de Havilland Inc.

Material Specification

TITLE:	**POLYETHERIMIDE BLEND SHEET AND INJECTION MOLDED MATERIAL**
SPECIFICATION NUMBER:	**DHMS P 1.47**
ISSUE:	**E**
AMENDMENT:	**---**
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PAGE:	**1 of 14**

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REVISION RECORD

Issue	Page	Description and Reason for Change
B		This is a complete revision and detail changes have been noted Addition of pellet form material for injection modeling.
C		Addition of Grade A for Interim Rule material and Grade B for Final Rule material. Delete Ultem 1613 from QPL, Second page for QPL added.
D		This is complete revised issue. Detail changes have not been noted.
E		This is complete revised issue. Detail changes have not been noted.

1 SCOPE

This specification covers the requirements for a self extinguishing, low heat release, low smoke emission, impact and chemical resistant, thermoplastic, polyetherimide blend sheet form material for vacuum forming and resin pellet form material intended for injection molding.

1.1 Classification

The materials supplied to this specification shall be one of the following Classes, Types and Grades:

1.1.1 Classes

Class I Sheet form intended for manufacturing vacuum or pressure formed parts.

Class II Resin pellet form intended for injection molding.

Class III Resin pellet with glass fiber reinforcement intended for injection molding:

- 10 10% glass reinforcement
- 20 20% glass reinforcement
- 30 30% glass reinforcement.

Note: If no class is mentioned, the material call-out shall be considered as Class I - sheet form.

1.1.2 Types (for Class I only)

The polyetherimide blend sheet material shall be supplied in one of the following types:

Type A - Smooth both sides

Type B - Suede finish one side only

Type C - Haircell finish one side only.

Type D - Velvet finish one side only

1.1.3 Colour

Colours used by de Havilland are listed in the Qualified Product List and identified by dash numbers:

-1 Beige (DS82-07-100-150)

-2 Grey (DS82-07-800-153)

-3 Grey (DS82-07-800-223)

-4 Natural

-5 Black

1.1.4 Grade

Grade A - Meets requirements of FAR 25.853(a-1) Amd. 25-61, 1988 Interim Rule

Grade B - Meets requirements of FAR 25.853(a-1) Amd. 25-66, 1990 Final Rule

Note: If no grade is mentioned, the material call-out shall be considered as Grade B - 1990 Final Rule material.

2 APPLICABLE DOCUMENTS

The following documents form part of this specification to the extent specified herein. In the event of conflicting requirements between this specification and those listed below, the requirements of this specification shall govern. Where a specific issue of a document is not specified, the current issue shall be used.

2.1 U.S. Government Specifications

2.1.1 American Society for Testing and Materials

ASTM D570	-	Test Method for Water Absorption of Plastics
ASTM D638	-	Test Method for Tensile Properties of Plastics
ASTM D790	-	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	-	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D1238	-	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D3029	-	Test Method for Impact Resistance of Rigid Plastic Sheeting or Parts by Means of a Tup (Falling Weight)
ASTM E162	-	Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM E308	-	Method for Computing the Colours of Objects by Using CIE System

2.1.2 Federal Aviation Administration

FAR 25.853(a) APP. F Amd. 25-66	-	Flammability Requirements
FAR 25.853(a-1) APP. F Amd. 25-61	-	Flammability Requirements
FAR 25.853(a-1) APP. F Amd. 25-66	-	Flammability Requirements

3 DEFINITIONS

Room Temperature - Room temperature of a clean room shall be controlled such that the minimum temperature is 65^{o} F with a corresponding relative humidity not greater than 63% and the maximum temperature is 75^{o}F with a corresponding relative humidity not greater than 46%. The temperature and relative humidity values between the minimum and maximum acceptable values listed above should form a straight line relationship.

Batch - A batch is defined as a production run of sheet material manufactured from one batch of resin with uninterrupted production.

4 REQUIREMENTS

Prior to procurement, for applications requiring OSU heat release attributes, equivalency to currently procured materials tested in accordance with FAR 25.853(a-1), Amd. 25-66 must be demonstrated.

4.1 Materials

Materials used in the manufacture of this product shall be of high quality and suitable for the intended purpose.

4.2 Finished Product

The self extinguishing, low smoke emission, low heat release, impact and chemical resistant thermoplastic (polyetherimide) sheet and pellet material shall meet the requirements specified herein.

TABLE 1. Physical and Chemical Properties

Test	Material Requirements			Test Method
	Class I	Class II	Class III, -30	
Specific Gravity	1.27 ± 0.05(unpig-mented)	1.305 ± 0.085	1.495 ± 0.055	ASTM D792
Water Absorption[1], % of weight increase, maximum	0.50	N/A[2]	N/A	Para. 5.1
Chemical Resistance	Chemicals listed in section shall have no detrimental effects on the material.			Para. 5.2
Colour and Finish	Shall match standard.			Para. 5.3
Workmanship	Shall be free of voids, blisters, foreign particles and scratches. It shall not be cracked, chipped, warped or twisted. Perforations are not permitted.			Para. 5.4
Vacuum Forming[3]	No excessive thinning or cracking.	N/A	N/A	Para. 5.5
Sheet Thickness, %	±10	N/A	N/A	N/A
Melt Flow Rate, grams in 10 min.	5 - 10	1.4 - 3.4	2.5 - 6	Para. 5.9

1. Testing after 24 hours immersion in water.

2. N/A - Not Applicable

3. Impact resistance after forming shall be in accordance with Table 2.

TABLE 2. Mechanical Properties

Property	Minimum Value Average			Test Method
	Class I	Class II	Class III, -30	
Tensile Strength, ksi	9.0	9.0	20.0	Para. 5.6
Tensile Modulus, ksi	300	300	1000	Para. 5.6
Flexural Strength, ksi	14.5	14.5	28.0	Para. 5.7
Flexural Modulus, ksi	300	300	1300	Para. 5.7
Impact Strength, inch-pounds				
(i) Unscratched, Gardner, Tri-corner head	80	N/A	N/A	Para. 5.8.1
(ii) Scratched with 200 grams	25	25	N/A	Para. 5.8.2

TABLE 3. Flammability Requirements

Test	Requirement	Test Method
60 Seconds Vertical, maximum (i) extinguishing time (ii) burn length (iii) drip extinguishing time	 12 seconds 6 inches no drips	FAR 25.853 (a) APP. F, Amd. 25-66
Heat Release, maximum Grade A	Material shall exhibit a 2 minute: 80 kW-min/m^2 peak: 80 kW/m^2	FAR 25.853 (a-1) APP. F, Amd. 25-61
Heat Release, maximum Grade B	2 minute: 65 kW-min/m^2 peak: 65 kW/m^2	FAR 25.853 (a-1) APP. F, Amd. 25-66
Smoke Density, at 4 minutes, maximum	100 Ds	FAR 25.853 (a-1) APP. F, Amd. 25-66

5 TEST METHODS

Unless otherwise specified all tests shall be performed at Room Temperature.

5.1 Water Absorption

Water absorption shall be determined in accordance with ASTM D570, 24 hour Immersion Method.

5.2 Chemical Resistance Under Stress

Clamp three specimens (5 x 0.5 x 0.080 ± 0.002 inches) over a 5.0 inch radius curve. The specimens are to be clamped at both ends. Using a cotton swab, apply the test chemical to the middle area of the stressed specimens so as to keep their surfaces wetted for at least one minute. Repeat the applications after one and two hours respectively. After 24 hours (total stress time) the specimens are to be inspected for evidence breakage, cracking, swelling or softening.

The test is to be performed for each of the following chemicals using three fresh specimens for each solvent:

Solvent	Class I	Class II & III
IPA	x	x
Methanol	x	x
Methyl Ethyl Ketone	x	-
Toluene	x	-

5.3 Colour and Finish

Comparison shall be made by placing the new sample side by side with the control sample in a Macbeth Industrial Colour Matching Unit, or equivalent. The direction of illumination shall be normal to the surfaces being compared. Both "North Sky Daylight" (7500K) and "Horizon Sunlight" (2300K) shall be used to compare colours. An acceptable alternative is sample comparison using a spectrophotometer in accordance with ASTM E308.

5.4 Workmanship

For inspection purposes, the polyetherimide sheet shall be viewed from a distance of one yard with the material in the vertical position. Adequate illumination must be used which produces a 25 to 35 foot-candles of light at the surface of the specimen.

Test equipment shall consist of a Spectra Lumicon Series II Incident Light Meter (manufactured by Photo Research Division of Kollmorgen Corporation, Burbank, California, U.S.A.) or equivalent.

5.5 Vacuum Forming

5.5.1 Prepare three 12" x 12" samples of sheet material. Dry for a minimum of 8 hours at 300˚ ± 10˚F. Form the samples over the mold shown in **Figure 1** using a minimum vacuum of 22 inches of Hg.

5.5.2 Check the formed parts for thinning, discolouration, finish, and cracking as per **Table 1**, **Para. 5.3** and **Para. 5.4**, and impact after forming (material must meet the impact requirements of **Table 2**).

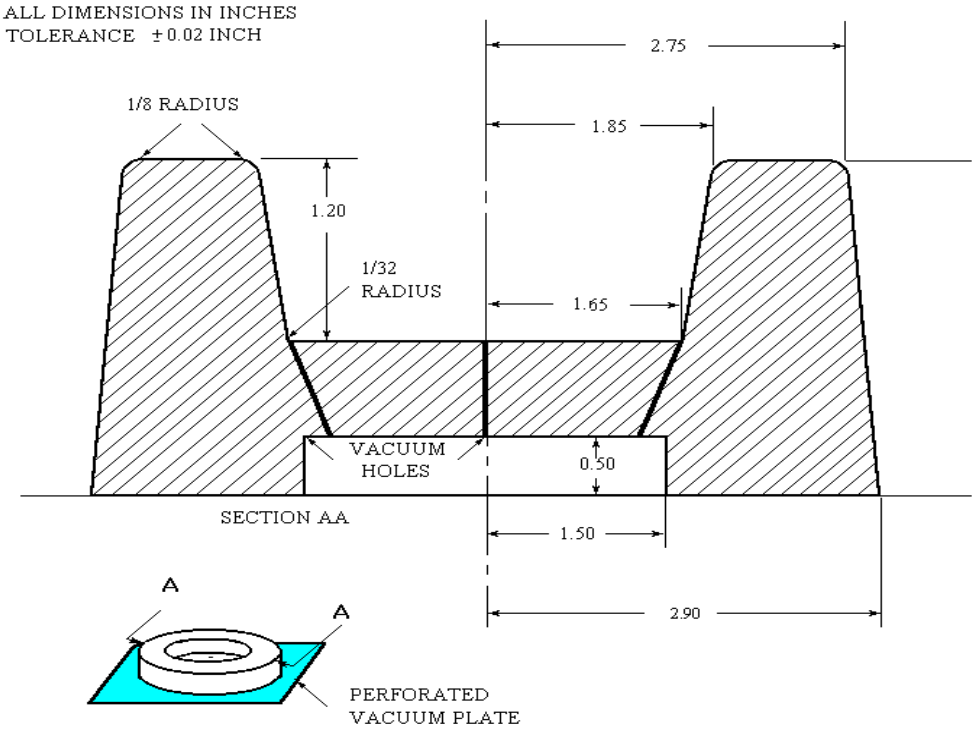


FIGURE 1. MOLD FOR VACUUM FORMING

5.6 Tensile Strength and Modulus of Elasticity

Determine the tensile strength and modulus of elasticity in accordance with ASTM D638. Cross-head speed shall be 0.20 ± 0.05 in./minute. Test a minimum of five specimens.

5.7 Flexural Strength and Flexural Modulus

Determine the flexure properties in accordance with ASTM D790, Method I. A minimum of five specimens shall be tested.

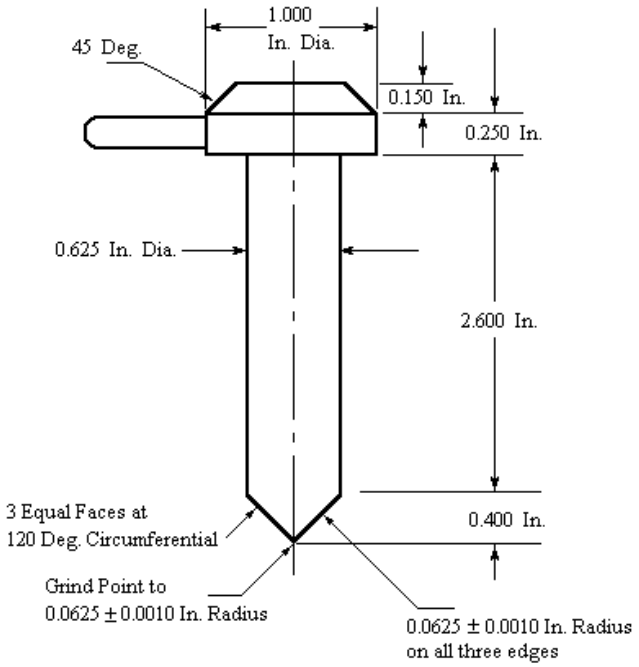
5.8 Impact Resistance (Dropped Weight Test)

5.8.1 Unscratched

(a) The impact test specimens shall be 3" x 3" minimum and shall be 0.080" ± 0.005" thick.

(b) Impact flat specimens using a Gardner Impact Tester Model 10-1120, 10-1125 (Gardner Laboratories, Bethesda, Maryland) or equivalent, and a striker with dimensions as shown in **Figure 2**. Use a specimen support ring with a 0.650 ± 0.010 inch diameter hole.

(c) Failure is defined when the light shines through a puncture or split caused by the impact. The drop height shall be varied to produce a failure-producing load. The average and standard deviation of the failure loads for a set of test specimens shall be calculated by the method described in ASTM D3029.



Dimensional Tolerances:

a. Linear: ±0.010 Inch unless otherwise specified
b. Angular: ±1.0 Degree
c. Material: Steel
d. Surface: 32 microinches in accordance with BACD 2097

FIGURE 2. IMPACT TEST STRIKER

5.8.2 Scratched, Reverse Impact

(a) Use a standard carbide tooling insert, Type TNMC-2.5NVR Grade VC-7, weighed with a 200 gram load to scratch test specimens, see **Figure 3**.

(b) Impact specimens on the reverse side directly over the scratch following the method described in **Para. 5.8.1**.

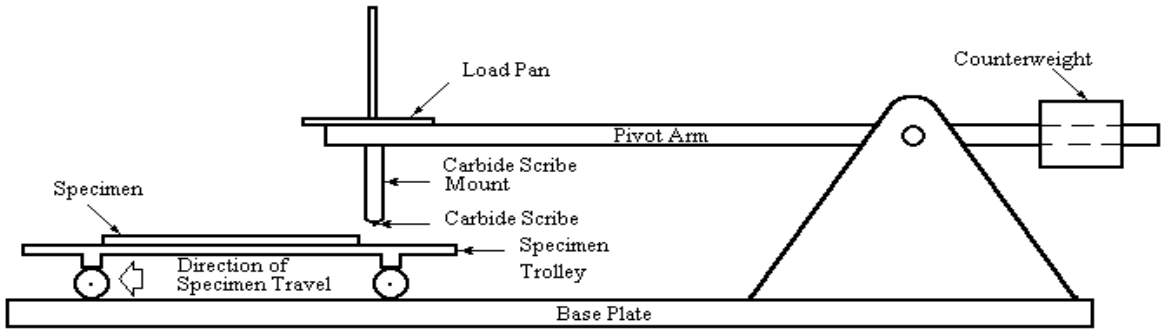


FIGURE 3. DIAGRAM OF SCRATCHING FIXTURE SHOWING CARBIDE SCRIBE

5.9 Melt Flow Rate

Determine melt flow index in accordance with ASTM D1238 using the following:

Material	Temperature	Load Including Plunger Weight
Class II	563˚F (295˚C)	6700 grams
Class III	638.6˚F (337˚C)	6700 grams

Pre-dry the sample 4 hours at 300˚F (149˚C). Equilibrate a 4 to 5 gram sample for 4 to 5 minutes in the extrusion barrel prior to taking readings.

6 QUALITY ASSURANCE

6.1 Qualification

6.1.1 A supplier is responsible for the performance of all qualification testing as specified in **Table 4** of this specification. A three lots/batches qualification is required.

6.1.2 A supplier desiring qualification shall submit a copy of a report showing actual qualification test data and a sufficient quantity of product for de Havilland evaluation tests.

Materials submitted for qualification must demonstrate equivalency to the materials of the same Grade originally qualified to this specification when tested in accordance with ASTM E162 and with FAR 25.853(a-1), Amd. 25-66 (both test methods conducted in the flaming mode at 3.5 watts/cm^2 for Heat Release and 2.5 watts/cm^2 for Smoke Density). These tests will be performed by a FAA approved facility, at the time of qualification and at any time thereafter at the discretion of de Havilland Inc. Qualified products will be listed in the Qualified Products List to this specification in the Grade for which qualification was granted.

6.1.3 Upon review of supplier's data and de Havilland tests, the supplier will be advised either of product qualification or of reasons for disqualification.

6.1.4 No changes in the method of manufacture and/or formulation shall be made without notification and prior written approval of Materials Technology Department of de Havilland Inc.

6.1.5 Requalification of the product may be requested by the purchaser if there are any changes in the method of manufacture and/or formulation.

6.2 Qualification by Similarity

Where a product has been qualified to another similar specification, the supplier may submit the qualification data applicable to this specification for consideration. The similar specification may be a government, company, or other specification where the requirements are similar to this specification.

6.3 Acceptance Tests

6.3.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for all acceptance tests, as specified in **Table 4** of this specification.

6.3.2 The supplier, performing acceptance tests per **Table 4** shall furnish with each lot of product one copy of an Acceptance Test Report showing actual test data conformance to the acceptance tests specified in **Table 4**. The report shall include the supplier's batch identification.

6.3.3 de Havilland Inc. reserves the right to perform any or all of the tests set forth in this specification to ensure that the product continues to meet specification requirements. Any product not meeting the requirements of this specification will be returned to the supplier at the supplier's expense.

TABLE 4. Qualification and Acceptance Test

Property	Reference	Qualification	Acceptance
Specific Gravity	Table 1	x	
Water Absorption	Table 1	x	
Chemical Resistance	Table 1	x	
Colour and Finish	Table 1	x	x
Workmanship	Table 1	x	
Vacuum Forming	Table 1	x	
Sheet Thickness	Table 1	x	x[1]
Tensile Strength	Table 2	x	x
Tensile Modulus	Table 2	x	
Flexural Strength	Table 2	x	
Flexural Modulus	Table 2	x	
Impact Strength,	Table 2	x	
Impact Strength, scratched	Table 2	x	
Flammability (60 Seconds Vertical)	Table 3	x	x
OSU Heat Release	Table 3	x	
NBS Smoke Density	Table 3	x	

1. For Class I only.

6.4 Preproduction Samples

For qualification of sheet material purposes, the vendor shall submit five 6.5" x 10.5" samples of the initial batch of material manufactured to this specification, for approval of texture and colour. One sample shall be designated as the master standard; the remaining four samples shall be used as working standards. de Havilland Inc. (DHI) will assign a standard number to these samples.

7 ORDERING DATA

7.1 Prerequisite

7.1.1 The polyetherimide blend sheet or pellet furnished under this specification for production use shall be qualified and listed on the Qualified Products List prior to issuing a purchase order.

7.1.2 Prior to shipment of material a 6.5" x 10.5" sample (sheet material only), taken from the lot of material to be shipped, shall be forwarded to de Havilland Inc. for lot approval.

7.2 Procurement Documents

Procurement documents shall specify the following:

- Title, Number, Issue and Amendment Number of this Specification
- Class, Type, Thickness (Class I only), Grade and Colour Code
- Manufacturer's Product Identity
- Total Quantity
- Sheet Size (Class I only)

8 PREPARATION FOR DELIVERY

8.1 Preservation and Packing

The polyetherimide sheets or pellet shall be packed in such a manner as to assure that, during shipment and storage, the product shall be protected against damage from exposure to hazards which would adversely affect the property conformance to **Section 4** of this specification.

8.2 Marking

Each container shall be legibly marked with the following information:

- Polyetherimide Sheet or Pellet Material to DHMS P1.47, Type, Colour, Grade and Thickness (Class I only)
- Manufacturer's Name and Product Identification (Trade Name or Code Number)
- Sheet Size
- Quantity
- Lot Number.

8.3 Shipping Documentation

The shipping document shall show:

- de Havilland Purchase Order Number
- Specification Number, Class, Type, Grade, Thickness (Class I only) and Colour
- Quantity
- Number of Containers or Packages
- Acceptance Test Report
- Date of Manufacture
- Total Quantity.

9 HEALTH AND SAFETY DATA

When supplying samples for qualification per **Para. 6.1.2**, the supplier shall submit a Material Safety Data Sheet (MSDS) complying with the "Controlled Products Regulations" of the Hazardous Products Act (also known as W.H.M.I.S. Regulations). The document must state all hazardous ingredients, safe-handling procedures, first-aid measures, fire and explosion data, reactivity data, physical properties, preparation information and procedures for storage and disposal.

This (MSDS) must then be supplied with a completed DH 4339 "Application To Introduce A New Material" form to the Material Safety Committee.

Upon receipt of DH 4340 "Recommendation" form that approves the use of the material, it can then be included on the Qualified Products List.

NOTE: Any changes in the formulation of the material require a re-submission of the Material Safety Data Sheet.

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO.	PQS #	DATE OF PRODUCT APPROVAL
	GRADE A			
	Class I			
Canadian Distributor: Commercial Plastics & Supply Corporation, 47 Gurney Cres., Toronto, Ontario M6B 1S9 (416) 787-4215	Ultem DL1613S (sheet) - Beige, 0.040" thick Ultem Commercial Colour #5141 (to match Lexan Colour #50461)	0856 This material is qualified to BMS 8-293C.		04/04/89
Canadian Distributor: G.E. Canada, 2300 Meadowvale Blvd., Mississauga, Ontario L5N 5P9 (416) 858-5788	**Class II** Ultem 8007	Product discontinued.		
	GRADE B			
G.E. Canada	**Class I** Ultem 1668A -3 Gray 0.080" thick Type D, Colour GY4033	0856		04/04/89
	Class II Colour -5			
G.E. Canada	Ultem 9075 - Colour #71011	Material to be used by subcontractors only.		
	Class III -30% Colour -4			
G.E. Canada	Ultem AR9300 - Colour #1000	Material to be used by subcontractors only.		