
Specification for Rigid Polyurethane Foam for Impact Limiters for 8-120B Casks

Revision 2

Authored By:	<u>Signature on File</u> Mirza Baig, Manager Technical Services	<u>6/18/2012</u> Date
Reviewed By:	<u>Signature on File</u> Mike Vaught, Specialty Packaging Director	<u>6/18/2012</u> Date
Approved By:	<u>Signature on File</u> Pat Paquin, Director - Products	<u>6/18/2012</u> Date

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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 EnergySolutions licensed transport casks.

1.2 Prerequisites

The impact limiter shells shall be fabricated in accordance with an approved EnergySolutions 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 EnergySolutions and obtain a resolution from the authorized EnergySolutions representative.

2.0 REFERENCES

2.1 ASTM D1621-04: "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 Code of Federal Regulation, Part 25 - Airworthiness Standards: Transportation Category Airplanes, Section 25.853.

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/ft³.
- 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.
- 3.2.4 The foamed-in impact limiters shall be weighed. The weight of each impact limiter shall be recorded. The acceptable weight limit of each impact limiter is between 4,630 and 4,860 lb.

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 tests shall be performed at 75°F(±5°F). The average of the results of all tests shall be within the ±10% limit shown in the stress-strain diagrams given in Appendix A at 10, 30, 50, and 60 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 appropriate 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 $0.5 \pm .030$ 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 *EnergySolutions* 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:
- thermal conductivity
 - specific heat
 - 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 *EnergySolutions*, its customer, or its customer's regulator may impose hold points to allow witnessing of certain testing functions. The Company shall give *EnergySolutions* a minimum of one week's notice prior to the reaching any identified hold points.
- 6.8 *EnergySolutions*, 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 *EnergySolutions* a Certificate of Compliance certifying that the foam has been fabricated in accordance with these specifications and the purchase order. A record of any *EnergySolutions* approved deviations shall be attached.

APPENDIX A

Compressive Stress-Strain Curve for Foam (8-120B) (Page 9)

