BOMBARDIER

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Material Specification

TITLE:	**FUEL VAPOUR BARRIER COATING FOR AIRCRAFT INTEGRAL FUEL TANKS**
SPECIFICATION NUMBER:	**DHMS C 4.20**
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Prepared by:

Shiraz Haniff
Materials Technology

Approved by:

Kenneth. Quon
SES. Materials Technology

FUEL VAPOUR BARRIER COATING FOR AIRCRAFT INTEGRAL FUEL TANKS

REVISION RECORD

Iss.	Page	Description and Reason for Change
NC		Issue of the new document
A	All	Updated manufacturer's name and product identification number. Updated format throughout.
B	All	Table 1: Cure time Was: "16 hrs" Now: "24 hrs". Added missing Fig. 1,2 and 3
C	4	Table 4: Updated Elongation requirement
	8	Para. 6.2.2 updated
	13	QPL: Added thinner TL-29
	8-13	Revised Qualification sections
D	2	Para. 2.4 Add reference to DHLP 3055 Tape adhesion testing.
	3	Para. 3.1.5 Updated volatile content as per manufacturer's request.
	5	Para. 4.1.1 Added alternative use of BAMS 565-001. Removed requirement for UV aged specimens. Para. 5.1 Updated adhesion test as per DHLP 3055
	10	Table 6 Removed Low Temperature Flex test for batch acceptance test
	All	General editorial changes .
Amd. 1	4	Table 2, revised Fluid test temperature
	10	Table 6, Removed Fluid resistance testing from batch acceptance requirement.

1 SCOPE

This specification covers the requirements for a two-part, epoxy based clear organic coating/sealant to be used as a secondary fuel barrier on the external surfaces of the integral fuel tanks.

2 APPLICABLE DOCUMENTS

The following documents form part of this specification, to the extent defined 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 stated, the current issue shall be used.

2.1 U.S. Government Specifications

QQ-A-250/5 - Aluminum Alloy, Alclad 2024, Plate and Sheet

MIL-C-5541 - Chemical Conversion Coatings for Aluminum Alloys

2.2 Federal Specification

Federal Test Method Standard No. 141 - Paint, Varnish, Lacquer and Related Materials and Methods of Inspection and Testing

TT-S-735 - Standard Test Fluid Hydrocarbon

2.3 American Society for Testing & Materials

ASTM D412 - Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.

ASTM D522 - Mandrel Bend Test of Attached Organic Coatings.

ASTM D2196 - Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer.

ASTM D2369 - Volatile Content of Coatings.

2.4 Bombardier Aerospace Toronto Specifications

DHMS C4.01 - Primer, Fluid Resistant, Epoxy

DHMS S5.01 - Slow Evaporating, Manual Wipe, Degreasing and Cleaning Compound

DHLP 3055 - Tape Adhesion Test for Organic Coatings

2.5 Other Company Standards

BMS 3-11G, Type IV, Class I, Grade A - Hydraulic Fluid, Fire Resistant

3 REQUIREMENTS

3.1 Component Requirements

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

3.1.2 Components - The coating shall consist of two components, packaged separately, and supplied in kit form. The components shall not be batch oriented.

3.1.3 Condition in Container - Freshly opened, full containers of the base component shall be free from lumps, skins, grit and coarse particles and shall show no more settling or caking than can be easily dispersed with a paddle to a smooth, homogeneous condition. The catalyst component shall be clear and clean.

3.1.4 Storage Stability - The previously unopened, packaged product shall meet all the requirements specified herein for a period of at least one year from the date of manufacture when stored at 16 - 30^{o}C.

3.1.5 Nonvolatile Content - The nonvolatile content of the base component shall be 79.9% minimum when tested per ASTM D2369.

3.2 Mixed Material Requirements

3.2.1 Mixing Ratio - The base and catalyst shall be mixed according to the manufacturer's instructions.

3.2.2 Spraying Properties - When the base, catalyst and thinner components are mixed according to manufacturer's instructions, the mixed enamel shall exhibit satisfactory spraying characteristics with acceptable leveling properties. The catalyzed material shall spray satisfactorily with no sagging, running or streaking.

3.2.3 Viscosity - The viscosity of the mixed material, determined 60 minutes after mixing when tested per ASTM D2196 Method A at 25 ± 1^{o}C (77 ± 2^{o}F) using RVF Brookfield viscometer (spindle no. 5 and speed of 20 rpm), shall be 7500 cps maximum.

3.2.4 Pot Life - A one quart sample of catalyzed material reduced if necessary, shall show no lumping, gelling or separation after being stored in a closed container for 2 hours at 25 ± 1^{o}C (77 ± 2^{o}F), and shall be capable of meeting all the requirements of this specification.

3.3 Film Properties

3.3.1 Drying Time - The fuel vapor barrier shall have the following drying characteristics under standard conditions (25 ± 1^{o}C (77 ± 2^{o}F) and 50 ± 5% relative humidity):

Table 1: Drying Times for Fuel Vapour Barrier Primer

DRY CONDITION	CURE TIME[1]
Dry Hard	24 hours minimum
Dry Through	96 hours minimum

1. The primer shall be capable of being force cured at temperatures up to 150^{o}F.

3.3.2 Surface Appearance - The dried film shall be free from grit, seeds, craters, blisters or any other surface irregularities.

3.3.3 Colour - The fuel vapour barrier shall be clear.

3.3.4 Adhesion - No loss of adhesion of coating when tested according to para. 5.1.

3.3.5 Flexibility - The fuel vapour barrier coating shall exhibit no cracking, crazing or loss of adhesion when bent over a 0.25 inch diameter mandrel. Two test specimens A per Table 5 shall be tested according to ASTM D522 Method B.

3.3.6 Low Temperature Flexibility - The primer coating shall exhibit no cracking, crazing or loss of adhesion. Two test specimens A, per Table 5 shall be tested according to para. 5.2.

3.3.7 Fluid Resistance - When immersed in the fluids per Table 2, the cured fuel vapour barrier coating shall show no blistering, loss of adhesion or other deleterious effects after specified immersion time. Two test specimens A per Table 5 shall be

tested for each fluid per para. 5.1 within 30 minutes from removal from the test fluid.

Table 2: Fluid Resistance Test

TEST FLUID	IMMERSION TIME	FLUID TEST TEMPERATURE
distilled water	42 days	25± 1°C (77± 2°F)
hydraulic fluid[1]	7 days	25± 1°C (77± 2°F)
TT-S-735 Type III	42 days	25± 1°C (77± 2°F)

1. Hydraulic Fluid to BMS 3-11 Type IV, Class 1, Grade A

3.3.8 Repairability - The fuel vapour barrier coating shall show no blistering, loss of adhesion or other deleterious effects when tested according to para. 5.3.

3.3.9 Tensile Strength & Elongation - The tensile strength and elongation of fuel vapour barrier coating when tested according to para. 5.4 shall be as follows:

TABLE 3. Minimum Tensile Strength Properties for Fuel Vapour Barrier Coating

EXPOSURE CONDITIONS	TENSILE STRENGTH (psi)
Unexposed	1500
After 168 hours @ 200°F	400
After 24 hours @ 250°F	300

TABLE 4. Elongation % for Fuel Vapour Barrier Coating

EXPOSURE CONDITIONS	ELONGATION % (Min)
Unexposed	100
After 168 hours @ 200°F	25
After 24 hours @ 250°F	20

3.3.10 Pressure Resistance - The fuel vapour barrier coating shall show no cracking, loss of adhesion or other film failures in the pressure rupture or fastener sealing tests per para. 5.5.

4 PREPARATION OF TEST SPECIMENS

4.1 Preparation of Test Specimens (if LAB test specimens are not used)

Table 5: Test Panels

ID	Lab Dwg	Material	Size	Pre-Treatment
A	062-1C2a	2024-T3 clad QQ-A-250/5	3"x 6" x 0.032”	chromate conversion coating to MIL-C-5541 Class1A

4.1.1 Test Specimens A- shall be primed with epoxy primer to DHMS C4.01 Type 2 or BAMS 565-001 Grade A, Catagory 1, Type 1 to a dry film thickness of 0.0004 to 0.0006 inch and cured for 7 days minimum at ambient conditions.

4.1.2 Cleaning of Stored and Primed Test Specimens - After ageing of the specimens, clean all test panels using DHMS S5.01 Class 2 and Scotch Brite and wipe dry with a clean lint-free cloth.

4.1.3 Application of Fuel Vapour Barrier Coating - Immediately after cleaning, test specimens shall be coated with fuel vapour barrier coating to a dry film thickness of 0.005 - 0.010 inch and air dried at room temperature. The coating shall be air cured at ambient conditions for 96 hours before testing. The fuel vapour barrier coating shall prepared according to manufacturer specifications.

5 TEST METHODS

Unless otherwise specified, tests shall be conducted at 18 - 25^{o}C and 30 - 80% relative humidity.

5.1 Adhesion - Carry out adhesion test as per DHLP 3055, Method IV, Class 1.

5.2 Low Temperature Flexibility - The test specimens shall be conditioned at -65 ± 5^{o}F for 5 ± 0.5 hour. The specimens shall then be rapidly bent over a 4 inch diameter mandrel that has been conditioned at the same temperature and time as the test panels according to ASTM D522 Method B.

5.3 Repairability - The test specimens used in para. 3.3.7 shall be air dried for 24 hours, sanded using 400 grit aluminum oxide abrasive paper and solvent cleaned using DHMS S5.01 Class 2. The fuel vapour barrier coating shall be reapplied and air dried for 96 hours. The test specimens shall be immersed for seven days in the test fluids specified Table 2. The test specimens used in the repairability test shall be immersed in the same fluids, which were used for the fluid resistance test. Test for adhesion per para 5.1 within 30 minutes of removal from the test fluid.

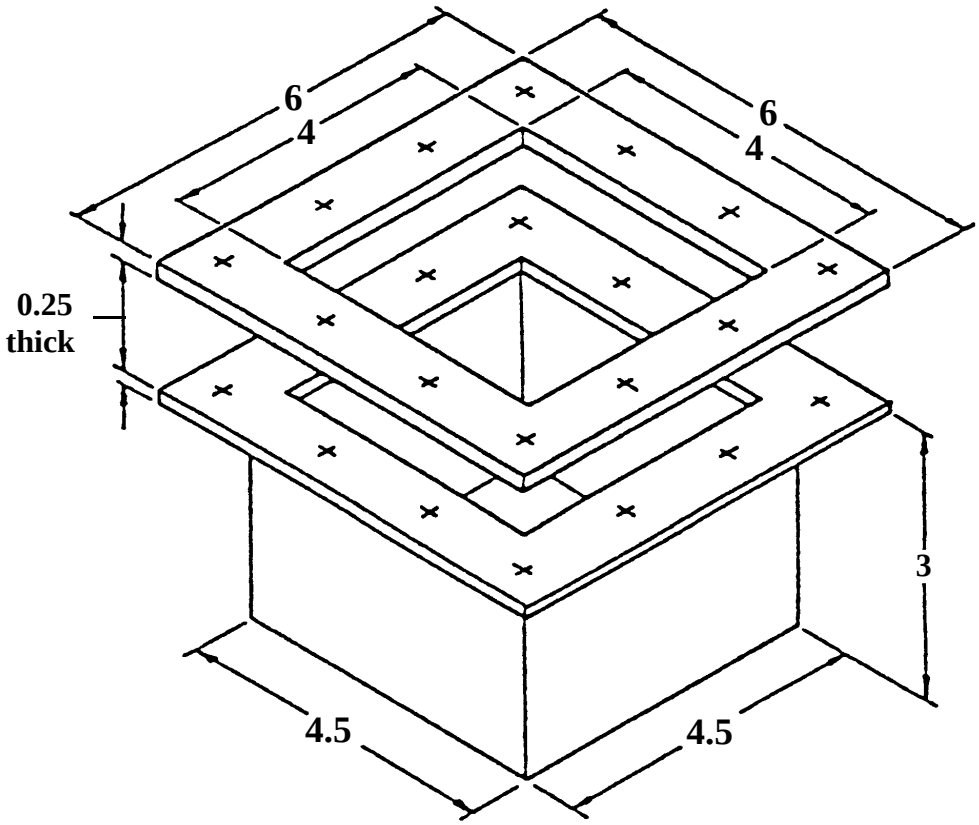
5.4 Tensile Strength & Elongation - Cast sheets of free films of fuel vapour barrier coating 0.005 to 0.010 inch in thickness onto a release material such as polyethylene, and allow the coating to dry through. Expose one sheet to a temperature of 200^{o}F for 168 hours, second to a temperature of 250^{o}F for 24 hours. Hold the third sheet at the standard conditions. Cut five dumbbell shaped tensile specimens from each sheet using ASTM D412 die C. Test all specimens per ASTM D412 Method A except use a jaw separation rate of 2 inches per minute.

5.5 Pressure Resistance (Figure 1, pressure vessel)

5.5.1 Pressure Rupture - A free film of fuel vapour coating, 0.005 to 0.010 inch in thickness, shall be fitted over a 0.25 inch diameter hole and sealed in place with DHMS S3.01 on the pressure rupture plate (Figure 2). Cure DHMS S3.01 for 14 days at standard ambient conditions. Attach rupture plate to the pressure vessel. Slowly pressurize the assembly to 30 psi and hold for 3 minutes. Check for leakage, blowout and delamination.

5.5.2 Fastener Sealing - Apply fuel vapour barrier coating onto a fastener plate that has leaking countersink rivets (Figure 3). Cure the coating for the minimum of 96 hours. Attach the faster sealing plate to the pressure vessel. Slowly pressurize the

assembly to 90 ± 5 psi. and hold for 3 minutes. If no leaks occur, depressurize the vessel, add 250 ml of TT-S-735 Type III test fluid to the vessel and pressurize at 2 psi for 7 days. After 7 days, immerse pressurized vessel assembly in water for 14 days. Examine the test panel for cracks, delamination, adhesion loss and other film failures.



Note. All dimensions in inches.

FIGURE 1. Pressure vessel (made from any weldable aluminum 0.25 inch thick plate)

Note
All dimensions in inches.

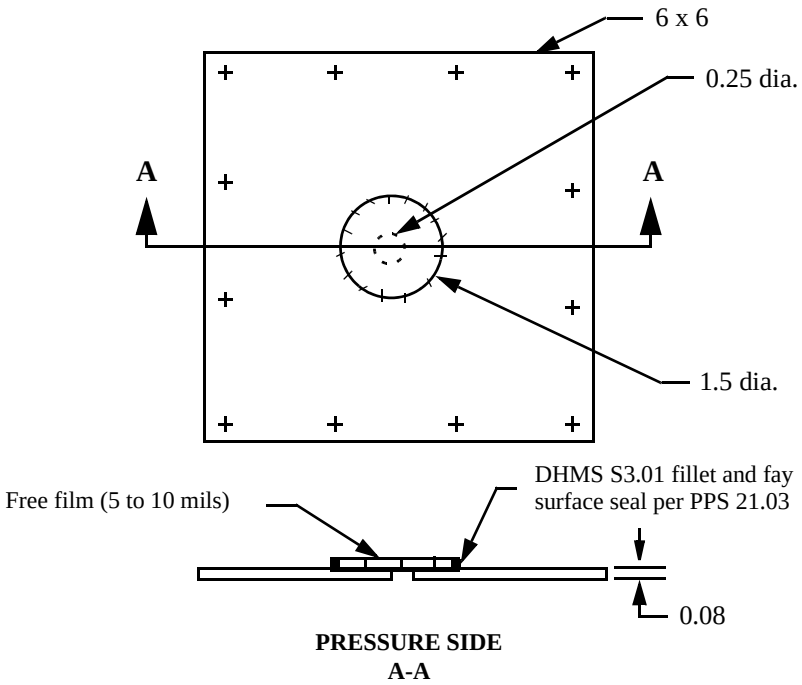


FIGURE 2. Pressure Rupture

Note
All dimensions in inches.

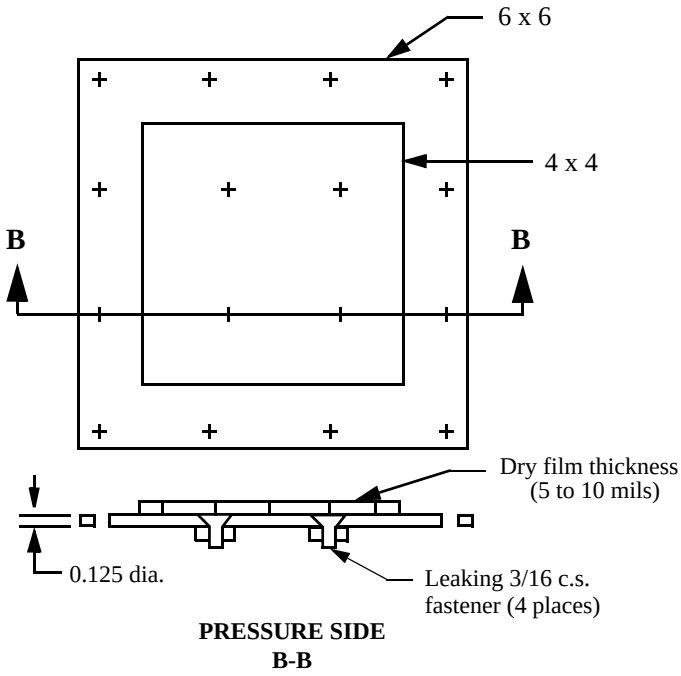


FIGURE 3. Fastener Sealing

6 MATERIAL QUALIFICATION REQUIREMENTS

6.1 Request For Qualification

All requests for qualification to this specification shall be addressed to Bombardier Aerospace Materials Technology Engineering department for approval.

All material qualification shall be site specific.

An audit of the manufacturers and/or test facilities by Materials Technology Engineering may be necessary prior to approval.

6.2 Definitions

6.2.1 Batch is defined as the end product of all the raw materials mixed and/or manufactured at the same time and place. The weight or volume may vary, depending upon the capacity of the manufacturer's facilities.

6.2.2 Lot is defined as the total quantity of product in a shipment taken from the same batch.

6.3 Qualification Testing

Potential suppliers shall submit a written qualification test report based on 3 batches/lots of materials (unless otherwise specified by BAMPE) showing compliance with the requirements contained in section 3. The test report shall contain actual numerical test values, average test results as well as failure modes where applicable.

A sample shall be submitted for testing at the discretion of Bombardier Aerospace Materials Technology for evaluation.

Upon review of supplier's data, PCD and Materials Technology tests, the supplier will be advised either of product qualification or reasons for disqualification.

Products that are qualified will be listed in the Qualified Products List of this specification.

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

Re-qualification of the product may be requested by the Bombardier Materials Technology if there are any changes in the method of manufacture and/or formulation.

6.4 Qualification by Similarity

6.5 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.

6.6 Process Control Document

6.6.1 The manufacturer shall develop and maintain a Process Control Document (PCD). The PCD shall define the manufacturing and quality control requirements and procedures for assuring consistent, uniform and compliant products. The PCD shall identify baseline chemical constituents, in-process test procedures and requirements, and manufacturing procedures. All specifications and test procedures employed during the process shall also be listed and issue/date controlled.

6.6.2 When qualification has been granted, the PCD shall be signed by the supplier and Bombardier Aerospace Materials Technology Engineering and shall not be changed without prior written approval.

6.6.3 The PCD and all production data shall be available to any Bombardier Aerospace auditors when requested.

6.7 Qualification Approval

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

Products that are qualified will be listed in the Qualified Products List of this specification.

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

Re-qualification of the product may be requested by the Bombardier Materials Technology if there are any changes in the method of manufacture and/or formulation.

7 QUALITY ASSURANCE REQUIREMENTS

7.1 Batch/Lot Acceptance Tests

The manufacturer/supplier is responsible for the performance of all sampling, inspection and testing of each batch/lot as specified in **Table 6.**

The manufacturer/supplier shall issue with each batch of product one copy of an Acceptance Test Report showing actual test data conformance to the acceptance tests specified in **Table 6**. The report shall include the supplier's batch identification, materials specification and date of testing.

Bombardier Aerospace Materials Technology Engineering 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.

The manufacturer/supplier shall certify with a Certificate Conformance that each batch of each shipment meets the requirements of this specification.

7.2 Purchaser Batch/Lot acceptance tests

7.2.1 The purchaser is required to perform of all sampling, inspection and testing of each batch/lot as specified in **Table 6**

Table 6: Qualification And Batch Acceptance Tests

Test	Paragraph	Qualification	Acceptance Manufacturer/ Supplier	Acceptance Purchaser/user
Condition in Container	3.1.3	x	x	x
Non-Volatile Content	3.1.5	x	x	x
Viscosity	3.2.3	x	x	x
Pot Life	3.2.4	x	x	x
Drying Time	3.3.1	x	x	x
Surface Appearance	3.3.2	x	x	x
Colour	3.3.3	x	x	x
Adhesion	3.3.4	x	x	x
Flexibility	3.3.5	x	x	
Low Temperature Flexibility	3.3.6	x		
Fluid Resistance	3.3.7	x		
Repairability	3.3.8	x		
Tensile Strength & Elongation	3.3.9	x		
Pressure Resistance	3.3.10	x		

8 ORDERING DATA

8.1 Prerequisite

8.1.1 Products furnished under this specification for production use shall be qualified and listed on the Qualified Products List prior to issuing of a Purchase Order.

8.2 Procurement documents shall specify the following:

- Title, Number, Issue and Amendment Number of this Specification
- Manufacturer's Name and Product Identification (Trade Name or Code Number)
- Type or Size of Containers
- Total Quantity
- Coating to DHMS C4.20
- Acceptance Report
- Material Data Safety Sheets

9 PREPARATION FOR DELIVERY

9.1 Preservation and Packing

9.2 The coating shall be packed in such a manner as to ensure that, during shipment and storage, the product will be protected against damage from exposure to hazards which would affect adversely the property conformance to Section 3 of this specification.

9.3 Packaging

9.4 The coating shall be supplied in a kit packaged as a unit, or as separate components in bulk form as stated on the Purchase Order, consisting of base component and the required amount of catalyst and thinner to bring the coating to spraying consistency.

9.5 Marking

9.5.1 Each container shall be legibly marked with the following information:
- Fuel Vapour Barrier, (conforms to DHMS C4.20)
- Manufacturer's Name and Product Identification (Trade Name or Code Number)
- Date of Manufacture
- Batch Number
- Net Quantity (Imperial, U.S. or Metric Measure)

9.6 Shipping Documentation

9.6.1 Shipping document shall show:
- Bombardier Aerospace Purchase Order No.
- Specification Number
- Number of Containers
- Batch Number
- Total Quantity (Imperial, U.S. or Metric Measure)
- Acceptance Test Reports
- Material Safety Data Sheets

10 PROCUREMENT DOCUMENTS

10.1 Procurement documents shall specify the following:
- Title, Number, Issue and Amendment Number of this Specification
- Manufacturer's Name and Product Identification (Trade Name or Code Number)
- Type or Size of Containers
- Total Quantity

11 HEALTH AND SAFETY DATA

When supplying samples for qualification per Section 3, 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, re-activity data, physical properties, preparation information and procedures for storage and disposal.

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

Upon receipt of DH 4340 form, “Recommendation”, 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 MSDS.

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	QUALIFICATION SHEET NO.	MSDS #	DATE OF PRODUCT APPROVAL
Akzo Nobel East Water St., Waukegan IL USA 60085	473-13 Base C-31 Catalyst TL-29 Thinner	1	0315 0317	June 5, 1997