, etc. that may prevent the o-ring from sealing properly. Defective items are replaced or remedied, as appropriate and tested in accordance with Section 8.1.4.

Cask bolts, bolt holes, and washers are inspected for damaged threads, severe rusting or corrosion pitting. Defective items are replaced or remedied, as appropriate.

Lift Lugs/Trunnions and visible lift lug welds are inspected to verify that no deformation of the lift lug/trunnion is evident and that no obvious defects are visible. Defective items are replaced or remedied, as appropriate and tested in accordance with Section 8.1.2.5.

8.2.1 Structural and Pressure Tests

No routine or periodic structural or pressure testing will be performed on the 3-60B packaging.

8.2.2 Leakage Tests

8.2.2.1 Periodic Leak Test.

The 3-60B packaging shall have been leak tested as described in Section 8.1.4 within the preceding 12-month period before actual use for shipment and after seal replacement.

The 3-60B packaging seals shall have been replaced within the 12-month period before actual use for shipment.

8.2.2.2 Pre-Shipment Leak Test.

a. This test is required before each shipment of Type B material quantities. The test will verify that the containment system has been assembled properly.

Note: The pre-shipment leak test is not required before a shipment if the contents meet the definition of low specific activity materials or surface contaminated objects in 10CFR71.4, and also meet the exemption standard for low specific activity materials or surface contaminated objects in 10CFR71.14(b)(3)(i).

b. The test will be performed by pressurizing the annulus between the O-ring seals of either the lid or vent port, as applicable, or inlet to the drain lines with dry air or nitrogen.

Note: The pre-shipment leak test is typically performed using a test manifold that may be constructed from tubing, fittings, isolation valves and a pressure gauge. Any test apparatus used for this test must have an internal volume, with isolation valves closed and the apparatus connected to the test port location, of less than or equal to 31.6 cm^3 to achieve the required test sensitivity for the hold time specified in Section 8.2.2.2.d.

Note: If air is used for the test, the air supply should be clean and dry. If it is not, or if the quality of the air supply is uncertain, the test should be performed with nitrogen to ensure reliable results.

c. The test shall be performed using a pressure gauge, accurate within 1%, or less, of full scale.

d. The test pressure shall be applied for at least 15 minutes for the lid, vent port, or drain port. A drop in pressure of greater than the minimum detectable amount shall be cause for test failure. The maximum sensitivity of the gauge shall be 0.1 psig.

e. Sensitivity at the test conditions is equivalent to the prescribed procedure sensitivity of 10^{-3} ref-cm^3/sec based on dry air at standard conditions as defined in ANSI N14.5-1997 (See Section 4.5 for the determination of the test conditions).

Table 8.2 summarizes pre-shipment leak test requirements for the 3-60B:

Table 8.2
Pre-Shipment Leak Test of 3-60B Components

Component	Hold Time	Procedure
Lid	15 min.	Connect test manifold to the test port. Pressurize void between O-rings with the test gas, close the isolation valves and hold for the minimum hold time. A drop in pressure of greater than the minimum detectable amount shall be cause for test failure.
Vent Port	15 min.	
Drain Port	15 min.	Remove the threaded cap covering the drain port. Connect test manifold to the drain port. Pressurize the seal and head of the drain port plug for the minimum hold time. A drop in pressure of greater than the minimum detectable amount shall be cause for test failure.

8.2.3 Component and Material Tests

Cask seals are inspected each time the cask lid, vent port or drain port are removed. Inspection and replacement of the seal is discussed in Section 8.2.

New seals are lightly coated with a lightweight lubricant such as Parker Super O-Lube or equivalent prior to installation. The lubricant will minimize deterioration or cracking of the elastomer during usage and tearing if removal from the dovetail groove is necessary for inspection. Coating the exposed surfaces of installed lid seals with the lightweight lubricant immediately prior to closing the lid can help to minimize deterioration or cracking of the seal during use. Excess lubricant should be wiped off before closing the lid.

Painted surfaces, identification markings, and match marks used for closure orientation shall be visually inspected to ensure that painted surfaces are in good condition, identification markings are legible, and that match marks used for closure orientation remain legible and are easy to identify.

8.2.4 Thermal Tests

No periodic or routine thermal testing will be performed on the 3-60B packaging.

8.2.5 Miscellaneous Tests

No other testing is required on the 3-60B.

8.3 APPENDICES

8.3.1 Appendix

Polyurethane Foam Specification ES-M-172

CHEM-NUCLEAR SYSTEMS

	PRINTED OR TYPED NAME	SIGNATURE	DATE
PREPARER:	Charles R. Witt	On File	9/30/99
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DOCUMENT TITLE:

Specification for Rigid Polyurethane Foam For Impact Limiters

DOCUMENT NO.	REV.	PAGE
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1.0 SCOPE

1.1 Purpose

This document provides the technical specification for polyurethane foam that is used as the impact absorber for Chem-Nuclear's licensed transport casks.

1.2 Prerequisites

The impact limiter shells shall be fabricated in accordance with an approved Chem-Nuclear Specification for equipment fabrication.

1.3 Priority

1.3.1 Requirements listed in this specification must be followed. Additional requirements can be added by use of Equipment Data Sheets, but these must not materially change the foam properties, nor reduce the testing requirements given in this specification.

1.3.2 In the event of any conflicts between this procurement specification and any referenced documents, it shall be the responsibility of the fabricator to notify CNS and obtain a resolution from the authorized CNS representative.

2.0 REFERENCES

2.1 ASTM D1621-94: "Compressive Properties of Rigid Cellular Plastics"

2.2 TM 9704, Rev. J, "Test Method for Quality Assurance of Crash Resistant Polyurethane Foam," General Plastics Manufacturing Co., Tacoma, WA, September 1998.

2.3 ASTM F-501-93: "Aerospace Materials Response to Flame, With Vertical Test Specimen (For Aerospace Vehicles Standard Conditions)"

3.0 MATERIAL

3.1 Type

The finished foam product shall be a closed cell polyurethane plastic foam of the self-extinguishing variety of the density specified. The closed cell configuration will ensure that the foam will not be susceptible to significant water absorption. General Plastics Manufacturing Company type FR-3700 or FR-6700, or equivalent, shall be used.

3.2 Density

3.2.1 Rigid polyurethane foam shall have a nominal density of 24 - 26 lbs/ft^3.

3.2.2 Density shall be determined in accordance with Reference 2.2.

3.2.3 One sample shall be taken per batch and tested in accordance with 3.2.2.

3.3 Mechanical Properties

3.3.1 The average stress-strain properties of the foam material, measured perpendicular to the direction of rise, shall be determined from the results of tests performed in accordance with TM-9704 (Reference 2.2), which substantially complies with ASTM D1621 (Reference 2.1). The average of the results of all tests shall be within the $\pm$10% limit shown in the stress-strain diagram given in Appendix A at 10, 30, 50, 60, and 70 percent strain.

3.3.2 A minimum of three samples per impact limiter will be taken and the average values determined in accordance with 3.3.1 shall be plotted on a copy of the stress-strain curve in Appendix A and provided with the documentation package required by this specification.

3.4 Flame Retardant Characteristics

Flame retardancy testing shall be performed for each foam batch per the requirements of ASTM F-501 (Reference 2.3) with the following exceptions:

a) A 50 x 30 x 18 inch draft free cabinet may be used in lieu of Figure 3 of ASTM F-501.

b) A 6 inch rule may substitute for the flame indicator in F-501, paragraph 2.2.2.

c) Specimen conditioning shall be a minimum of 12 hours at 70 to 80°F and 40-60% relative humidity. Test conditions shall be 70 to 80°F and 30-70% relative humidity.

d) Conditioning and environmental conditions do not have to be reported if within the limits shown in (c) above, but must be attested to on the flame test record.

e) Nominal specimen size shall be 0.5±.030 thick x 3.0 wide x 7.0 inches minimum length.

f) Flame application time shall be 60±1 sec. (and shall be reported as 60 seconds nominal).

g) The test data shall be recorded by the Supplier and reviewed by the buyer's Quality Assurance representative to verify the following acceptance criteria are met:

i) The average burn length shall not exceed six inches.

ii) The average flame time after removal of the flame source shall not exceed fifteen seconds.

iii) After falling, drippings from the test specimen shall not continue to flame for more than an average of three seconds.

3.5 Test Requirements

Testing, measuring, and other similar functions shall be performed using approved equipment with sufficient sensitivity to meet the requirements of this specification. All equipment used shall show evidence of valid calibration.

Personnel performing these tests shall be familiar with the testing methods. Training and qualification records shall be available for review.

4.0 MATERIAL INSTALLATION

4.1 The component chemicals may be summarized as an A/B system. The mix ratio will be in the proportion used to meet the requirements of this specification.

4.2 The component materials shall be combined and mixed to provide a mixture of uniform consistency. Evidence of uniform consistency is provided by the resultant foam meeting all physical properties in this specification.

4.3 The liquid foam material shall be “poured in place” within surrounding walls of the impact limiter shell. The liquid components must react to form the rigid foam and rise in such a way that the required volume is filled with expanded foam.

4.4 Steel Surface Preparation: Steel surfaces, that will contact the foam, must be clean and dry to provide a consistent interface between the foam and the steel.

4.5 Shoring: Bracing and shoring for all surrounding assembly walls shall be provided as necessary to prevent distortion due to internal foaming pressures. The method used must allow the container to meet its required dimensions and dimensional tolerances.

4.6 The Company shall submit its foam filling and pouring procedure to Chem-Nuclear for review prior to start of foaming the impact limiters.

5.0 CHEMICAL COMPOSITION

The foam will be a rigid polyether polyurethane formed as reaction product of the primary chemicals: polyphenylene, polymethylene, polyisocyanate (polymeric isocyanate) and polyoxypropylene glycols (polyether polyols). These materials react to produce a rigid polyether polyurethane foam. The foam will not contain halogen containing flame retardants nor trichloromonofluoromethane (Freon 11).

6.0 QUALITY ASSURANCE

6.1 Production Record and Certification

6.1.1 Production Record: A foam pouring record shall be compiled during the foaming operation. Each production pour made into the assembly and any sample taken for testing shall be completely recorded. All testing and production pour evaluations shall be adequately documented so as to provide objective evidence of production, inspection and test.

6.1.2 Certification: A certification referencing the production record data and all testing data pertaining to each unit shall be forwarded to buyer’s Quality Assurance representative within five (5) working days of production foam completion. Testing data generated in accordance with this section of the specification shall also be included with the certification.

6.1.3 The standard values from qualification testing performed by the Company for the same type of foam as used in the impact limiters shall be reported for:

a. thermal conductivity

b. specific heat
c. leachable chlorides

6.2 All QA submittals shall be dated and signed by the foam supplier's designated QA representative.

6.3 As a check that the correct weight of foam was properly installed and in order to verify that each pour increment has reacted properly, the pour weight and elevation (rise height) of each pour increment shall be recorded.

6.4 The foam weight in each impact limiters (top and bottom) shall be recorded.

6.5 All test data shall be recorded and presented to the buyer's Quality Assurance representative for review and verification that properties are within specified limits for compressive strength, density and flame retardancy.

6.6 A schedule shall be developed and provided to the Buyer to cover the foam pouring and testing operations.

6.7 Chem-Nuclear, its customer, or its customer's regulator may impose hold points to allow witnessing of certain testing functions. The Company shall give Chem-Nuclear a minimum of one week's notice prior to the reaching any identified hold points.

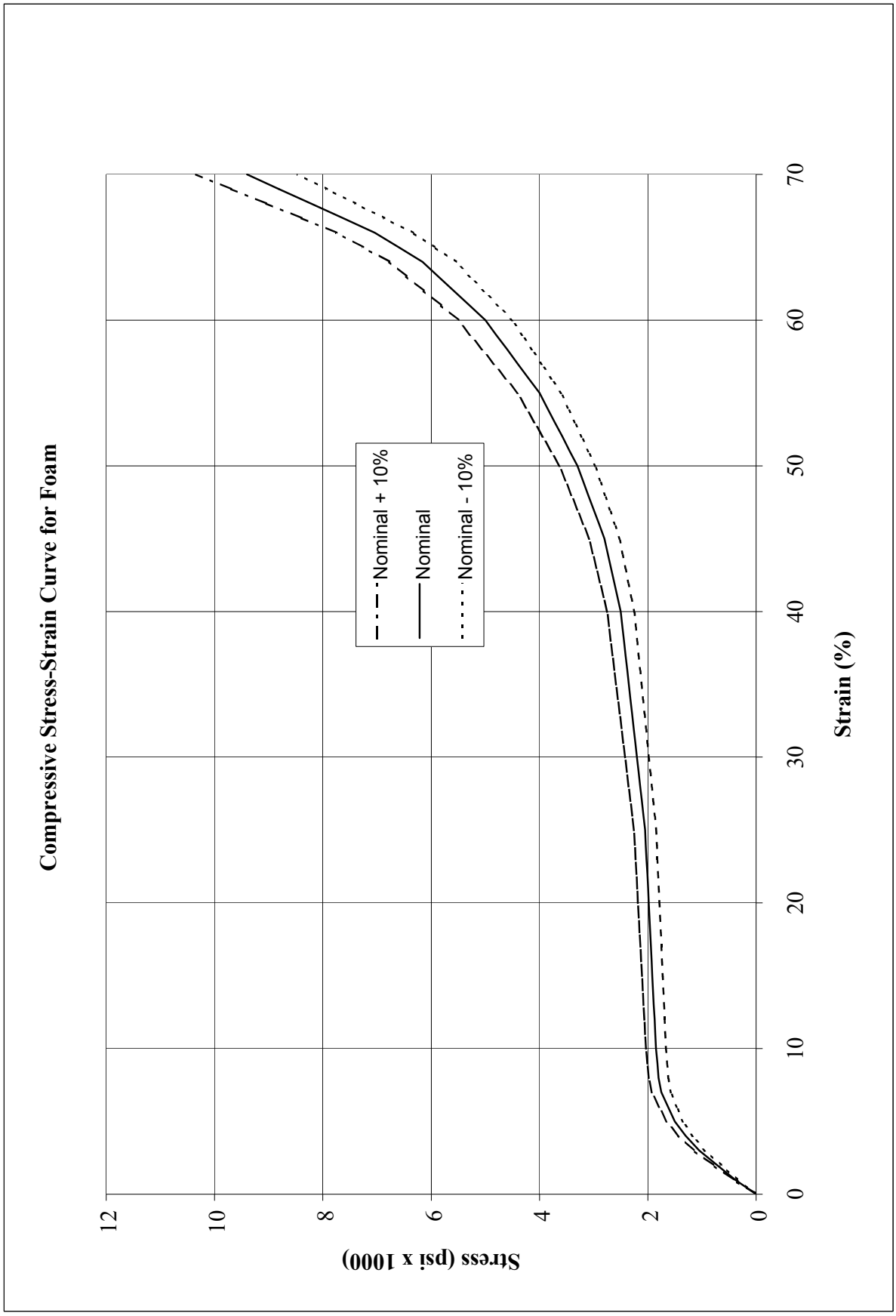
6.8 Chem-Nuclear, its customer, or its customer's regulator shall have access to the Company's facilities at all reasonable times to witness testing or to assess compliance with these specifications.

6.9 The Company shall provide Chem-Nuclear a Certificate of Compliance certifying that the foam has been fabricated in accordance with these specifications and the purchase order. A record of any Chem-Nuclear approved deviations shall be attached.

APPENDIX A

Compressive Stress-Strain Curve for Foam

(1 Page)


Compressive Stress-Strain Curve for Foam
Stress (psi x 1000)
Strain (%)
Nominal + 10%
Nominal
Nominal - 10%
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70