GAMMA-RAY LARGE AREA SPACE TELESCOPE (GLAST) PROJECT

AntiCoincidence Detector (ACD) Tile Shell Assembly Honeycomb Panels

Statement of Work

March, 2003

ORIGINAL

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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Tile Shell Assembly Honeycomb Panels
Statement Of Work

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Special Proposal Instructions

Included in the proposal, the contractor shall address the detailed approach and scheduling of the following items:

1. Achieving and Verifying Honeycomb Panel Tab & Slot Machining Specified on Drawings in Appendix B
2. Opportunities For Cost Reduction
3. Contractor Kick-off Meeting
4. Procurement of Material and Tooling
5. Material Verification Testing
6. Manufacturing Verification Testing
7. Product Assurance Implementation Plan
8. Schedule for Manufacturing Readiness Review
9. Schedule For On Time Delivery of All Items

Additionally, the contractor shall price one option.

Option 1 calls for the thermal cycle testing of the flight honeycomb panels, with panel flatness measurements and non-destructive examination performed again after thermal cycling. The decision to exercise Option 1 shall be made at contract award.

This document defines the detailed Mechanical Requirements for the AntiCoincidence Detector (ACD) Tile Shell Assembly Honeycomb Panel Fabrication.

This document is an internal quality record that is controlled by the Product Design Lead (PDL) for the Tile Shell Assembly. Proposed changes to this document must be submitted to the PDL along with supportive material justifying the proposed change. Comments or questions concerning this document and proposed changes shall be addressed to:

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1. SCOPE

This Statement of Work (SOW) sets forth the scope of effort and requirements to be met by the contractor for delivery of the flight composite honeycomb panels, blank spare honeycomb panels, beam flexure specimens and moment test specimens for the Tile Shell Assembly (TSA), a structural component of AntiCoincidence Detector (ACD) of the Large Area Telescope (LAT) instrument. The LAT is a payload on the Gamma-ray Large Area Space Telescope (GLAST), a Goddard Space Flight Center (GSFC) managed project.

The contractor shall perform the effort in two phases. The first phase shall be comprised of material purchase, material verification testing and manufacturing process review. The second phase shall consist of test specimen fabrication, manufacturing process verification testing, flight panel fabrication ("tab and slot" machining capability shall be demonstrated on a single panel prior to machining the remaining panels), spare blank honeycomb panels, "dry-fit" of the TSA assembly, and delivery. A Manufacturing Readiness Review (MRR) shall be held at the end of the first phase and shall define the beginning of the second phase. The program schedule is outlined in Appendix A. The contractor shall fabricate, inspect, and deliver the test specimens, spare blank honeycomb panels and flight honeycomb panels defined in the drawings listed in Appendix B of this SOW. The deliverables shall perform in accordance with and meet the manufacturing-verification requirements given in this SOW. This effort is build to print. The Mechanical Engineering Branch at GSFC is responsible for the design and analysis of these items. The materials are dictated by GSFC to the contractor. All materials are to be purchased by the contractor, and in accordance with in-house contractor material specifications, subject to review by GSFC. GSFC shall provide all deliverable hardware drawings and applicable documents.

2. APPLICABLE DOCUMENTS

2.1 Government Documents

500-PG-8700.2.5	GSFC Engineering Drawing Standards Manual
ACD-QA-8001	Large Area Telescope (LAT) ACD Quality Plan
FED-STD 209	Clean Room and Work Station Requirements, Controlled Environments
MIL-I-45208	Inspection System Requirements
MIL-STD-45662	Calibration System Requirements
MIL-STD-1246	Product Cleanliness Levels and Contamination Control Program
NASA RP 1124 Rev. 4	Outgassing Data for Selecting Spacecraft Materials
NASA SP-R-022	Vacuum Stability Requirements of Polymeric Material for Spacecraft Application

2.2 Industry Standards

ASTM C297	Standard Test Method for Tensile Strength of Flat Sandwich Constructions in Flatwise Plane
ASTM D792	Specific Gravity and Density of Plastics by Displacement
ASTM D3039 SRM 4, SRM 9	Tensile Properties of Fiber-Resin Composites
ASTM D3410	Compressive Properties of Fiber-Resin Composites
ASTM D3518 ASTM D5379, SRM 7	Inplane Shear Stress-Strain of Fiber Reinforced Plastics
ASTM D2344, SRM 8	Short Beam Shear Strength of Oriented Fiber-Resin Composites
ASTM D3529, SRM 23	Resin Solids Content and Fiber Areal Weight of Carbon Fiber-Resin Composites
ASTM D3530	Volatiles Content of Carbon Fiber-Resin Prepreg

ASTM D3531, SRM 22	Resin Flow of Carbon Fiber-Epoxy Prepreg
ASTM D3532	Gel Time of Carbon Fiber-Resin Prepreg
ASTM D3171	Fiber Content of Resin-Matrix Composites by Matrix Digestion
SRM 10	Fiber Volume, Percent Resin Volume and Calculated Cured Ply Thickness of Plied Laminates
ASTM D3418, SRM 18	Glass Transition Temperature (Tg) of Fiber-Resin Composites By Thermal Analysis
ASTM D2734	Void Content of Fiber-Resin Composites
SRM 11	Environmental Conditioning of Composite Test Laminates
ASTM D5229/D5229M	Moisture Absorption Testing of Polymer Matrix Composites
ASTM E595	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Material from Outgassing in a Vacuum Environment

2.3 Order of Precedence

In the event of conflict between two or more documents, the order of precedence regarding statement of work documents shall be:

1. Drawings listed in Appendix B
2. This Statement of Work
3. Government documents
4. Industry standards

3. MANAGEMENT AND REPORTING

The contractor shall have full responsibility for management and administration of all phases of the work specified by the contract, ensure that all objectives are accomplished within schedule, and provide timely visibility of overall performance to the GSFC (see Appendix A for Program Schedule).

3.1 Progress Reports

The contractor shall submit progress reports per the schedule in Appendix A. The report shall contain a summary of work accomplished, a summary of problems encountered, nonconformance's and their resolution, summaries of inspection and test activities, copies of written approvals for deviations from approved drawings, copies of material certifications and certificates of conformance for raw materials received that period, and a discussion of issues that might affect schedule.

3.2 Kickoff Meeting/Meetings

A kickoff meeting shall be scheduled per Appendix A. The government reserves the right to call for a meeting at any time during the contracting period. A Manufacturing Readiness Review shall be conducted prior to the fabrication of flight hardware and shall be scheduled by the contractor.

3.3 Acceptance Review

Acceptance reviews shall be held at the contractor's facility before the delivery of the flight panels. The contractor must notify the government 5 (five) working days before the review dates. The contractor shall deliver objective evidence with the hardware, showing product assurance acceptance of in-process workmanship, processes, and final inspection. The contractor must implement all corrective actions necessary to remedy, before final acceptance, any nonconformance with respect to this SOW or the specifications noted on the drawings included in Appendix B. A government source inspection shall be required prior to shipment. GSFC or its representative shall have final authority over all tests, verification, and documentation.

3.4 Acceptance Data Package

The contractor shall provide the acceptance data package at the acceptance review for the deliverable hardware. The acceptance data packages shall contain, but not be limited to, the following:

- top level traveler
- GSFC Form DD250 or equivalent
- "as-built" materials and process lists
- nonconformance reports, copies of waivers and deviations
- test reports per Section 6.1.1
- "as built" drawings with actual measured dimensions noted
- material certifications

- verification documentation per Section 4
- open items list with reason for being open and appropriate authorization/approvals (waivers/deviations)

4. VERIFICATION

The contractor shall demonstrate that all requirements are met for each deliverable item. The contractor shall provide documentation of compliance to the requirements described in sections 7 and 8. The contractor shall provide methods as to how these requirements shall be met at the Manufacturing Readiness Review.

5. CONTRACTOR TASKS

5.1 Phase 1 Tasks

5.1.1 Material Purchase

The contractor shall purchase required materials per in-house contractor material specifications. The quantities of material shall be enough to fabricate all specified deliverable hardware, with scrap, as well as all test coupons. Prepreg and film adhesives shall be purchased from a single lot each. Both the prepreg and film lots shall be within manufacturer's shelf life.

5.1.2 Material Verification Testing

The contractor shall perform material and lamina verification tests as required by in-house contractor material specifications. Test data shall be made available to GSFC upon request.

5.1.3 Concurrent Engineering

The contractor shall participate in concurrent engineering with GSFC throughout the program to resolve any discrepancies between coupon and/or part design and their specified performance.

5.1.4 Manufacturing Readiness Review

The contractor shall hold at least one Manufacturing Readiness Review (MRR) prior to machining of the flight honeycomb panels. This review shall define the end of Phase 1 and the beginning of Phase 2.

5.2 Phase Two Tasks

Phase 2 includes all tasks related to fabricating flight panels, spare blank panels, beam flexure specimen and moment test specimen hardware. The start of Phase 2 requires the successful completion of all Phase 1 Tasks including the Manufacturing Readiness Review.

5.2.1 Manufacturing Process Verification Testing

The contractor shall perform the laminate and honeycomb panel manufacturing verification tests and inspections specified in this statement of work for flight hardware. All data shall be made available to GSFC upon request.

5.2.2 Concurrent Engineering

The contractor shall participate in concurrent engineering with GSFC throughout the program to resolve any discrepancies between coupon and/or part design and their specified performance. This applies particularly to control of overall panel thickness and the impact on slot positions.

5.2.3 Demonstration of Machining Capability

The contractor shall demonstrate tab and slot machining capability by successfully completing one panel per drawing GE 2054536 prior to machining of the remaining panels. GSFC approval shall be required for fabrication of remaining panels.

5.2.4 Dry Fit Check of Shell Assembly

The contractor shall perform a fit check of the Tile Shell Assembly panels using all possible combinations of flight and flight-spare panels. GSFC representative shall be present at the fit check.

5.2.5 Piece Part Delivery

The contractor shall fabricate and deliver all flight hardware parts, spare blank panels, beam flexure specimen, moment test specimen and scrap material as defined on the drawings listed in Appendix B and to the quantities defined in section 6.1.2, Table 1.

6. DELIVERABLE ITEMS

Deliverable items are articles of hardware and documentation, which shall be provided by the contractor as part of this contract.

6.1 Deliverables

6.1.1 Documentation

Testing performed under section 8 shall be documented in a summary test report and submitted as part of the acceptance data packages described in section 3.4.

- Process Specification for Manufacture of Composite Facesheets.*
- Process Specification for Manufacture of Honeycomb Panels.*
- Product Assurance Implementation Plan.
- Test Reports on material, laminate, and manufacturing verification tests.
- Dimensional Inspection Data.

* GSFC, or its representative, review at contractor facility is acceptable if proprietary

6.1.2 Hardware

Table 1 lists the deliverables and the appropriate quantities of each to be fabricated and delivered to GSFC. In addition, scrap left over from honeycomb panel fabrication shall be delivered to GSFC

Table 1 Hardware Deliverables

Item Number	Part Description	Drawing Number	Total Each Item	Optional Thermal Cycling
1	ACD Top Panel: Flight	2054641	1	Yes
2	ACD Top Panel: Spare Blank No final machining	Reference: 2054641	1	No
3	ACD Side Panel: Flight	2054536	4	Yes
4	ACD Side Panel: Spare Blank No final machining	Reference: 2054536	1	No
5	ACD Top Panel Beam Flexure Specimen	Figure 2, Appendix C	3	No
6	ACD Side Panel Beam Flexure Specimen	Figure 3, Appendix C	3	No
7	Moment Test Coupon – Part 1	4057427	3	No
8	Moment Test Coupon – Part 2	4057428	3	No

Option 1 calls for the thermal cycle testing of the flight honeycomb panel to the specification of Appendix D. Option 1 shall include non-destructive examination and measuring the flatness of the flight honeycomb panel again after thermal cycling is completed.

6.1.3 Ground Support Equipment (GSE)

No GSE is deliverable by the contractor, with the exception of shipping containers required for shipping the flight and other deliverable hardware to GSFC.

6.2 Provided Items

No items are provided by GSFC.

7. REQUIREMENTS

7.1 General Description

The flight honeycomb panels will be assembled at GSFC to form the Shell Assembly, one of several structural component of the Anti-Coincidence Detector. The top honeycomb panel consists of carbon epoxy facesheets, 2-inch thick 3.1pcf vented aluminum (5056) honeycomb core, and film and foaming adhesives. The side panels consist of carbon epoxy facesheets, 1-inch thick 3.1pcf vented aluminum (5056) honeycomb core and film adhesive.

The outer surface of the honeycomb panels shall be smooth and easily cleanable. The contractor shall submit a sample of the outer surface's finish for evaluation by GSFC. The panels shall be vented in accordance with the detail drawings prior to panel consolidation for particulate control. Vent holes filled with film adhesive during panel cure shall be reworked after panel consolidation.

7.2 Materials and Processes Requirements

7.2.1 Materials

The contractor shall procure all of the M46J/EX-1522-2 prepreg material according to in-house contractor material specifications, or equivalent federal or aerospace material specifications subject to the approval of GSFC. The contractor shall use a single lot of prepreg, which is within shelf life, for the material specified for the facesheets.

All composite materials must test less than 1% total mass loss (TML) and 0.1% collected volatile condensable materials (CVCM) per ASTM E595. Materials are specified on the drawings included in Appendix B. Deviation, waivers and exceptions shall be handled by GSFC on a case-by-case basis.

The contractor shall have in place a system to regulate and document storage and use of frozen prepreg and film adhesive materials with limited shelf life. GSFC shall approve the contractor's materials control system.

7.2.1.1 Facesheet Laminate

The facesheet laminate shall consist of 8 unidirectional 0.0025-inch thick plies. The plies are M46J/EX-1552-2 unidirectional tape. The lay-ups shall be as defined on the drawings in Appendix B. For reference, the facesheet laminate is $[0,45,90,-45]_s$, and tolerance on fiber placement angle shall be ± 1 degree. Each prepreg tape used in the laminate shall be continuous without fiber butt splices from panel edge to panel edge.

7.2.1.2 Honeycomb Panels

The honeycomb panels shall be fabricated as defined on the drawings included in Appendix B. The film adhesive for bonding the facesheets is FM73. The foaming adhesive for core splices and is FM 410. Flatness requirements are given on the drawings in Appendix B. Flatness is required on both sides of the panel, and in the unrestrained condition.

7.2.2 Process Controls

All processes used shall be identical to those used for flight quality fabrication. The contractor shall control all critical composite facesheet and honeycomb panel fabrication processes with specifications and travelers/certification logs. The contractor shall maintain process records of critical fabrication parameters (temperature, vacuum, pressure and time). Only equipment within calibration shall be used.

The same facilities, tooling, and personnel shall be used throughout the program.

7.2.2.1 Workmanship

Workmanship shall be consistent with producing high-quality flight hardware. Non-destructive examination and defect acceptance criteria are defined in 7.4. The contractor shall have a demonstrated heritage of building composite honeycomb panels for space flight applications.

7.2.2.2 Facilities and Equipment

The contractor shall use facilities and equipment suitable for fabrication of flight hardware.

In the area(s) for lay-up, the contractor shall exclude machining and other dust and oil producing activities. While the facility is not required to meet the classic requirements of FED-STD-209, it shall be maintained as a clean area to reduce the risk of contamination. The lay-up areas should be under positive pressure with respect to the surrounding areas and free of contamination hazards (poor housekeeping, visibly dirty work surfaces, oil-laden surfaces, silicones, fumes, etc.). Eating, drinking and smoking in or near composite lay-up facilities shall be prohibited. Application of mold release agents shall be prohibited in this area. The use of any material dispensed from an aerosol container is prohibited.

7.3 Thermal and Physical Properties

All test specimens for the quality assurance testing of section 8.4 shall come from the cured part scrap areas wherever possible.

7.3.1 Lamina Material Properties

Fully cured unidirectional lamina material properties shall meet the values specified in Table 2. Cured ply thickness of facesheet material shall be 2.5 ± .3 mils for unidirectional tape prepreg.

Table 2 Cured, Unidirectional Laminate Property Requirements for Purchase Acceptance

Unidirectional M46J/EX-1522-2, 2.5 mil" Ply Thickness (nominal), 12" Wide			
Property* (Room Temp.)	**Requirement**	**Replications**	**Test Method**
0^0 Tensile Modulus Avg. Value, Minimum (psi) Single Value, Minimum (psi)	 $33x10^6$ $32x10^6$	5	ASTM D3039 or SACMA SRM4
0^0 Tensile Strength Avg. Value, Minimum (psi) Single Value, Minimum (psi)	 $215x10^3$ $210x10^3$	5	ASTM D3039 or SACMA SRM4
0^0 Compressive Modulus Avg. Value, Minimum (psi) Single Value, Minimum (psi)	 $31x10^6$ $30x10^6$	5	ASTM D695 or SACMA SRM1
0^0 Compressive Strength Avg. Value, Minimum (psi) Single Value, Minimum (psi)	 $110x10^3$ $105x10^3$	5	ASTM D695 or SACMA SRM1
0^0 Short-Beam Shear Strength Avg. Value, Minimum (psi) Single Value, Minimum (psi)	 $9.5x10^3$ $9.1x10^3$	5	SACMA SRM8
Glass Transition Temp. (^{0}C)	150 (minimum)	1	SACMA SRM18 or TMA Penetration Method
Cured Ply Thickness (mils) @60% Fiber Volume	2.5±0.3	Ten Measurements per each SBS panel	MIL-T-29586

*Normalize all properties except short-beam shear strength and cured ply thickness to 60% fiber volume.

7.3.2 Laminate Density

The contractor shall demonstrate that the density of facesheets does not exceed 0.062 lb/in^3.

7.3.3 Laminate Fiber Volume and Voids

When fully cured, the facesheets shall have a fiber volume between 60% ± 5%. The maximum void content shall not exceed 2% in any facesheet.

7.3.4 Honeycomb Panel Strength

The flatwise tension strength of the honeycomb panel shall be measured for manufacturing process verification. A minimum of three samples from each panel shall be tested. The failure mode shall be core tension failure. Failure of the facesheet in flatwise tension or of the film adhesion to the core or facesheet shall constitute failure of process verification testing, unless it

is shown that this value exceeds nominal aluminum honeycomb core tension strength values. Deviation, waivers and exceptions shall be handled by GSFC on a case-by-case basis.

7.3.5 Identification, Marking and Traceability

The contractor shall provide documentation to prove all deliverables are traceable back to raw materials. An end item data package containing processing records, certification logs, acceptance test results, inspections, change orders, discrepancy reports, etc. is required. All parts shall be marked as indicated on the detail drawings.

7.4 Non-destructive Examination Requirements, Defect Acceptance

7.4.1 Non-destructive Examination (NDE)

The contractor shall perform 100% non-destructive examination of all composite piece parts at the detail part level after all machining operations are complete. Trained and qualified operators using techniques for which controls and standards have been established shall do all non-destructive inspections. Non-destructive inspection of facesheets and honeycomb plates shall be done with ultrasonic or equivalent methods capable of finding internal defects, such as delaminations, voids, cracks and porosity. NDE techniques shall be demonstrated using a defect standard with defects positioned internal to the facesheets and between the facesheet and the honeycomb core. GSFC must approve non-destructive inspection techniques. A hard copy map of the scanned parts shall be provided with enough resolution to discern size and position of any defects not meeting the defect acceptance criteria of section 7.4.2.
Any and all non-conformances must be approved by GSFC. The results of all inspections shall be made available to GSFC upon request.

7.4.2 Defect Acceptance Criteria

All facesheets, honeycomb panels, and test piece parts shall meet the following defect acceptance criteria:

a. The maximum permissible defect diameter in all facesheets shall be <0.25 inch.
b. The maximum permissible defect diameter between honeycomb-to-facesheet bonds on the flexure mounting side (external side) of the panels shall be <0.25 inch.
c. The maximum permissible defect diameter between honeycomb-to-facesheet bonds on the internal side of the panels shall be < 0.750 inch.
d. The maximum permissible defect diameter between honeycomb-to-facesheet bonds within 2-inch of panel edges shall be < 0.25 inch.
e. The maximum permissible total flaw area of all defects (A_T) in a given panel is A_T < 1.50 $inch^2$ within any 6-inch diameter circular area.
f. The minimum permissible flaw spacing (D_S) between flaw boundaries is D_S > 3 x largest flaw dimension. See Figure 1. No defect with area larger than 0.40 in^2.
g. No internal defects shall be allowed within 0.25 inches of holes or cutouts.
h. Surface scratch depth shall be less than 0.0025 inch, and shall not sever first ply fibers.

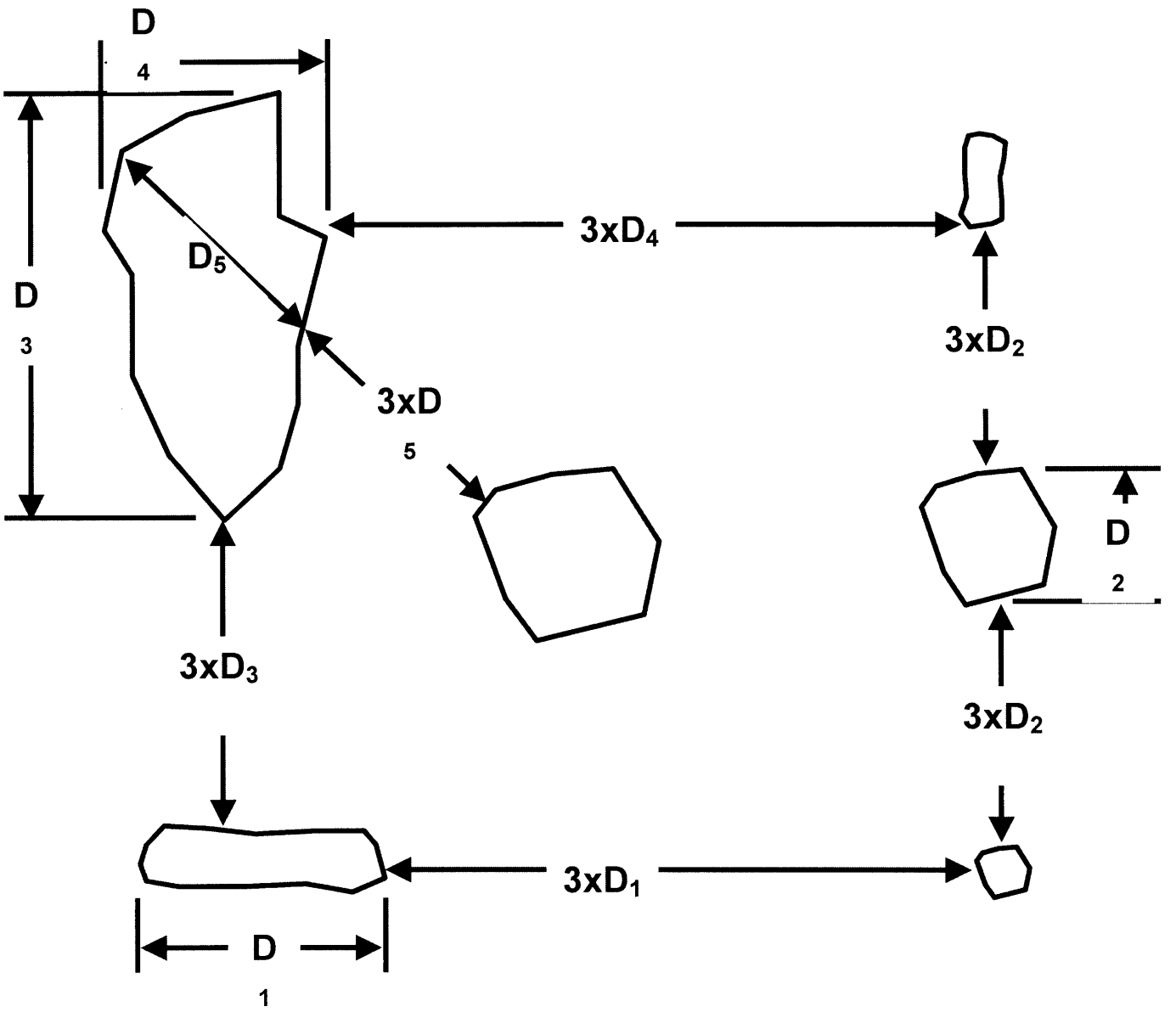
7.4.3 Edge Effects of Machining (Cutting)

Breakout or chipping of an external ply exceeding 0.063 inches from the finished edge of any piece part shall be cause for rejection. Deviation, waivers and exceptions shall be handled by GSFC on a case-by-case basis.

7.5 Packaging and Transportation

As a result of packaging, storage, or transportation, the composite piece parts and bagging materials shall not be damaged nor cleanliness degraded. After cleaning, the contractor shall package the parts in two layers (doubled bagged). Both layers shall be externally marked with the piece part drawing and dash number. Packaging, storage, and transportation shall be chosen to eliminate particulate generation from rubbing, chafing, impacts, etc.

Figure 1 Honeycomb Panel and Facesheet Defect Spacing



8. QUALITY ASSURANCE PROVISIONS

The contractor shall provide quality assurance support to assure delivery of a flight qualified finished product per this statement of work and the Large Area Telescope (LAT) ACD Quality Plan, ACD-QA-8001.

8.1 Responsibility for Inspections and Tests

The contractor is responsible for all inspections and tests in section 8.4.

8.2 Use of Non-Conforming Materials or Parts

GSFC approval shall be required of all nonconforming materials or parts prior to their use.

8.3 Documentation

GSFC or its representative shall review all material specifications, process specifications, fabrication planning, inspection results and reports, contamination control documentation, and test results.

8.4 Product Assurance Tests

The contractor shall test the prepreg lot for material, fiber volume, outgassing, glass transition temperature (T_g), and cured ply thickness properties. The contractor shall test each cured facesheet laminate for density, fiber volume, and voids. The contractor shall test each cured honeycomb panel for flatwise tension failure mode.

Table 3 contains a summary of product assurance provisions for the composite parts. The requirements from section 7 are cross-referenced with the corresponding test and inspection provisions for material and manufacturing quality assurance verification.

All test and inspection data shall be recorded and made available to GSFC upon request.

GSFC is responsible for the design, structural analysis, and structural requirements of the composite piece parts and completed instrument structure.

Table 3 Product Assurance Summary

Requirements	Test and Inspection (Paragraph Number)	Test Methods (Paragraph Number)
7.2.1 Materials	8.4.1	8.6.2
7.2.2 Process Controls	8.4.2	N/A
7.3.1 Lamina Material Properties	8.4.3	8.6.3
7.3.2 Laminate Density	8.4.4	8.6.1
7.3.3 Laminate Fiber Volume and Voids	8.4.5	8.6.4
7.3.4 Honeycomb Panel Strength	8.4.6	8.6.5
7.4 Non-destructive Examination (NDE)	8.5	N/A

8.4.1 Materials

The materials used for piece part fabrication shall meet the requirements of 7.2.1 and must be within original shelf life. GSFC shall review the composite material specifications before part fabrication. Outgassing tests shall be preformed in accordance with 8.6.2.

8.4.2 Processes

Processes for qualification of fabrication shall meet the requirements of 7.2.2. GSFC shall review the contractor's process specifications before part fabrication. Results of all process control testing shall be documented and provided to GSFC.

8.4.3 Lamina Material Properties

All lamina material properties shall be tested to and in accordance with the specifications given in Table 2 of section 7.3.1.

8.4.4 Laminate Density

Laminate density shall be tested to verify meeting the requirements of 7.3.2. The contractor shall test the facesheet density on a minimum of three tag-end pieces from the first two facesheet cures. These tests shall be performed in accordance with 8.6.1.

8.4.5 Laminate Fiber Volume and Voids

Laminate fiber volume and voids shall be tested for each facesheet per 8.6.4 to verify meeting the requirements of 7.3.3.

8.4.6 Flatwise Tension Strength

The contractor shall test to failure in flatwise tension three samples from each honeycomb panel cure per 8.6.5 to verify meeting the requirements of 7.3.4.

8.5 Non-destructive Evaluation

Each article shall be inspected by appropriate non-destructive methods for internal and external defects per requirements of section 7.4. Results of all inspections shall be documented and provided to GSFC.

8.6 Test Methods

8.6.1 Unspecified Test Methods

Unspecified testing methods may be chosen by the contractor in accordance with common industry practice and shall be presented to and approved by GSFC.

8.6.2 Material Outgassing

TML and CVCM shall be tested per ASTM E595.

8.6.3 Lamina Material Properties

Material properties shall be tested in accordance with the methods in Table 2.

8.6.4 Lamina Fiber Volume and Void Content

The preferred fiber volume test method is ASTM D 3171. The contractor can use SRM 10 or an optical technique if correlation is shown with ASTM D 3171.

Void content test method shall be ASTM D 2734.

8.6.5 Flatwise Tension Testing of Honeycomb Plate Coupons

Flatwise tension tests shall be done according to ASTM C297.

9. PREPARATION FOR DELIVERY

9.1 Cleaning and Packaging

All composite parts shall be inspected for cleanliness before bagging and shipping. The contractor shall package the bagged composite parts in accordance with section 7.5. This assemblage shall be packed in a shipping container cushioned with foam (2 to 6 lb/ft^3), or equivalent.

9.1.1 Packing

The contractor shall supply a shipping container that is adequate in preventing damage to the composite parts during storage, shipping and handling.

9.1.2 Marking for Shipment

a. Contractor's name and address
b. Product designation

The shipping container shall be marked durably and legibly with the following information:

a. All markings necessary for delivery and storage
b. GSFC contract number
c. All markings required by regulations, statutes, and common carrier
d. All markings necessary for safe handling and delivery

9.2 Shipping Conditions and Mode of Transport

Ship by any means necessary to assure safe and timely arrival.

10. NOTES

10.1 Intended Use

The honeycomb panels, once successfully fabricated, qualified and fit checked, shall constitute all items needed to begin assembly of the flight ACD Tile Shell Assembly.

Appendix A

Contract Schedule

The overall program schedule is provided in Table A.

Table A: Program Schedule

Item Number	Activity	Date/Time of Delivery After Program Award
1	Contract Award and Start of Phase 1	-
2	Kick-off Meeting at Contractor Facility	Within 10 days
3	Status Telephone Calls	Weekly
4	Program Schedule	21 days
5	Fabrication and Assembly Flow Plan	21 days
6	Quality Assurance Implementation Plan	21 days
7	Progress Reports	Every 4 weeks
8	Written Inspection & Test Procedures	3 days prior to test
9	Records of In-Process Inspection	Upon demand
10	Nonconformance Documentation	Upon occurrence
11	Malfunction/Failure Report	Within 3 days of occurrence
12	Manufacturing Readiness Review and Start of Phase 2	To be scheduled by contractor
13	Acceptance Review With Acceptance Data Package	1 week prior to delivery
14	Delivery of Hardware to GSFC	No later than July 11, 2003

Note - all days shown are calendar days. All dates shown are days after contract award except as noted.

Appendix B

ACD Tile Shell Assembly

Piece Part Drawing Package

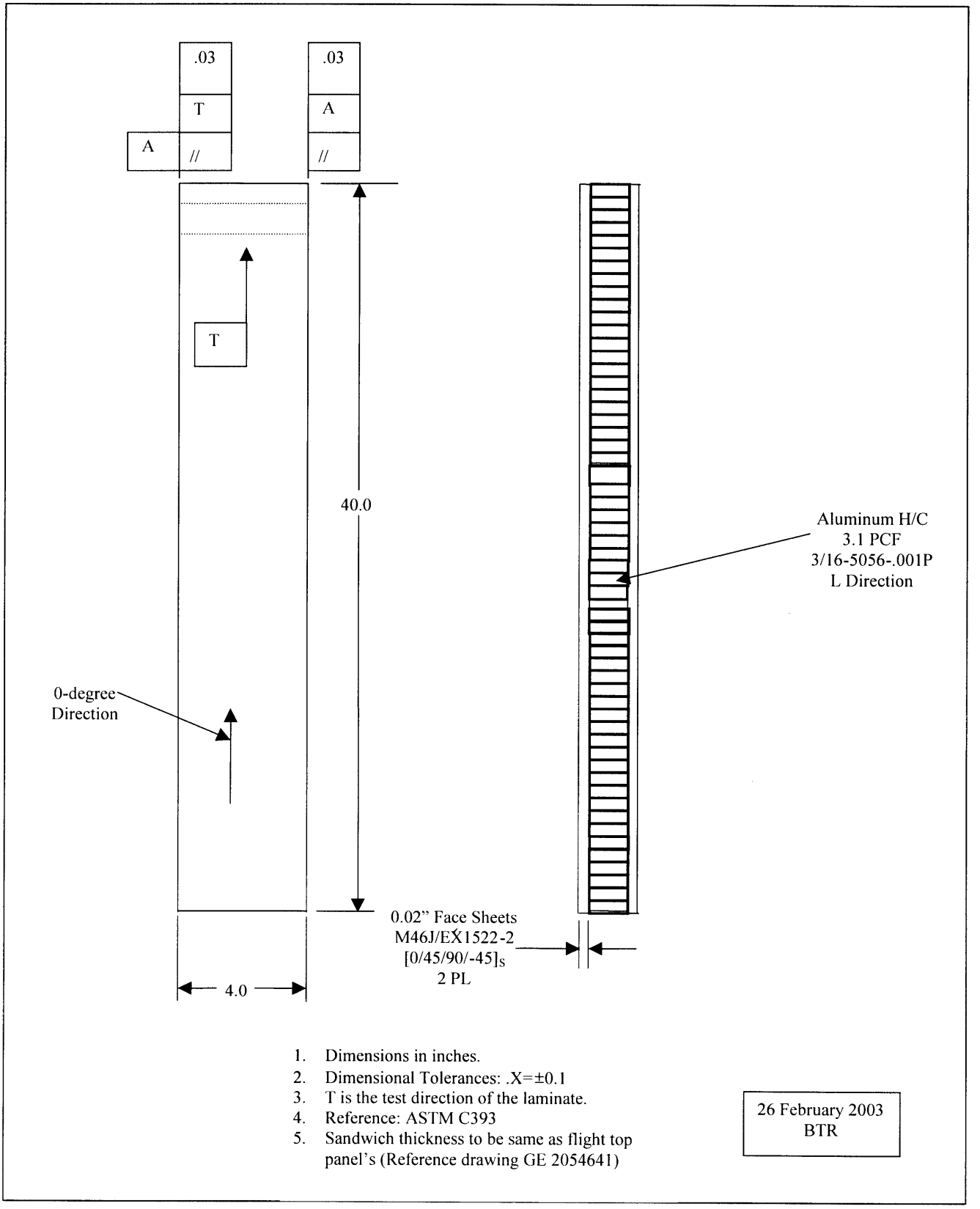
LIST OF DRAWINGS

1. GE 2054536, ACD Side Panel Assembly Drawing
2. GE 2054641, ACD Top Panel Assembly Drawing
3. Figure 2 in Appendix C, ACD Top Panel Beam Flexure Specimen
4. Figure 3 in Appendix C, ACD Side Panel Beam Flexure Specimen
5. 4057427, Moment Test Coupon, Part 1
6. 4057428, Moment Test Coupon, Part 2

The contractor shall interpret the provided drawings per 500-PG-8700.2.5.

Appendix C - Panel Test Specimen Drawings

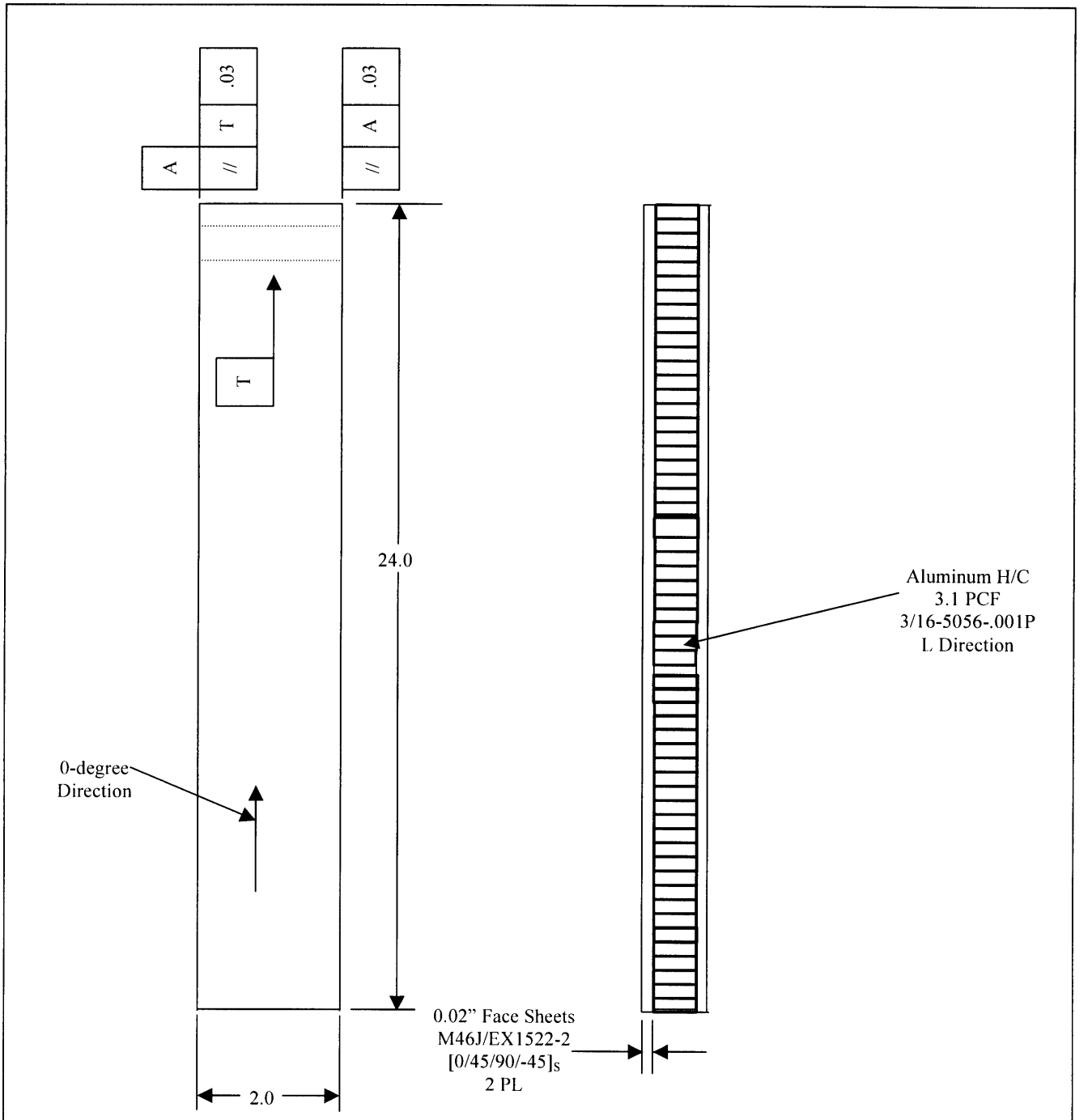
Figure 2 ACD Top Panel Beam Flexure Specimen



1. Dimensions in inches.
2. Dimensional Tolerances: .X=±0.1
3. T is the test direction of the laminate.
4. Reference: ASTM C393
5. Sandwich thickness to be same as flight top panel's (Reference drawing GE 2054641)

26 February 2003
BTR

Figure 3 ACD Side Panel Beam Flexure Specimen



1. Dimensions in inches.
2. Dimensional Tolerances: .X=±0.1
3. T is the test direction of the laminate.
4. Reference: ASTM C393
5. Sandwich thickness to be same as flight side panel's (Reference drawing GE 2054536)

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Appendix D

Option 1: Honeycomb Panel Thermal Cycling

Eight thermal qualification cycles shall be performed on the flight honeycomb panel. Thermal qualification cycles shall be performed at 45°C and -40°C. Time at temperature shall be one hour.

Figure 6 shows the test profile. During temperature transitions, the rate of temperature change of the optical bench shall not exceed 80°C/hr.

Figure 4 Thermal Cycle Test Profile