

**MATERIAL SPECIFICATION RIGID FOAM;
CLOSED CELL POLYMETHACRYLIMIDE (PMI)**

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1 SCOPE

1.1 Scope

This specification covers the requirements for a rigid, closed cell polymethacrylimide foam.

1.2 Classification

The material shall be classified according to processing method (grade) and to density (type).

1.2.1 Grades

Grades	Characteristics
A	For processing up to temperature of 125°C (257°F) and maximum pressure: 0.1 – 0.3 MPa (15 – 45 psi)
B	For processing up to temperature of 125°C (257°F) and maximum pressure: 0.3 – 0.7 MPa (45 – 100 psi)
C ¹	For processing up to temperature of 180°C (356°F) and maximum pressure: 0.35 – 0.7 MPa (50 – 100 psi)
D	For processing up to temperature of 125°C (257°F) and maximum pressure: 0.1 – 0.3 MPa (15 – 45 psi)
E	For processing up to temperature of 125°C (257°F) and maximum pressure: 0.3 – 0.7 MPa (45 – 100 psi)
F ²	For processing up to temperature of 180°C (356°F) and maximum pressure: 0.35 – 0.7 MPa (50 – 100 psi)
G	For processing up to temperature of 180°C (356°F) and maximum pressure: 0.1 – 0.45 MPa (15 – 65 psi)
H ³	For processing up to temperature of 190°C (374°F) and maximum pressure: 0.5 – 0.7 MPa (72 – 100 psi)
I	For processing up to temperature of 125°C (257°F) and maximum pressure: 0.3 – 0.7 MPa (45 – 100 psi)
J ⁴	For processing up to temperature of 180°C (356°F) and maximum pressure: 0.35 – 0.7 MPa (50 – 100 psi)

¹ Grade C = Grade B, heat-treated (HT) by supplier

² Grade F = Grade E, heat-treated (HT) by supplier

³ Grade H = Grade G, heat-treated (HT) by supplier

⁴ Grade J = Grade I, heat-treated (HT) by supplier

1.2.2 Types

Types	Nominal Density kg / m ³ (lbs / cft)	Grade available
Type 1	32 (2.00)	A D
Type 2	52 (3.25)	A B C D E F I J
Type 3	75 (4.68)	A B C D E F G H I J
Type 4	110 (6.87)	B C E F G H I J
Type 5	205 (12.80)	B C

2 APPLICABLE DOCUMENTS

The following standards, of the revision in effect on the date of invitation for bid or request for proposal, form a part of this specification to the extent specified herein.

- 2.1 ASTM D 1622 / C 271 Apparent density of Rigid Cellular Plastics
ISO 845 (density for core materials for structural sandwich
ISO 1855 constructions)

- 2.2 ASTM D 1621 / C 365 Compressive Properties of Rigid Cellular Plastics
ISO 844 (flat wise compression strength of Sandwich
 constructions)

- 2.3 ISO 527.2 Tensile Properties of Plastics (Metric)
ASTM D 638 (possible in year 2010)

- 2.4 ISO 527.2 Modulus of Elasticity in Tensile
ASTM D 638 (possible in year 2010)

- 2.5 DIN 53 294 Shear Test in Flatwise Plane of Flat Sandwich
ASTM C 273 Construction or Sandwich Cores (in compression)

- 2.6 DIN 53 294 Shear Modulus in Flatwise Plane of Flat Sandwich
ASTM C 273 Construction or Sandwich Cores (in compression)

- 2.7 DIN 53 428 Resistance of Plastics to Chemical
ASTM D 543 Reagents

3 REQUIREMENTS

3.1 Qualification

The materials furnished under this specification shall have been tested and have passed the qualification tests specified herein and have been listed or approved for listing on the applicable List of Approved Products. After qualification, any modification or change in method of manufacture that could affect the characteristics of the material shall require requalification.

3.2 Workmanship

The foam material shall be homogenous throughout. The cells shall be of approximately the same size. The foam shall be free of cracks, surface irregularities and contaminants. The foam shall conform to the dimensional requirements of the purchase order.

3.3 Properties

3.3.1 Character. The material shall be a dimensionally stable, closed cell, rigid foam.

3.3.2 Formulation. The material shall be expanded polymethacrylimide foam.

3.3.3 Colour. The material shall be white to yellow in colour.

3.3.4 Mechanical Properties. The minimum mechanical properties of the foam shall be in accordance with Table I for Grade A and Grade D, Table II for Grade B, Grade C, Grade E, Grade F, Grade G, Grade H, Grade I and Grade J.

3.3.5 Chemical Properties. The foam shall be resistant to common organic solvents. The compressive strength at 23°C (73.4°F) of the foam shall remain unaffected when immersed in the following chemicals for the exposure times and temperatures specified below:

Chemical	Exposure time
a. Gasoline (octane 100)	1500 hours at 23°C (73.4°F)
b. Jet fuel A1	1500 hours at 23°C (73.4°F)
c. Hydraulic oil (MIL-H-5606A)	1500 hours at 23°C (73.4°F)
d. Phosphoric acid ester Skydrol 500 B	1500 hours at 23°C (73.4°F) and 70°C (158°F)

3.4 Storage

Grade A, Grade B, Grade D, Grade E, Grade G and Grade I shall be stored under dry, ambient conditions. Grade C, Grade F, Grade H and Grade J shall be stored in a moisture proof (barrier) bagging. Bagging shall be in accordance with MIL-standard.

3.5 Marking

Each individual sheet shall be permanently marked in one corner with the following information:

- a) Customer material specification number, revision letter, type and grade
- b) Lot number and date of manufacture
- c) Batch number
- d) Manufacturer's product designation
- e) Purchase order number (on exterior package only)
- f) Quantity of material shipped (exterior package only)

In addition, the shortest edge of each individual sheet shall have a permanently coloured stripe with the colours list in chapter 8 Approved Source List.

4 QUALITY ASSURANCE PROVISION

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the supplier shall be responsible for the performance of all inspection requirements as specified herein. Except of otherwise specified in the contract or purchase order the supplier may use his own facilities or any commercial laboratory acceptable to customer. Customer serves the right to perform any and all of the inspections set forth herein where such inspections are deemed necessary to prove that the material conforms to the specified requirements.

4.1.1 Inspections Records. Inspection records of examination and test shall be maintained complete and available to customer. These records shall contain all data necessary to prove compliance with the requirements of this specification.

4.2 Sampling

4.2.1 Batch. A batch is defined as the quantity of material formulated at one time.

4.2.2 Lot. A lot is defined as all foam materials produced in a single production run.

4.3 Classification of Tests

4.3.1 Qualification Tests. Material qualification shall consist of examination for workmanship and all the specified requirements herein to determine compliance with this specification.

4.3.2 Quality Conformance Inspection. As a minimum, the material shall be tested for compressive strength and density in accordance with 4.4 and visually examined for workmanship to meet the requirements of 3.2.

4.4 Test Methods

4.4.1 Test Conditions

At least five (5) specimens for each test conditions shall be tested for each batch. Specimens shall be tested in accordance with the test methods specified in table III.

4.5 Rejection

Any foam material which does not conform to the Quality Conformance Requirements of this specification shall be retested once only. Material which fails to meet any of the requirements during the retest shall be rejected.

4.6 Report

The supplier of the foam material shall furnish with each shipment a certificate of conformance that the material meets the requirements of this specification. This report shall also include the following items:

- a) Purchase order number
- b) Quantity and material size
- c) Manufacturer's designation, lot and batch number
- d) Customer material specification number, revision letter, grade and type
- e) Date of manufacture
- f) Test values for density and compressive strength; also visual examination if required.

5 **PREPARATION FOR DELIVERY**

5.1 Packing

The material shall be packed in shipping containers of a type that adequately protect the material during normal handling and meet the minimum packing requirements of common carriers for acceptance and safe transportation at the lowest rate to the point of delivery.

5.2 Marking for Shipment

Each exterior package shall be permanently marked in accordance with 3.5.

6 MINIMUM PROPERTIES OF PMI FOAM

Table I

Minimum Properties of PMI Foam Grade A and Grade D according to CMS or MIL

Type	Density kg/m ³ (lbs/cft)	Compressive strength MPa (psi)	Tensile strength MPa (psi)	Modulus of elasticity MPa (psi)	Shear strength MPa (psi)	Shear modulus MPa (psi)
1	32 ± 7 (2.00 ± 0.44)	0.20 (29)	0.55 (79)	22 (3,190)	0.29 (42)	7.7 (1,100)
2	52 ± 12 (3.25 ± 0.75)	0.42 (60)	1.05 (152)	43 (6,236)	0.50 (72)	14 (2,030)
3	75 ± 15 (4.68 ± 0.94)	0.95 (137)	1.70 (246)	73 (10,587)	0.88 (127)	21 (3,045)

Table II

Minimum Properties of PMI Foam Grade B, Grade C, Grade E, Grade F, Grade G, Grade H, Grade I and Grade J according to CMS or MIL

Type	Density kg / m ³ (lbs / cft)	Compressive strength MPa (psi)	Tensile strength MPa (psi)	Modulus of elasticity MPa (psi)	Shear strength MPa (psi)	Shear modulus MPa (psi)
2	52 ± 12 (3.25 ± 0.75)	0.40 (58)	0.88 (127)	45 (6,500)	0.50 (72)	14 (2,000)
3	75 ± 15 (4.68 ± 0.94)	1.05 (152)	1.54 (223)	75 (10,800)	1.00 (145)	24 (3,400)
4	110 ± 21 (6.87 ± 1.3)	2.20 (319)	2.54 (368)	135 (19,500)	1.74 (252)	40 (5,800)
5	205 ± 35 (12.80 ± 2.2)	6.40 (928)	5.38 (780)	270 (39,100)	2.94 (426)	100 (14,500)

7 TEST METHODS

Table III

Apparent Density of Rigid Cellular Plastics

ASTM D 1622	4 inch x 4 inch x 1 inch or 2 inch
ISO 845	100 mm x 100 mm x 25 mm or 50 mm
ISO 1855	100 mm x 100 mm x 25 mm or 50 mm

Compressive Properties of Rigid Cellular Plastics

ASTM D 1621	2 inch x 2 inch x 1 inch or 2 inch, Test-Speed 0.2 inch / min
ISO 844	50 mm x 50 mm x 25 mm or 50 mm, Test-Speed 5 mm / min

Tensile Properties of Plastics

ASTM D 638	Specimen type M, 0.4 inch x 0.4 inch, Test-Speed 0.2 inch / min
ISO 527.2	Specimen type 1A, Thickness 10 mm, Test-Speed 5 mm / min

Modulus of Elasticity in Tensile

ASTM D 638	Specimen type M 0.4 inch x 0.4 inch, Test-Speed 0.04 inch / min
ISO 527.2	Specimen type 1A, Thickness 10 mm, Test-Speed 1 mm / min

Shear Test in Flatwise Plane of Flat Sandwich Constructions or Sandwich Core (Compression Method)

DIN 53 294	200 mm x 50 mm x 19.5 mm, Test-Speed 2 mm / min
	150 mm x 25 mm x 12.7 mm, Test-Speed 2 mm / min (Type 4, 5)
ASTM C 273	7.8 inch x 2 inch x 0.78 inch, Test-Speed 0.08 inch / min
	5.9 inch x 1 inch x 0.50 inch, Test-Speed 0.08 inch / min (Type 4, 5)

Shear Modulus in Flatwise Plane

DIN 53 294	200 mm x 50 mm x 19.5 mm, Test-Speed 2 mm / min
	150 mm x 25 mm x 12.7 mm, Test-Speed 2 mm / min (Type 4, 5)
ASTM C 273	7.8 inch x 2 inch x 0.78 inch, Test-Speed 0.08 inch / min
	5.9 inch x 1 inch x 0.50 inch, Test-Speed 0.08 inch / min (Type 4, 5)

8 APPROVED SOURCE LIST

The following Supplier's products have met the qualifications of this specification and are approved sources.

Grades	Type	Supplier Product Designation	Colour Code
A	1	ROHACELL 31 A	Red
A	2	ROHACELL 51 A	Green
A	3	ROHACELL 71 A	Blue
B	2	ROHACELL 51 WF	Orange
B	3	ROHACELL 71 WF	Yellow
B	4	ROHACELL 110 WF	Brown
B	5	ROHACELL 200 WF	White
C	2	ROHACELL 51 WF-HT	Orange
C	3	ROHACELL 71 WF-HT	Yellow
C	4	ROHACELL 110 WF-HT	Brown
C	5	ROHACELL 200 WF-HT	White
D	1	ROHACELL 31 HF	Red-Violet
D	2	ROHACELL 51 HF	Green-Violet
D	3	ROHACELL 71 HF	Blue-Violet
E	2	ROHACELL 51 RIST	Orange-Red
E	3	ROHACELL 71 RIST	Yellow-Red
E	4	ROHACELL 110 RIST	Brown-Red
F	2	ROHACELL 51 RIST-HT	Orange-Red
F	3	ROHACELL 71 RIST-HT	Yellow-Red
F	4	ROHACELL 110 RIST-HT	Brown-Red
G	3	ROHACELL 71 XT	Yellow-Green
G	4	ROHACELL 110 XT	Brown-Green
H	3	ROHACELL 71 XT-HT	Yellow-Green
H	4	ROHACELL 110 XT-HT	Brown-Green
I	2	ROHACELL 51 RIMA	Orange-Blue
I	3	ROHACELL 71 RIMA	Yellow-Blue
I	4	ROHACELL 110 RIMA	Brown-Blue
J	2	ROHACELL 51 RIMA-HT	Orange-Blue
J	3	ROHACELL 71 RIMA-HT	Yellow-Blue
J	4	ROHACELL 110 RIMA-HT	Brown-Blue

9 Supplier

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PROPOSAL