

1 SCOPE

- a. This specification establishes the requirement for foaming adhesives.
- b. These adhesives are suitable for bonding to all honeycomb core edges and for core reinforcement in accordance with BAC5514–590.
- c. The adhesives are closed cell and provide an environmentally durable morphology.
- d. This specification requires qualified products.

WARNING

WARNINGS may be included throughout this specification. Do not take these WARNINGS to be all inclusive, nor to completely describe hazards or precautionary measures applicable to specific procedures or operating environments.

Non–Boeing personnel must refer to their employer's safety instructions for information concerning hazards which may occur during operations described in this specification.

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Authorizing Signatures on File

FOAMING ADHESIVES

BMS

5–90V

BOEING MATERIAL SPECIFICATION

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2 CLASSIFICATION

This specification consists of the following Types, Grades, and Classes.

2.1 TYPES

Type represents the form of the material, either film or extrudable.

- a. Type I – Obsolete
- b. Type II – Obsolete. Superseded by Type III, IV, VI or VII
- c. Type III designates foaming film adhesives
- d. Type IV designates foaming extrudable adhesives
- e. Type V designates foaming film adhesives for special applications such as core edge closeouts and high compression strength applications. Type V is not approved for typical core splice applications, such as core to core and core to spar bonding.
- f. Type VI designates pre-expanded extrudable adhesive
- g. Type VII designates expanding extrudable adhesive with relatively low expansion and high shear strength capability.

NOTE: Types III, IV, VI and VII have the same minimum mechanical capability.

2.2 CLASS

Class 250/350–10–10–Obsolete – superceded by Class 1.

Class 1 – Material capable of being cured at both 250 and 350 F

2.3 GRADE

Grade represents the nominal film thickness in mils. Grade pertains to Types III and V.

| GRADE | THICKNESS (MILS) |
|-------|------------------|
| 25 | 25 |
| 50 | 50 |
| 100 | 100 |

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REFERENCES

The issue of the following references in effect on the date of invitation for bid shall form a part of this specification to the extent herein indicated.

- ASTM D695 – Compressive Properties of Rigid Plastics, Test Method for
- ASTM D792 – Standard Test Methods for Specific Gravity (Relative Density)
- ASTM D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics
- BAC5514 – Common Bonding Requirements for Structural Adhesives
- BAC5514-589 – Application of Corrosion Inhibiting Adhesive Primer
- BAC5514-590 – Bonding With Foam Adhesives
- BAC5555 – Phosphoric Acid Anodizing of Aluminum for Structural Bonding
- BSS7061 – Time and Temperature Recording Requirements
- BSS7101 – Requirements for PCD System for Suppliers of BMS Materials
- BSS7202 – Shear, Lap, Adhesive Bond
- BSS7206 – Peel, Metal to Metal, Adhesive Bonded
- BSS7286 – Statistical Process Control of Designated Engineering Characteristics
- D1-4426 – Approved Process Sources
- OSHA 1910.1200 – Hazard Communication Standard

4

DEFINITIONS

The following definitions apply to terms that are uncommon or have special meaning as used in this specification.

Auxiliary storage facility – A facility external to the supplier's manufacturing location where material is stored under the control of the supplier.

Batch – A homogeneous unit of finished adhesive of the same formulation manufactured under controlled conditions in a continuous operation or a blend of several manufactured units of finished adhesive of the same formulation.

Date of Manufacture (DOM) – The date that all filming operations on a batch of film adhesive or all mixing operations on a batch of extrudable adhesive have been completed.

Date of Shipment (DOS) – The date that a lot of material has been shipped from the supplier's manufacturing location, an authorized distributor, an authorized re-packager, or an authorized auxiliary storage location to the purchaser, whichever occurs later.

Distributor – An intermediate between the supplier and the purchaser who handles, stores, and allocates material without compromising the individual unit packaging.

Key Characteristic (KC) – Measurements taken from the final product that are representative of a stable production process, and that relate to the customer's specified engineering properties of the product.

Key Process Parameter (KPP) – A feature whose variation has a substantial impact on the fit, performance, service life, or manufacturability of the product from the perspective of the customer. Key process parameters are most effectively determined by the Supplier through the use of designed experiments.

Lot – All the adhesive from one adhesive batch received in one shipment.

Lot Size – The total number of units in any one lot irrespective of the volume of the container.

Process Control Document (PCD) – A document that describes the qualified materials, manufacturing processes, in-process testing, and alternate test methods used to document, and control variation of a Supplier's product.

Re-packager – An intermediate between the supplier and the purchaser who handles, re-packages, stores, and allocates material.

Statistical Process Control (SPC) – A systematic method of tracking, predicting and minimizing variation over time. It shall include tools to monitor the stability of a process over time, and have measures to establish the ability of the process to conform to applicable tolerance limits. This involves the use of control charts and capability indices.

Supplier Inventory Life (SIL) – The length of time that occurs between Date of Manufacture and Date of Shipment. Supplier Inventory Life begins on DOM and ends on DOS from the supplier's manufacturing location, an authorized distributor, an authorized re-packager, or an authorized auxiliary storage location.

Supplier Out-time – The time that a material is exposed to temperatures above 0 F and below 90 F at the supplier's manufacturing facility prior to shipping.

Unit – The smallest single portion of adhesive received in any one lot, such as a roll of Type III adhesive

5 MATERIAL REQUIREMENTS

5.1 PHYSICAL PROPERTIES

5.1.1 GENERAL

- a. All Types and Grades shall meet the requirements of Section 5 and Table I both as received and after aging at 90 ± 5 F for 240 ± 10 hours.
- b. Fillers in all Types are to be non-metallic

TABLE I PHYSICAL PROPERTY REQUIREMENTS

| PROPERTY | APPLICABLE TYPE | REQUIREMENT | TEST METHOD SECTION NUMBER |
|-----------------------------|---------------------|---|----------------------------|
| Film Weight FL 2 | | | 8.1.5 |
| Grade 25 | III | 0.195 lb/ft ² max. | |
| Grade 50 | III | 0.395 lb/ft ² max. | |
| Grade 100 | III | 0.755 lb/ft ² max. | |
| Film Weight FL 2 | | | |
| Grade 50 | V | 0.188 ± 0.018 | 8.1.6 |
| Grade 100 | V | 0.375 ± 0.035 lb/ft ² | |
| Expansion ratio | III, IV | 1.5 to 3.5 | 8.1.6 |
| Expansion Ratio FL 3 | | | 8.1.7 |
| 250 F cure; 1F/minute | V | 2.5 to 4.5 | |
| 250 F cure; 5F/minute | V | 2.5 to 4.5 | |
| 350 F cure; 1F/minute | V | 4 to 6 | |
| 350 F cure; 5F/minute | V | 5.5 to 8 | |
| 250/350 F cure; 5 F/minute | V | 2.5 to 4.5 | |
| Expansion Ratio | VII | 1.3 to 2.2 | 8.1.6 |
| Slump | III, IV, VI, VII | | 8.1.8 |
| Tested at 225 to 250 F | | 0.625 inch max. | |
| Tested at 325 to 350 F | | 0.750 inch max. | |
| Exotherm | III, IV, V, VI, VII | 550 F max. FL 4 | 8.1.9 |
| Volatiles FL 1 | III, IV, V, VI, VII | 1 percent max. | 8.1.10 |
| Penetration | III | 0.040 inches min. | 8.1.11 |
| Water Migration | III, IV, V, VI, VII | 24 hours, 10 percent max. 14 days, 15 percent max. Dye migration, 0.01 inch max. | 8.1.12 |

FL 1 For Type VI see the QPL for the percent volatile requirement

FL 2 Key Characteristics (KC) – SPC required

FL 3 Type V cure cycles shall be in accordance with Section 8.3.

FL 4 Exotherm shall not exceed 560 F for Type V, Grade 50 adhesive.

5.1.2 TACK CHARACTERISTICS (TYPE III, V)

Uncured adhesive shall have the following characteristics at 65 to 90 F.

- a. Backing paper can be removed easily. Dry ice may be used on a very small localized area to initiate peeling.
- b. Adhesive can be easily repositioned on details during layup.
- c. Adhesive will remain in position regardless of detail orientation.

5.1.3 HANDLING CHARACTERISTICS (TYPE IV, VI, VII)

Uncured adhesives shall have the following characteristics at 65 to 90 F.

- a. Extrudable using cartridge (Semco type) gun application.
- b. Adhesive will remain in position regardless of detail orientation.

5.1.4 STORAGE LIFE (ALL TYPES)

BMS5-90 components shall retain their ability to meet the physical property requirements of Section 5 for a minimum period of 6 months from the date of shipment from the manufacturer's facility, an authorized distributor, an authorized re-packager, or an authorized auxiliary storage facility, whichever occurs later.

- a. The adhesives shall remain in sealed cartridges or airtight wrappers, except for opening to obtain samples for acceptance tests.
- b. The temperature of all Types during shipment and storage shall remain at or below zero F.
- c. Continuous temperature monitoring during shipment is required as part of any reduced testing implementation.

5.2 STRENGTH PROPERTIES

All Types shall meet the requirements of Table II.

TABLE II MINIMUM STRENGTH REQUIREMENTS

| TESTS FL 1 | APPLICABLE TYPE | MINIMUM AVERAGE | MINIMUM INDIVIDUAL | TEST METHOD SECTION |
|--|-----------------|-----------------|--------------------|---------------------|
| 1. 75 F Tube Shear, psi | III, IV, VI | 600 | 450 | 8.1.1 |
| 2. -67 F Tube Shear, psi | III, IV, VI | 700 | 550 | 8.1.1 |
| 3. 180 F Tube Shear, psi | III, IV, VI | 500 | 400 | 8.1.1 |
| 4. 250 F Tube Shear, psi | III, IV, VI | 300 | 250 | 8.1.1 |
| 5. 350 F Tube Shear, psi | III, IV, VI | 100 | 75 | 8.1.1 |
| 6. 75 F Tube Shear after 15 minutes trichloroethane degreasing and 30 minute post baking at 250 F, psi | III, IV, VI | 600 | 450 | 8.1.1 |
| 7. 75 F Tube Shear after immersion in BMS3-11 for 7 days at 150 F, psi FL 2 FL 3 | III, IV, VI | 500 | 400 | 8.1.1 |
| 8. 75 F Tube Shear after 30 days salt spray exposure at 95 F, psi FL 3 FL 4 | III, IV, VI | 500 | 400 | 8.1.1 |
| 9. 75 F Tube Shear after 3 day water boil, psi | III, IV, VI | 500 | 400 | 8.1.1 |
| 10. -67 F Lap Shear | VII | 2500 psi | --- | 8.1.2 |
| 11. 75 F Lap Shear | VII | 3500 psi | 3000 psi | 8.1.2 |
| 12. 180 F Lap Shear | VII | 2500 psi | --- | 8.1.2 |
| 13. 250 F Lap Shear | VII | 1000 psi | --- | 8.1.2 |
| 14. 75 F Metal to Metal Peel | VII | 25 in-lb/in | --- | 8.1.3 |
| 15. 75 F Compression FL 5 FL 6 FL 7 | V | 1600 psi | 1400 psi | 8.1.4 |

FL 1 All temperatures are ± 5 F.

FL 2 The specimen shall be completely submerged.

FL 3 The specimen shall be tested within four hours of being taken out of the bath.

FL 4 Suspend each specimen by a non-corrosive wire or string so that salt spray has equal access to all sides.

FL 5 Cured density shall be 24.5 to 29.5 pounds per cubic foot as determined by Section 8.1.13.

FL 6 Type V cure cycles shall be in accordance with Section 8.3.

FL 7 Compression requirement applies to the 350 F cure cycle with the 1 F and 5 F/minute heat up rates only

5.3 ADHESIVE CHEMISTRY

The critical elements of the adhesive chemistry of composition and its control limits shall be identified in terms of measurable properties (see Section 6).

5.4 WORKMANSHIP (TYPE III, V)

- a. Creases, folds, tears, cracks, and defects shall not be allowed between the first and last foot of the Type III adhesive unless each is flagged and an equivalent yardage (1 linear foot minimum) is added to the roll. No more than five such anomalies will be allowed per roll. Creases, folds, tears, cracks and defects shall be removed from the Type V adhesive sheets.
- b. The following items will be considered to be defects:
 - (1) More than three pinholes which are larger than 0.05 inch but smaller than 0.20 inch per lineal foot of material.
 - (2) Any pinhole larger than 0.20 inch. Multiple pinholes larger than 0.20 inch may be flagged as a single defect if they are contained within 1 linear foot of material.
 - (3) Thinouts wider than 0.05 inch or longer than 4 inches.
- c. Flags shall consist of a single color polyethylene backing material extending out beyond the edges of the roll.

6 QUALIFICATION

Products qualifying to this specification shall meet all requirements specified in Section 5.

6.1 REQUESTS

- a. Direct all requests for qualification to a Supply Management and Procurement (SM&P) organization of The Boeing Company. SM&P coordinates all communication between material suppliers and the appropriate Boeing departments.
- b. Prior to submitting a material for qualification to this specification, the material supplier shall provide a Material Safety Data Sheet and a chemical formulation for the candidate material. Agreements for non-disclosure and control of proprietary information shall be considered and executed as appropriate. The information provided shall be submitted to the appropriate Boeing Safety, Health, and Environmental Affairs organizations to perform a health hazard evaluation. These organizations determine whether the information is adequate, or whether additional information is necessary, to identify and document appropriate precautions for the material's use.
- c. No changes in approved product formulation, raw materials, basic methods of manufacture, test methods, supplier inventory life, manufacturing plant site, authorized distributors, authorized re-packagers, or auxiliary storage locations for a material qualified to this specification shall be made without notification and prior approval in writing from The Boeing Company. It may be necessary to requalify material manufactured with the proposed change, and a revised product designation may be required.
- d. Qualified products are listed in the Qualified Products List.
- e. Production Materials shall be capable of meeting all qualification requirements.

6.2

SAMPLES AND TEST REPORTS

- a. Qualification samples submitted for approval shall be accompanied by a test report giving actual data for a minimum of three batches in accordance with Type and Class requirements for all tests in Section 5.

Both individual specimen values and average values for each test shall be reported. Each value reported shall be shown as being for an individually numbered specimen, the numbering of which shall be coded in the report in such a manner as to definitely establish the particular test assembly from which the specimen was cut and the particular batch (batch is defined in Section 4) with which the test assembly was bonded, together with the date of bonding. Coded identification of the component batches shall include the respective dates of manufacture and sizes of batches. Dates on which the different tests were performed shall be shown in the test report.

- b. In addition to the required tests in Section 5 the vendor shall submit a processing variables study that demonstrates that the material to be qualified meets the requirements of Section 5. The process variables study shall typically consist of two material batches evaluated for Tests 1, 4, and 5 of Table II when cured at both 1 F per minute and 10 F minute rate of rise during cure. The number of specimens for each batch shall be as required in Table III. A plan for this study shall be approved by The Boeing Company.
- c. All suppliers shall either have test facilities required to test in accordance with this specification or use certified commercial test laboratories to test in accordance with this specification.
- d. Qualification samples shall be submitted from each of three production batches for each candidate Type.
- e. The Supplier shall maintain a revision controlled list of all authorized distributors, re-packagers, and auxiliary material storage locations (foreign and domestic) for their qualified products. This list shall be either documented as part of the PCD or referenced within the PCD, and shall be made available to purchasers upon request.
- f. The Supplier shall have a process for granting and maintaining authorized distributor, re-packager, or auxiliary storage location status documented or referenced in their PCD. This process shall include documentation of all time and temperature exposures during shipping between and storage at authorized distributors, re-packagers, or auxiliary storage locations. In addition, the process shall include a method to ensure that supplier inventory life is not exceeded when the material is handled by an authorized distributor, re-packager, or auxiliary storage location prior to shipment to a purchaser.
- g. All qualification data, production records, and test data shall be kept on file for a minimum of seven years and shall be readily available for review.
- h. Supplier Inventory Life for each type and class of material shall be established by the Supplier and documented in their PCD.
- i. Supplier out-time for each type and class of material shall be established by the supplier based on supporting data and documented in their PCD.

6.2 SAMPLES AND TEST REPORTS (Continued)

TABLE III SPECIMENS REQUIRED FOR QUALIFICATION TESTS FOR EACH BATCH FL 4

| TESTS | TYPE | NUMBER REQUIRED | | TEST METHOD SECTION |
|---------------------------------------|--------------|-----------------|-----------|---------------------|
| | | FRESH FL 1 | AGED FL 2 | |
| Test 1, Table II FL 3 | III, IV, VI | 24 | 6 | 8.1.1 |
| Test 2, Table II FL 3 | III, IV, VI | 9 | --- | 8.1.1 |
| Test 3, Table II FL 3 | III, IV, VI | 9 | --- | 8.1.1 |
| Test 4, Table II FL 3 | III, IV, VI | 9 | --- | 8.1.1 |
| Test 5, Table II FL 3 | III, IV, VI | 9 | --- | 8.1.1 |
| Test 6, Table II FL 3 | III, IV, VI | 9 | 3 | 8.1.1 |
| Test 7, Table II FL 3 | III, IV, VI | 9 | 3 | 8.1.1 |
| Test 8, Table II FL 3 | III, IV, VI | 9 | 3 | 8.1.1 |
| Test 9, Table II FL 3 | III, IV, VI | 9 | 3 | 8.1.1 |
| Test 10, Table II | VII | 5 | 5 | 8.1.2 |
| Test 11, Table II | VII | 5 | 5 | 8.1.2 |
| Test 12, Table II | VII | 5 | 5 | 8.1.2 |
| Test 13, Table II | VII | 5 | 5 | 8.1.2 |
| Test 14, Table II | VII | 5 | 5 | 8.1.3 |
| Test 15, Table II | | | | 8.1.4 |
| 350 F cure; 1 F/minute | V | 5 | 5 | |
| 350 F cure; 5 F/minute | V | 5 | 5 | |
| Film Weight | III, V | 3 | 3 | 8.1.5 |
| Expansion Ratio | III, IV, VII | 3 | 3 | 8.1.6 |
| Expansion Ratio | | | | 8.1.7 |
| 250 F cure; 1 F/minute heat up | V | 5 | 5 | |
| 250 F cure; 5 F/minute heat up | V | 5 | 5 | |
| 350 F cure; 1 F/minute heat up | V | 5 | 5 | |
| 350 F cure; 5 F/minute heat up | V | 5 | 5 | |
| 250/350 F cure; 5 F/minute heat up | V | 5 | 5 | |

6.2 SAMPLES AND TEST REPORTS (Continued)

TABLE III SPECIMENS REQUIRED FOR QUALIFICATION TESTS FOR EACH BATCH (Continued)

| TESTS | TYPE | NUMBER REQUIRED | | TEST METHOD SECTION |
|---------------------------------------|------------------|-----------------|-----------|---------------------|
| | | FRESH FL 1 | AGED FL 2 | |
| Slump | III, IV, VI, VII | 1 | 1 | 8.1.8 |
| Exotherm | All Types | 3 | 3 | 8.1.9 |
| Volatiles | All Types | 3 | --- | 8.1.10 |
| Penetration | III | 1 | 1 | 8.1.11 |
| Water Migration | | | | 8.1.12 |
| 250 F cure; 1 F/minute heat up | All Types | 5 | --- | |
| 250 F cure; 5 F/minute heat up | All Types | 5 | --- | |
| 350 F cure; 1 F/minute heat up | All Types | 5 | --- | |
| 350 F cure; 5 F/minute heat up | All Types | 5 | --- | |
| 250/350 F cure; 1 F/minute heat up | All Types | 5 | --- | |

FL 1 Maximum exposure before cure initiation is 4 hours at 90 ± 5 F.

FL 2 Exposure before cure initiation is at 90 ± 5 F for the maximum allowable out time.

FL 3 Randomly select specimens from a minimum of eight tube shear assemblies, for the fresh tests. Randomly selected specimens from a minimum of two assembly for the aged tests.

FL 4 Cure cycle is in accordance with Sections 8.2 and 8.3 as applicable.

6.3 PROCESS CONTROL DOCUMENT

- Supplier shall submit a Process Control Document (PCD) for Boeing review prior to qualification audits of production material.
- The PCD shall document baseline raw material constituents, in-process test procedures and requirements, manufacturing procedures, alternate test methods, and procedures for dealing with issues of non-conformances in accordance with BSS7101. Rationale for the formulation and process parameters shall be supported by historical data and experimentation.
- The PCD shall document a statistical process control (SPC) program as specified in Section 7.1.1.

6.4 QUALIFICATION AUDIT

- Supplier shall submit to an audit of their manufacturing operations, Quality Assurance system, raw materials accountability system, product traceability, process records, test results, and quality assurance records.
- Qualification audits shall be conducted during the manufacture of the qualification batches in accordance with BSS7101.
- The Boeing Company reserves the right to perform an on-site audit of the manufacturing of any production order after qualification.

6.5 APPROVAL

The Boeing Company will grant written approval of a material and add it to the Qualified Products List when:

- a. All requirements of this specification are met.
- b. Service application test results are satisfactory to The Boeing Company. Service application tests shall include handling and tack characteristics in accordance with Section 5.1.2 on uncured material, in addition to machining characteristics and a study of the influence of process variables on cured material in accordance with Section 6.2b.
- c. An adhesive shall be approved only for the formula on which Boeing qualification tests are made.

7 **QUALITY CONTROL**

7.1 SUPPLIER QUALITY CONTROL

- a. Verify that each batch of material has been manufactured in accordance with an approved PCD. Verify that each lot of adhesive is shipped within the supplier inventory life documented in the PCD. If a lot of material will be handled by an authorized distributor, re-packager, or auxiliary storage facility ensure that sufficient Supplier Inventory Life is retained until DOS.
- b. Supplier shall test each production shipment in accordance with the requirements of Section 7.3 unless a reduced testing plan has been approved in accordance with Section 7.1.2. Each shipment shall be accompanied by a test report providing the results of such testing.
- c. All areas of Type III film adhesive shall be visually inspected and areas which do not meet Section 5.4 requirements shall be marked accordingly by the supplier.

7.1.1 STATISTICAL PROCESS CONTROL (SPC)

The supplier may establish and maintain procedures and requirements for an SPC system based on Key Characteristics (KC) and Key Process Parameters (KPP), in accordance with the requirements of this specification and the terms and methodology of BSS7286.

- a. Key characteristics (KC) for Types III and V are in accordance with Table I.
- b. The process for selecting and documenting KPPs is described in Section 7.1.1.1.

7.1.1.1 Key Process Parameters (KPP)

- a. The selection of KPPs shall be primarily the responsibility of the supplier, and shall be documented in accordance with the supplier's PCD.
- b. KPPs shall include those process parameters in each stage of the manufacturing process which have the greatest influence on the KCs and the performance of the final product.
- c. The supplier shall establish the nominal target value and upper and lower control limits for each KPP. The inspection method and monitoring frequency for each KPP shall be documented in the supplier's PCD.

7.1.1.2 Analysis and Review of KCs and KPPs

- a. The supplier shall conduct statistical analysis on all KCs and KPPs in accordance with BSS7286.
- b. Procedures used to establish and calculate control limits shall be documented in the PCD. A minimum of the most recent and consecutive twenty batches of each Type, Class, Grade, or Style shall be used to establish control limits.
- c. If statistical analysis determines that a KC becomes out of control, the supplier shall:
 - (1) Investigate the cause(s).
 - (2) Eliminate special causes of variation and reestablish statistical control.
- d. If a KC is no longer capable, the supplier shall take corrective action to establish capability in accordance with BSS7286, and assure all previous production material conforms to specification requirements.
- e. The supplier shall document all corrective actions affecting the process and assure the effectiveness of the actions
- f. The Boeing Company reserves the right to review the results of all SPC analysis, capability calculations and corrective actions.

7.1.1.3 Reporting of Data

Suppliers shall provide Boeing SM&P summary reports of SPC data including control charts, nominal value, standard deviation, number of batches, and Cpk for each KC. SPC data must be submitted biannually. If the control limits differ from a previous report, suppliers shall report both the previous and the current control limits.

7.1.2 REDUCED TESTING

- a. The supplier may establish a reduced testing plan based on the capability of the KCs and the performance of the KPPs.
- b. This plan shall be documented as part of the PCD or as part of the quality control system.
- c. Suppliers for which a reduced testing plan is approved by Boeing Quality Assurance shall be identified on the QPL of this specification.
- d. If reduced testing is in place so that the reporting of test results is affected, the supplier shall submit a certified test report which states the authorization for reduced testing. The test report shall be easily understood and certify that the material meets the requirements of the BMS.

7.2 PURCHASER QUALITY CONTROL

7.2.1 REQUIREMENTS

- a. Check the packaging, marking, and paperwork to ensure compliance with the appropriate sections of this specification and to ensure that the material was purchased from a QPL designated supplier or an authorized distributor, re-packager, or auxiliary storage facility of a QPL designated supplier.
- b. Verify that all records of shipping and storage times and temperatures have been received with each shipment, and that the material meets the shipping requirements of Section 10.c from the date the material was shipped from the supplier's manufacturing facility.
- c. Each roll or container of adhesive shall be checked for compliance with the identification requirements of Section 9. Incorrectly identified packages shall not be released for storage or production until the correct information has been marked on the package, as required by Section 9.
- d. Lot numbers for material storage shall be established at the time of receipt and marked on each unit of adhesive to establish traceability to the date of shipment.
- e. Purchaser shall review supplier's test report for required compliance. Purchaser shall test each lot in accordance with the requirements of Section 7.3 unless purchaser testing requirements have been eliminated for that product in accordance with Section 7.2.1f.
- f. When a supplier has demonstrated consistent conformance to required testing in accordance with Section 7.1, Boeing SM&P may remove purchaser testing as a requirement for material procurement from that supplier. Boeing Quality Assurance documentation such as the appropriate D1-4426 Supplier Code will indicate which products are exempt from the purchaser testing requirement.
- g. In addition to the tests specifically listed as acceptance tests, any other test described in Section 5 of this specification may be used to ensure that production shipments of adhesive conform to the requirements of this specification and are comparable to the material previously qualified.
- h. When consistent conformance to specification acceptance (receiving) requirements has been demonstrated, Quality Assurance may implement reduced testing in accordance with a suitable sampling plan. Authorization of a reduced testing plan shall be approved by Boeing Quality Assurance.
- i. Purchaser Quality Assurance shall review all supplier test data submitted with shipment and perform any additional inspection or testing necessary to assure that the production material meets all requirements specified herein.

7.2.2

STATISTICAL PROCESS CONTROL APPROVED SUPPLIERS

- a. When the supplier has shown to be in control and capable in accordance with their PCD and BSS7286, the purchaser shall review the SPC approved supplier's test certification data submitted with each shipment and perform any additional inspection or testing necessary to assure that production material meets all requirements herein, especially those of Section 7.1.1a.
- b. When the purchaser receives a shipment with no discrepancies in shipping temperature (in accordance with Section 5.1.4), the purchaser may place the material into production use without any further receiving tests (in accordance with Section 7.2.1h.).

Temperature variations during shipment of ± 10 degrees which do not exceed 15 minutes maximum are allowed as long as the total time does not exceed 60 minutes.

- c. The purchaser shall retain all shipping information and supplier test data for a period of 7 years.

7.3

SAMPLING, ACCEPTANCE, AND REJECTION CRITERIA

- a. For any Type the lot size (units) for use in Table IV and Table V shall be as follows:

$$Lot\ Size,\ unit = \frac{Lot\ Quantity\ (pounds)}{50}$$

- b. Determine the number of sampling units from Table IV or Table V as appropriate. Each sample shall be of sufficient size to conduct all Table VI tests.
- c. Accept the lot when all the test values have met the requirements of Table I and Table II.
- d. Reject the lot when any of the test values do not meet the requirements listed in Table I and Table II.

TABLE IV SUPPLIER SAMPLING CRITERIA

| LOT SIZE (UNITS) FL 1 | UNITS TO BE TESTED |
|-----------------------|--------------------|
| 1 to 4 | 1 |
| 5 to 25 | 4 |
| 26 to 50 | 5 |
| 51 to 100 | 6 |
| 101 to 200 | 7 |
| 201 to 300 | 8 |
| 301 to 500 | 10 |
| Over 500 | 15 |

FL 1 The supplier may certify a batch using this sampling frequency provided that all lots are shipped within 6 months of the date of manufacture. All lots from this batch would have the same certification data.

7.3 SAMPLING, ACCEPTANCE, AND REJECTION CRITERIA (Continued)

TABLE V PURCHASER SAMPLING CRITERIA

| LOT SIZE (UNITS) | UNITS TO BE TESTED |
|------------------|--------------------|
| 1 to 4 | 1 |
| 5 to 25 | 2 |
| 26 to 50 | 3 |
| 51 to 100 | 4 |
| 101 to 200 | 5 |

TABLE VI SUPPLIER AND PURCHASER INSPECTION TESTING REQUIREMENTS FL 4

| TESTS | TYPE | REQUIREMENT | NUMBER OF SPECIMENS PER UNIT |
|---|------------------|-------------|------------------------------|
| 1. 75 F Tube Shear Strength, psi FL 1 | III, IV, VI | Table II | 5 |
| 2. Film Weight lb/ft ² FL 5 | III, V | Table I | 2 |
| 3. Expansion Ratio – 250 F FL 2 | III, IV, V, VII | Table I | 2 |
| 4. Slump, Inches Maximum – 250 F | III, IV, VI, VII | Table I | 2 |
| 5. Penetration | III | Table I | 2 |
| 6. 75 F Compression FL 1 FL 3 | V | Table II | 3 |
| 7. 75 F Lap Shear FL 1 | VII | Table II | 3 |

FL 1 Supplier Testing only, purchaser testing not required.

FL 2 For Type V use 250 F cure; 5 F/minute heat up rate in accordance with Section 8.3. For other types, cure in accordance with Section 8.2.

FL 3 Use 350 F cure; 5 F/minute heat up rate only

FL 4 For purchaser and supplier tests, only unaged specimens need to be tested.

FL 5 Key Characteristic (KC) – SPC required

8

MATERIAL TEST METHODS

WARNING

This specification involves the use of chemical substances which are hazardous. Boeing personnel shall refer to the work area Hazard Communication Handbook for health effect and control measure information contained in the HazCom Info Sheets and Material Safety Data Sheets. For disposition of hazardous waste materials, consult site environmental engineers for proper disposal methods.

Non-Boeing personnel should refer to manufacturer's Material Safety Data Sheet(s) and their employer's safety instructions.

8.1

TEST METHODS

8.1.1

TUBE SHEAR TESTING

- a. Use drawn aluminum tubes, 5052, 2024, or aluminum alloy of comparable compressive strength.
- b. The outer tube shall be 1 inch O.D. and the inner tube one-half inch O.D. Both tubes shall be 9 inches long and have wall thickness of 0.049 inch.
- c. Clean the tubes in accordance with BAC5555 or equivalent method.

NOTE: Equivalent methods shall result in a non-interfacial failure mode.

- d. The quantity of adhesive required to fill the tube shear assembly annular volume (approximately 4 cubic inches) shall be determined experimentally for each adhesive. This quantity normally falls in the range of 35 to 45 grams. Use the same quantity ± 1 gram for all tube shear tests with the same adhesive.
- e. Cover each end with a suitable flow retardant cloth and assemble in a curing jig as shown in Figure 1. Tighten bolts by hand. The cure jig shall be functionally similar to ST6779 CF.
- f. Cure in accordance with Section 8.2 with the tube in a horizontal position.
- g. Cut test specimens 0.50 ± 0.02 inch long with flat faces normal to the tube axis. Deburr specimens. Discard one specimen from each end.
- h. Test by shearing the inner tube using the tube shear test fixture shown in Figure 1. The jig shall be similar to ST6779 TF.
- i. Apply load-to-failure at a head travel rate of 0.06 ± 0.02 inch per minute.
- j. Maintain the specimen within ± 5 F of the required temperature for 10 minutes minimum before load is applied and 20 minutes maximum before test is complete. Continuously verify test temperatures by a thermocouple attached to the inner tube of the specimen.
- k. Calculate shear strength in lbs/in^2 using the outer surface of the inner tube as the shear surface (1.571 times actual specimen length).

8.1.1 TUBE SHEAR TESTING (Continued)

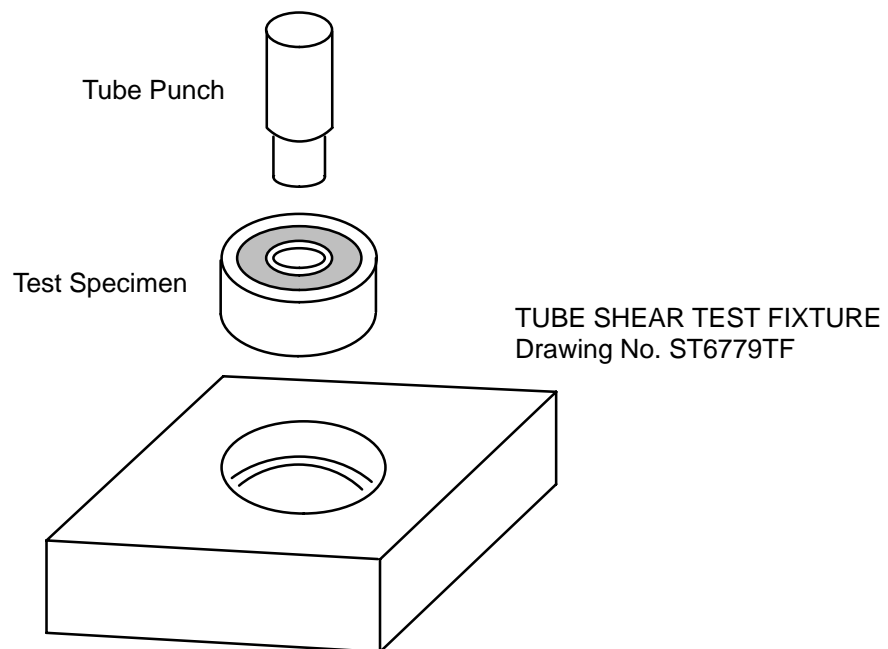
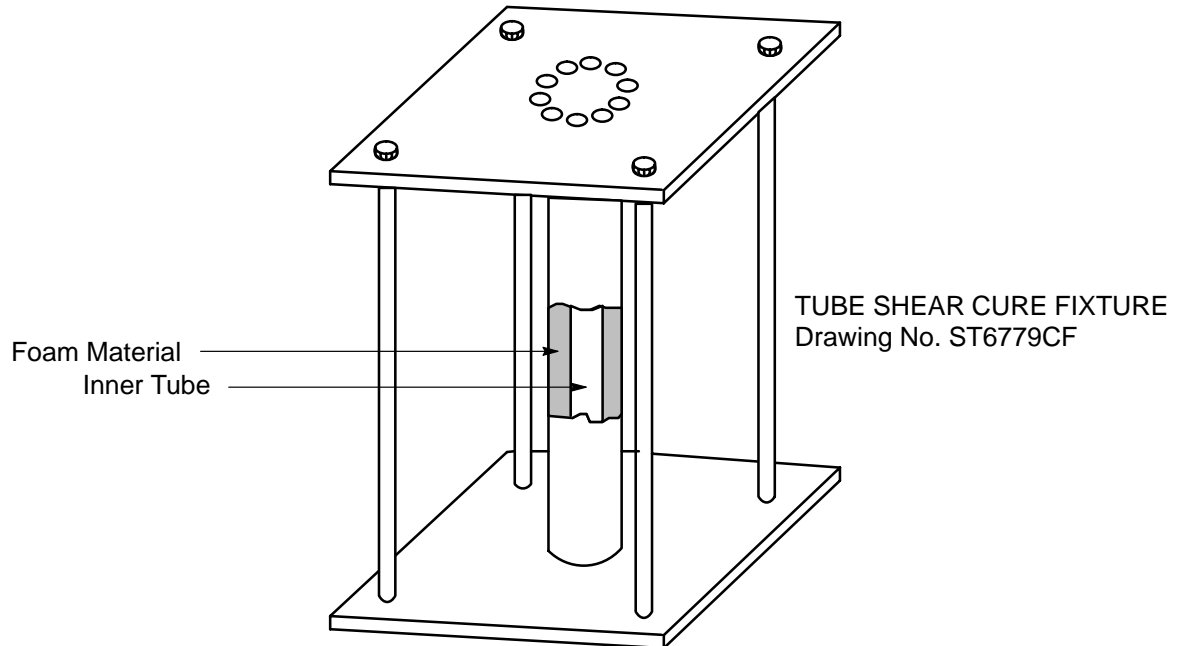


FIGURE 1 TUBE SHEAR TEST FIXTURE

8.1.2 LAP SHEAR TESTING

- a. Use 2024 T3 bare or clad adherends. Adherend dimensions shall be in accordance with BSS7202 Type IV. The adherends shall be anodized in accordance with BAC5555 and primed with BMS5-89 in accordance with BAC5514-589.
- b. Apply Type VII adhesive to both adherends. Use approximately 0.5 percent by weight of 0.010 inch diameter glass beads for bondline thickness control.
- c. Machine and test specimens in accordance with BSS7202 Type IV.

8.1.3 METAL TO METAL PEEL

- a. Use 2024 T3 clad adherends. Adherend dimensions shall be in accordance with BSS7206 Class I, Type II. The adherends shall be anodized in accordance with BAC5555 and primed with BMS5-89 in accordance with BAC5514-589.
- b. Apply Type VII adhesive to both adherends. Use approximately 0.5 percent by weight of 0.010 inch diameter glass beads for bondline thickness control.
- c. Machine and test specimens in accordance with BSS7206.

8.1.4 COMPRESSIVE STRENGTH

- a. Determine compressive strength in accordance with ASTM D 695. Specimens shall have a square cross section of 0.5 by 0.5 inch and be 0.5 inch long nominal. Specimens shall be loaded parallel to the thickness of the cured compression blank.

$$\text{Compressive Strength} = \frac{\text{Ultimate Load (Pounds)}}{\text{Cross Sectional Area (Square Inches)}}$$

- b. Test speed shall be 0.05 ± 0.01 inch/minute.

8.1.5 FILM WEIGHT TESTING

- a. Prepare an uncured sample, approximately 6 inches on a side. Determine the area to the nearest 0.1 square inch.
- b. Remove separator sheets.
- c. Weigh the sample to the nearest 0.1 gram.
- d. Report the weight to the nearest 0.001 lbs/ft²
- e. Document according to the requirements for a key characteristic per Section 7.1.1.

8.1.6

EXPANSION RATIO TESTING (TYPE III, IV AND VII)

- a. For Type III films, prepare a square sample 1.00 ± 0.06 inch on a side, and 100 mils nominal thickness. If necessary, laminate in accordance with BAC5514–590.
- b. For Type IV and VII pastes, fill a cavity with approximate dimensions of 2 by 2 by 0.125 inches.

NOTE: Use additional shims to constrain the lateral expansion as necessary for all types.
- c. Measure the original film thickness with a suitable instrument having an accuracy of ± 0.001 inch.
- d. Place a sheet of release film (Mylar or FEP) of known thickness (0.007 inch minimum) on the top and bottom of the foam sample. A light gauge (<0.050 inch) caul sheet is allowed to reduce pillowing.
- e. Place sample on a flat surface.
- f. Cure Type III, IV, VII in accordance with Section 8.2.
- g. Measure the final sample thickness, including all release film, in accordance with Section 8.1.6c.
- h. Calculate final thickness by subtracting the known release film thickness.

$$\text{Expansion Ratio} = \frac{\text{Final Thickness}}{\text{Original Thickness}}$$

8.1.7

EXPANSION RATIO TESTING (TYPE V)

- a. Cut an approximately 2 inch by 2 inch sample and measure its length (L1) and width (W1) to the nearest 0.01 inch. L1 and W1 should be nearly identical.
- b. Measure the pre-expanded thickness by averaging the thickness of the four corners, measured approximately 0.5 inches in from each corner, and one measurement at approximately the center of the specimen with a suitable instrument having an accuracy of ± 0.001 inch. Remove the poly separator films from the top and bottom of the specimen and measure their combined thickness. Subtract the poly thickness from the overall average thickness to determine the pre-expanded specimen thickness (T1) prior to cure.
- c. Place the specimen on top of a flat surface, such as an aluminum plate covered with Armalon release fabric and cure in accordance with Section 8.3 without applying pressure.
- d. After cure, take five thickness measurements in accordance with Section 8.1.7b and determine the average post-expansion thickness (T2).
- e. Measure the post-expansion length (L2) and width (W2) to the nearest 0.01 inch.
- f. The volume is calculated as: length (L) x width (W) x average thickness (T) in inches. Calculate both the pre-expansion and post-expansion volumes.
- g. The Expansion Ratio is determined by dividing the post-expansion volume (V2) by the pre-expansion volume (V1).

8.1.8

SLUMP TESTING

- a. Scribe a line on a standard lap shear panel (BAC5514), about 2 inches from one end.
- b. Clean the panel in accordance with BAC5514.
- c. Place a 1.00 ± 0.06 inch by 2.00 ± 0.06 inch sample of adhesive, between the scribed line and the end of the panel, with a 2 inch edge on the line. For Type III film, use a thickness of approximately 0.100 inches. If necessary, laminate in accordance with BAC5514–590. For Type IV, VI, VII paste use a thickness of approximately 0.250 inches.
- d. Cure in accordance with Section 8.2 with the panel vertical, and oriented with the sample above the line.
- e. Measure slump as the maximum distance the adhesive has moved below the line.

8.1.9

EXOTHERM TESTING

8.1.9.1

Exotherm Testing of Types III, IV, VI, VII

- a. Remove separator sheets for Type III to produce a specimen with approximate dimensions of 2 by 2 by 0.5 inch. For Type IV, VI and VII extrude the adhesive into a cylinder with approximate dimensions of inch diameter by 1 inch tall.
- b. Secure the thermocouple leads firmly in position, and use any suitable method to keep the thermocouple at the center, such as a piece of aluminum foil tape attached to the leads between the adhesive layers.
- c. Place the laminate on a degreased standard aluminum lap shear panel (BAC5514).
- d. Cure in accordance with Section 8.2 with the panel in a horizontal position.
- e. Continuously monitor sample temperature. Record the peak temperature as the exotherm.

8.1.9.2

Exotherm Testing of Type V

Exotherm samples shall be prepared in the following manner.

- a. Obtain BMS8–124, Type III, Class 1, any Grade, 1.0 and 3.5 inches thick honeycomb cores. It is acceptable to use BMS8–124 Type III, Class 1, Grade 4.5, Style C. Cut the core to nominal dimensions of 2 inches by 3 inches.
- b. For the 1.0 inch core, cut 6, 2 inch by 3 inch pieces of Type V Grade 100. For the 3.5 inch core cut 18, 2 inch by 3 inch pieces of Type V Grade 100.
- c. Remove the Type V separator sheet and insert into the cores. Leave two unfilled cells around the periphery of the core sample. Film may be inserted one ply at a time or as a laminate. It is permissible to use heat to 120 F and vacuum for up to a maximum of 1 hour. It is recommended that no more than 5 plies of Grade 100 film be inserted at any one time. Other methods may be used as long as the film be inserted at any one time. Other methods may be used as long as the film is flush to one surface.

■ 8.1.9.2 Exotherm Testing of Type V (Continued)

- d. Position a minimum of one thermocouple into the middle of the unexpanded laminate. Thermocouples shall be firmly secure into position. Core shall be envelope bagged at a maximum vacuum of 10 inches Hg. Cores may be supported to prevent core crush.
- e. Bagged cores shall be cured at 350 with a 5 F/minute heat-up rate in accordance with Section 8.3. Samples shall be monitored continuously. Record the cure cycle temperature and the peak temperature of the exotherm.

■ 8.1.10 VOLATILES

Weigh approximately 2 grams of each sample to the nearest 0.001 gram. Heat for 2 hours nominal at 217 ± 5 F. Cool in desiccator and reweigh. Repeat until a constant weight is obtained.

$$\text{Percent Volatiles} = \frac{\text{Weight Loss}}{\text{Sample Weight}} (100)$$

■ 8.1.11 PENETRATION TESTING

- a. Use 2.00 ± 0.06 inch square samples to provide a 0.10 to 0.20 inch thickness (stack pieces together if necessary to meet the thickness requirement).
- b. Remove the top separator sheet.
- c. With the sample at 75 ± 5 F, measure the penetration distance with an instrument having a precision of ± 0.001 inch and a travel limit of 0.150 inch minimum. Apply a force of 184 ± 3 grams on a flared-end probe. The flared-end shall be such that no contact is made with the adhesive by the sides of the probe (see Figure 2).
- d. Place the sample under the probe, lower probe until contact is made with the adhesive surface. Release the probe and allow penetration for 360 ± 10 seconds. Record probe travel.

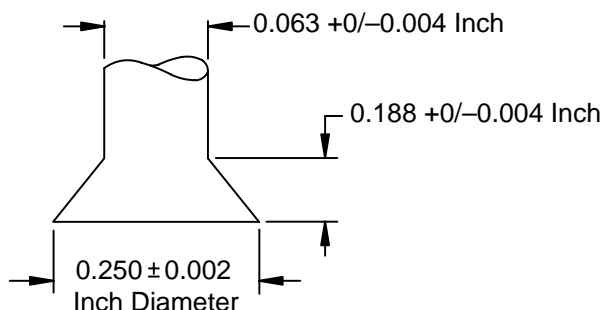


FIGURE 2 FLARED-END PROBE

8.1.12

WATER MIGRATION

- a. Laminate square samples 4.00 ± 0.05 inches (on a side) of Type III or V adhesive together in accordance with BAC5514–590. For Type IV, VI, VII extrude adhesive between shims that are 0.30 ± 0.01 inch, then remove shims. Adhesive thickness requirements are included in Figure 3.
- b. Place samples on a degreased caul sheet using 0.5 ± 0.1 inch shims on all sides (picture frame type) cover sample with FEP and a suitable dry peel ply cloth as shown in Figure 3.
- c. Bag and autoclave cure in accordance with Section 8.2 or Section 8.3 as applicable.
- d. Cut 0.50 by 0.50 ± 0.03 inch specimens from the cast, cured block of material and remove the peel ply.
- e. Weigh each specimen to the nearest 0.001 gram.
- f. For each batch, save one specimen as a control, submerge the other four specimens in dyed water and place into an environment of 160 ± 5 F and 12 to 15 psi.
- g. Remove one specimen after 24 hours and the other three specimens after 14 days.
- h. Following immersion, remove the specimens, wipe outside surface with a soft cloth, and weigh within 1 minute.
- i. Calculate the percent weight increase from the following equation:

$$\frac{\text{Final Weight} - \text{Initial Weight}}{\text{Initial Weight}} (100) = \text{percent weight increase}$$
- j. Record maximum weight increase after 24 hours and 14 days.
- k. After weighing, shear each specimen in half (using a sharp bladed tool) and measure the distance the dyed water migrated into the specimen from the edge.
- l. Machine and test specimens in accordance with BSS7206, Class I.

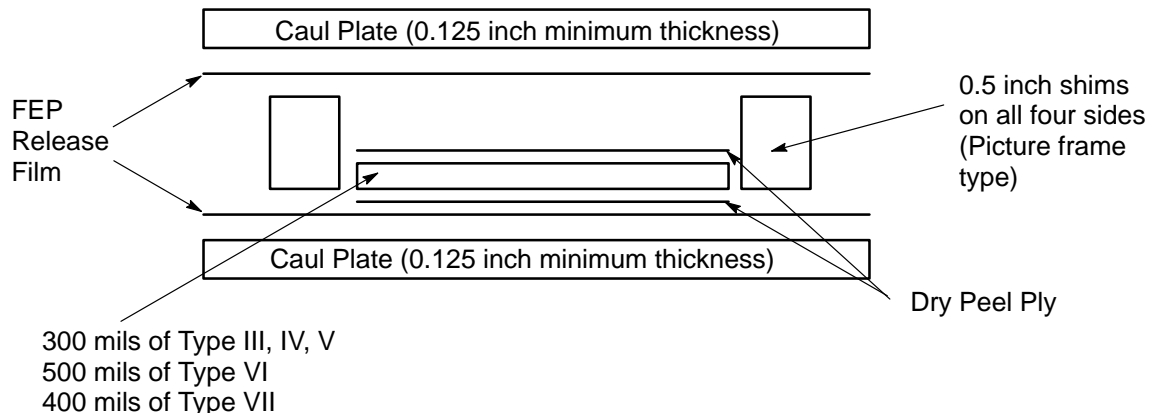


FIGURE 3 WATER MIGRATION SPECIMEN FABRICATION

■ 8.1.13

DENSITY

Determine density according to ASTM D 792 or ASTM D 1622. Perform test at 77 ± 5 F.

8.2

CURE CONDITIONS (TYPE III, IV, VI, VII)

- a. Increase oven temperature from room temperature to cure temperature at a rate of 5 to 10 F per minute except as required in accordance with Section 6.2b.
- b. Cure 90 ± 5 minutes at 225 to 250 F except Test 5, Table II, which shall be cured for 60 ± 5 minutes at 325 to 350 F.
- c. For water migration, lap shear and metal to metal peel tests, autoclave cure the samples at a rate of rise of 5 to 10 F per minute for 90 ± 5 minutes at 220 to 250 F with 45 ± 5 psi pressure and a vented bag.
- d. Allow adhesive to reach room temperature before removing separator sheets. Dry ice may be used only on a very small, localized area to initiate peeling.

8.3

CURE CONDITIONS (TYPE V)

- a. Use one of the following cure cycles as referenced.
 - (1) 250 F cure, 1F/minute: heat from room temperature to 250 ± 10 F. Use a 0.5 to 1.5 F/minute heat up rate. Hold at 250 ± 10 F for 60 to 90 minutes. Cool to room temperature at 4 to 6 F/minute ramp rate.
 - (2) 250 cure, 5F/minute: heat from room temperature to 250 ± 10 F. Use a 4 to 6 F/minute heat up rate. Hold at 250 ± 10 F for 60 to 90 minutes. Cool to room temperature at 4 to 6 F/min. ramp rate.
 - (3) 350 F cure, 1 F/minute: heat from room temperature to 350 ± 10 F. Use a 0.5 to 1.5 F/minute heat up rate. Hold at 350 ± 10 F for 60 to 90 minutes. Cool to room temperature at 4 to 6 F/minute ramp rate.
 - (4) 350 F cure, 5 F/minute: heat from room temperature to 350 ± 10 F for 60 to 90 minutes. Cool to room temperature at 4 to 6 F/min. ramp rate.
 - (5) 250/350 F cure, 5 F/minute: heat from room temperature to 250 ± 10 F. Use a 4 to 6 F/minute heat up rate. Hold at 250 ± 10 F for 60 + 10/-0 minutes. Heat from 250 F to 350 ± 10 F. Use a 4 to 6 F/minute heat up rate. Hold at 350 ± 10 F for 60 + 10/-0 minutes. Cool to room temperature at 4 to 6 F/min. ramp rate.
- b. Samples for compression tests shall be press cured or bagged and cured in an autoclave at a 90 ± 5 psi.
- c. Samples for expansion ratio, slump and exotherm shall be cured in an oven.

9

MATERIAL IDENTIFICATION

Each unit shall be identified as follows:

- a. BMS5–90 (including the latest revision letter) adhesive Type, Class, and Grade.
- b. Supplier's name, address, and product designation
- c. Supplier's batch number
- d. Date of manufacture
- e. Unit number (only applicable to Types III and V)
- f. Storage / shipment requirements (state temperature limitations when refrigeration is required)
- g. Name and address of distributor, re–packager, or auxiliary storage facility if applicable.
- h. Date of Shipment from the supplier, distributor, re–packager, or auxiliary storage facility if applicable, whichever occurs last.

10

PACKAGING, MARKING, AND SHIPPING

- a. Packaging

Labeling shall conform to OSHA 1910.1200.

- b. Marking

Mark each shipping package on opposite ends with the information in Section 9 and the following:

- (1) Purchase order number
- (2) Quantity in the shipping package
- (3) Shipping and storage temperature of zero F or below.

10

PACKAGING, MARKING, AND SHIPPING (Continued)

c. Shipping

- (1) Ship and store all materials according to the requirements of Section 5.1.4.
- (2) Temperature recorders are required with each lot of material to be shipped from the supplier's manufacturing facility or from a supplier authorized distributor, re-packer, or auxiliary warehouse. Include sufficient temperature recorders with each lot shipped to ensure that all temperature excursions above the ranges noted in this Section are recorded.
- (3) The use and placement of temperature recorders shall be in accordance with BSS7061.
- (4) A system for material out-time tracking and control shall be implemented and maintained at all supplier authorized distributors, re-packagers, and auxiliary warehouses. This system must be capable of recording all out-time consumed at each facility for each lot of material stored or shipped.
- (5) During shipment and handling at authorized distributors, re-packagers, or auxiliary storage facilities, the material is allowed to accumulate a total of 16 hours of exposure at temperatures above 0 F and at or below 90 F.