Fabrication and Assembly Procedure

for the

Anticoincidence Detector (ACD)

Tile Detector Assembly (TDA)

Procedure # ACD-PROC-000059

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Fabrication and Assembly Procedure for the Anticoincidence Detector (ACD) Tile Detector Assembly (TDA)

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1.0 INTRODUCTION

This procedure contains the necessary instructions to fabricate and assemble the Tile Detector Assemblies for the Large Area Telescopes (LAT) Anticoincidence Dectector (ACD). The ACD is a subsystem of the LAT and will fly on the Gamma-ray Large Area Space Telescope (GLAST) Mission, which is a joint venture between the National Areonautics and Space Administration (NASA) and the Department of Energy (DOE). A pictural view of the ACD Subsystem can be seen in Figure 1.

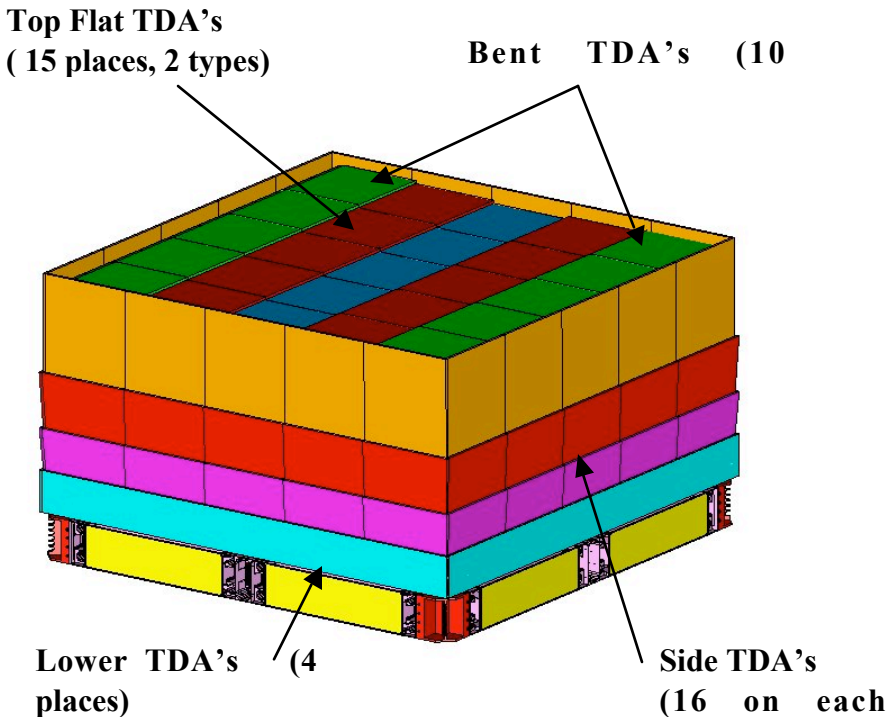


Figure 1. Anticoincidence Detector

2.0 TILE DETECTOR ASSEMBLY DESCRIPTION

The ACD TDA's are plastic scintillator detectors. The light generated in the plastic scintillator is collected by wave shifting fibers that are bonded into the plastic scintillator. The fibers transmit the light to photomultiplier tubes (PMT's) where the light is changed to an electronic signal.

Plastic scintillator detectors with photomultiplier tube readout have a long and successful history in space, dating back some 40 years. All the Compton Gamma Ray Observatory instruments, for example, carried plastic scintillator detectors. Generically, scintillator

can be considered a well-established space technology. Scintillators are relatively rugged, and they are not damaged by radiation at the level expected for the LAT or by temperature changes over a fairly wide range. Known risks are breakage, surface deterioration (crazing) caused by stress or solvents, and deformation at high temperatures (above 60 C).

There are 89 TDA's used on the ACD. Of these 89 TDA's, there are three basic types. The first type is a flat TDA as shown in Figure 2. There are 11 (TBR) flat tile geometries used on the ACD and this type makes up 75 of the 89 TDA's. The second type of TDA is the bent TDA and it is shown in Figure 3. There are 10 identical bent TDA's on the ACD. The purpose of the bend in the TDA is to provide a safe path for the fibers to reach the PMT's. The third and final type is the lower TDA. There are four lower TDA's that wrap around the entire perimeter of the ACD as can be seen in Figure 1. Figure 4 shows a picture of the lower TDA.

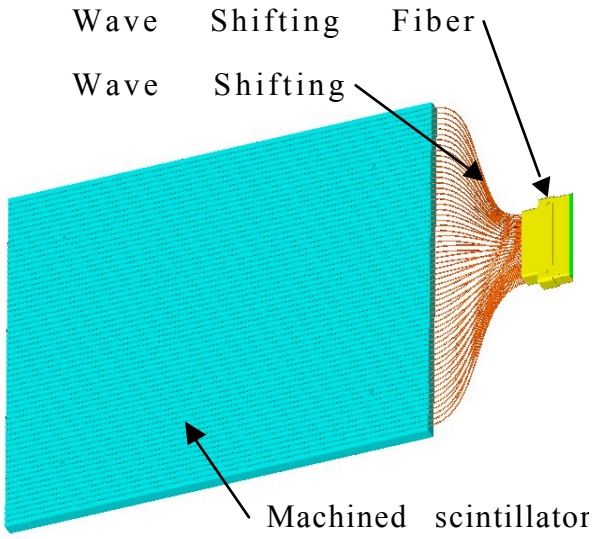


Figure 2. Typical Flat TDA

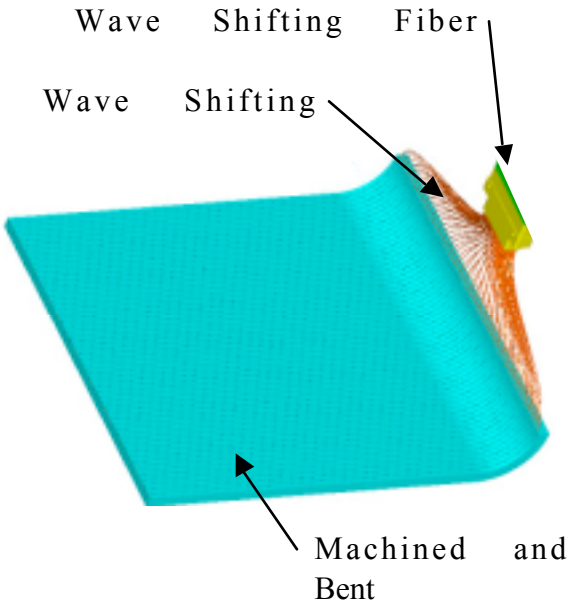


Figure 3. Bent TDA

Figure 4. Lower TDA

3.0 Fermilab TDA Fabrication

The TDAs will be purchased from Fermi National Laboratory (Fermilab), a leading maker of scintillator tiles with waveshifting fibers. Several of the tests for the ACD TDAs are carried out as part of the procurement, so that GSFC is responsible principally for the acceptance tests, performance monitoring, and careful handling of the flight detectors.

Fermilab shall provide the following services to fabricate and assemble the ACD TDAs:

- Purchase all materials required to fabricatre and assemble the TDA's with the exception of the wave shifting fiber connector (GDTBD), PMT Connector (GDTBD), PMT Coupling? (GDTBD), all of which shall be provided by the GSFC.
- Cut the scintillator material to size and cut the grooves in the tile according to drawings provided by GSFC.
- Polishing the tile edges and chamfering the corners per GSFC provided drawings.
- Drilling the holes for the TDA attachment per GSFC drawings.
- Polishing and mirroring the wave shifting fiber ends per Fermi lab developed processes and procedures.
- Bending of the tiles (where applicable), per Fermi lab developed processes and procedures.
- Gluing the fibers in the tiles per Fermi lab developed work instructions.
- Gluing the fiber ends in PMT fittings (GDTBD) or wave shifting fiber connector (GDTBD), per Fermilab developed work instructions
- Annealing the tiles at 55C for 6 (TBR) hours
- Polishing the fiber ends in the PMT connector or WFS connector using Fermilab developed processes and procedures
- Wrapping tiles using 2 layers of white Tetratec reflective material and 2 layers of black Tedlar opaque material
- Testing tiles to verify that they are light tight.
- Ship TDAs to the GSFC using Fermilab fabricated TDA shipping containers

4.0 Definitions and Acronyms

ACD	The LAT Anti-Coincidence Detector Subsystem
GLAST	Gamma-ray Large Area Space Telescope
IAW	In Accordance With
ICD	Interface Control Document
LAT	Large Area Telescope
MGSE	Mechanical Ground Support Equipment
NCR	Nonconformance Report
PMT	Photomultiplier Tube
QA	Quality Assurance
TDA	Tile Detector Assembly
TBD	To Be Determined
TBR	To Be Resolved
WSF	Wave Shifting Fiber

WOA Work Order Authorization

5.0 Quatnities Required

5.1 Flat TDA's

5.1.1 GD2054497-1, Quantity = TBD (tbd flight + tbd spare)
5.1.2 GD2054497-3, Quantity = tbd (tbd flight + tbd spare)
5.1.3 GD2054497-5, Quantity = tbd (tbd flight + tbd spare)
5.1.4 GD2054497-7, Quantity = tbd (tbd flight + tbd spare)
5.1.5 GD2054497-9, Quantity = tbd (tbd flight + tbd spare)
5.1.6 GD2054497-11, Quantity = tbd (tbd flight + tbd spare)
5.1.7 GD2054499-1, Quantity = tbd (tbd flight + tbd spare)
5.1.8 GD2054499-3, Quantity = tbd (tbd flight + tbd spare)
5.1.9 GD2054501-1, Quantity = tbd (tbd flight + tbd spare)
5.1.10 GD2054501-3, Quantity = tbd (tbd flight + tbd spare)

5.2 Bent TDA's

5.2.1 GD2054496, Quantity = 12 (10 flight + 2 spare)

5.3 Lower TDA's

5.3.1 GD2054582, Quantity = 6 (4 flight + 2 spare)

6.0 APPLICABLE DOCUMENTS AND DRAWINGS

6.1. Applicable Documents:

6.1. TBD, ACD Contamination Control Plan
6.1. TBD, Work Order Authoriztion Form
6.1. ACD-QA-8001, ACD Quality Plan

6.2. Applicable Drawings:

6.2.1 GD2054497-1, Tile Detector Assembly Assembly
6.2.2 GD2054497-3, Tile Detector Assembly Assembly
6.2.3 GD2054497-5, Tile Detector Assembly Assembly
6.2.4 GD2054497-7, Tile Detector Assembly Assembly
6.2.5 GD2054497-9, Tile Detector Assembly Assembly
6.2.6 GD2054497-11, Tile Detector Assembly Assembly

6.2.7 GD2054499-1, Tile Detector Assembly Assembly
6.2.8 GD2054499-3, Tile Detector Assembly Assembly
6.2.9 GD2054501-1, Tile Detector Assembly Assembly
6.2.10 GD2054501-3, Tile Detector Assembly Assembly
6.2.11 GD2054496, Tile Detector Assembly Assembly
6.2.12 GD2054582, Tile Detector Assembly Assembly
6.2.13 GTBD, Connector, Wave Shifting Fiber
6.2.14 GTBD, Connector, PMT

7.0 REQUIRED MATERIALS

7.1 Elgen TBD or Bicron B408 plastic scintillator. Thickness to be 10.0 or 12.0 +/- 0.15mm over 340 cm x 340 cm area
7.2 Bicron B600 Epoxy
7.3 Bicron 1mm diameter Wave Shifing Fiber (BCF-91AMC)
7.4 GTBD, Connector, Wave Shifting Fiber
7.5 GTBD, Connector, PMT
7.6 TBD, Spring
7.7 GTBD, Cap, PMT
7.8 Tetratex reflective material (0.010” thick)
7.9 Tedlar opaque material (0.002” thick)
7.10 Black Kapton Tape

8.0 General Requirements

8.1 Requirements for epoxying the waveshifting fiber in the tile.

8.1.1 The operation of epoxying the wave-shifting fibers (WSF) into the scintillating tiles is of great importance for ACD performance. The ACD design assumes a level of 1-2% uniformity of the signals from detectors (tiles), so the quality of fibers gluing should be on a corresponding level of uniformity.

8.1.2 The required optical epoxy is a two part epoxy produced by Bicron (BC-600)

8.1.3 The fibers should be completely inside the grooves.

8.1.4 The fibers shall be cleaned before glueing into the grooves.

8.1.5 There should be no air bubbles under the fibers.

8.1.6 The amount of glue spilled out from the groove on the tile surface shall be minimized, so that there are no glue spots on the surface and edges of the scintillating tile

8.1.7 The bundling of the fibers in the connectors should be done so as to have all fibers at the same tension (no loose or tight fibers)

8.1.8 To relieve stresses in the wave shifting fibers due to bending, an annealing process shall be performed on the scintillator/fiber assembly within 24 hours after glueing the fibers in the scintillator tile.

8.2 Machining of the scintillator material.

8.2.1 The machined grooves shall be free of the signs of melting.

8.2.2 To minimize crazing of the scintillator material, a post machining annealing process shall be performed on the scintillator.

8.2.3 The machined edges of the scintillator shall be diamond machined or polished.

8.2.4 The only acceptable cooling to be used for machining shall be clean cool air. All machining shall be performed in an oil-free environment.

8.3 Material Requirements

Material certifications shall be provided for all materials used in the construction of the GLAST ACD Tile Detector Assemblies and Clear Fiber Cables. Material samples shall be provided to GSFC for each lot of material used.

8.3.1 Scintillator material: Bicron BC-408, Eljen EJ-200, or equivalent. Thickness as specified on the drawing +/- 0.15 with a flatness of 0.20 mm over 35 square cm.

8.3.2 Wave Shifting Fibers: 1 mm diameter Bicron BCF-91AMC green scintillating fiber or equivalent.

8.3.3 Adhesives: The glue used to bond the wave shifting fibers to the scintillator shall be Bicron BC-600. The epoxy used to bond the fibers into the connector bodies shall be Bicron BC-600.

8.3.4 All materials used in the assembly of a TDA shall have material certifications and be properly controlled.

8.3.5 Plastic Scintillator: Three 10 cm x 10 cm square samples without fiber grooves shall be be fabricated from each batch of plastic scintillator. These three samples shall have the edges polished. They will be tested for quality, labeled and stored.

8.3.6 Wave Shifting Fiber: The wave shifting fiber shall be visually inspected for defects. Three pieces from each batch shall be tested for attenuation, labeled, and stored.

8.4 TDA Handling Requirements

8.4.1 All handling of the TDAs and TDA materials shall be performed using gloves to prevent contaminating the TDAs.

8.4.2 Great care must be excersized when handling the TDAs and TDA wave shifting fibers to prevent breaking the fibers.

9.0 Quality Assurance for the Tile Detector Assemblies

As with all flight hardware for the ACD, TDAs will be handled, processed, and controlled under the provisions of the PAIP (LAT-MD-00039-01, LAT Performance Assurance Implementation Plan) and the LAT ACD Quality Plan (ACD-QA-8001, ACD Quality Plan). Some aspects (not intended to be a exhaustive list) of these plans as applied specifically to the TDAs are:

1. All work will be documented with a Work Order Authorization (WOA), GSFC Form 4-30. This WOA will remain with the TDA as a traveler until the TDA is integrated onto the ACD assembly, after which it will be retained as a reference document. Section 11 of this procedure, Detailed Steps for the Fabrication and Assembly of a TDA, shall be used as a WOA for each TDA fabricated.
2. All fabrication and assembly work shall be performed In Accordance With (IAW) signed off and approved GSFC provided drawings.
3. All work shall be inspected by a representative of the Quality Assurance group. The WOA provided in Section 10 specifies the required Quality Assurance (QA) inspection points.
4. The TDAs will be stored in a locked facility except while actual work on them is in progress.

5. Because TDAs can suffer degraded performance after excessive exposure to some solvents, the areas where TDAs are stored or being worked on will only have isopropyl or ethyl alcohol available for cleaning. The isopropyl and ethyl alcohol shall be stored in well labeled containers.

6. When the TDAs are assembled into their wrapping, the serial number of the TDA will be transferred to the wrapping in a permanent and visible marking as specified on the TDA assembly drawing.

7. Except for solvents, there are no special environmental conditions for the Tile Detector Assemblies. Normal laboratory conditions are acceptable.

8. TDA Serial Numbers: Each TDA shall be assigned a unique serial number. The serial number shall be the drawing number, inlucding the dash number, followed by a number. For example, a flat TDA with the drawing number GTBD, would have a part number of GTBD-01. The second identical unit to be fabricated would have a part number of GTBD-02, the third identical unit would be GTBD-03, and so on.

11.0 DETAILED STEPS FOR THE FABRICATION AND ASSEMBLY OF A TDA

No.	Action	Resp.	Initials
10.1	Record serial number of the TDA being fabricated: (i.e. Drawing number – specific dash number) _____		_____
10.2	Record the batch number of plastic scintillator used to make blank tile: Batch Number _____		_____
10.3	Machine scintillator tile as specified on the drawing. Check relevant dimensions and verify that the 1.0mm diameter wave shifting fibers fit in the grooves.		_____
10.4	Install a temporary serial number label on the scintillator tile. Note: The temporary serial number shall be removed prior to the TDA being wrapped and a permanent serial number will be installed at that time.		
10.5	For bent scintillators, bend to specified shape by using a warm temperature bending process IAW Fermi Procedure #TBD. Verify that the 1.0mm diameter wave shifting fibers fit into the grooves		_____
10.6	Polish the edges of the scintillator in lab 6 using Fermilab developed work instructions. Chamfer the eight corners of the scintillator tile as shown on the drawing.		_____
10.7	Anneal the scintillator using a temperature of 55^{o}C for 8 hours followed by a cool down to room temperature over an 8-hour period.		_____
10.8	Dimensionally inspect all dimensions of the scintillator tile. Note all discrepancies on the problem record sheet. If any discrepancies are found, do not continue until the problem record is approved by the lead engineer and quality assurance.		_____

10.9	Record the batch number of the wave shifting fibers that will be installed into this TDA. Diamond mill one end of each fiber perpendicular to the fiber axis and vapor deposit aluminum on the milled ends of the fibers IAW Fermilab Procedure #TBD.	_____
10.10	Coat the mirrored end of the wave shifting fiber with TBD. Note to Todd and Phylis. Can you provide me info on the RedSpot coating you use on the end of the fibers so that I can have our materials folks check it out.	
10.11	Cut waveshifting fibers to specified lengths and install them into the scintillator tile	_____
10.12	Glue the mirrored end of waveshifting fibers into grooved scintillator using Bicron BC-600 IAW Fermilab generated work instuctions. The fiber ends shall be within the edge of the tile as specified on the drawing. Note: Take care to minimize air bubbles in the epoxy.	_____
10.13	Install and glue transmitting end of waveshifting fibers into GSFC supplied connector (GDTBD) while maintaining the relative position of the connector to the scintillator tile as shown in the TDA Assembly Drawing	_____
10.14	Anneal the scintillator and wave shifting fiber assembly using a temperature of 55^{o}C for 8 hours followed by a cool down to room temperature over an 8-hour period.	_____
10.15	Cut and polish (or diamond mill) the fibers and connector face perpendicular to the fiber axis.	_____
10.16	Quality Assurance shall visually inspect the TDA and note all discrepancies on the problem record sheet.	
10.17	Remove temporary serial number on the TDA. NOTE: Take care not to lose track of the correct serial number for the TDA during the subsequent wrapping process.	_____
10.18	Clean the TDA using isopropyl alcohol to Mil Std level 750B (TBR).	

10.19	Wrap tile with two layers of white 0.010” thick Tetratex reflectrive material followed by two layers of 0.002” thick Tedlar IAW ACD-TBD, ACD TDA Wrapping Procedure.	_____
10.20	Install a permanent serial number on the TDA as shown on the assembly drawing	_____
10.21	Check the TDA assembly for light leaks IAW TBD	_____
10.23	Pack the TDA in a shipping box. Take care to eliminate the possibility of breaking fibers by properly secureing both the tile and connector.	_____

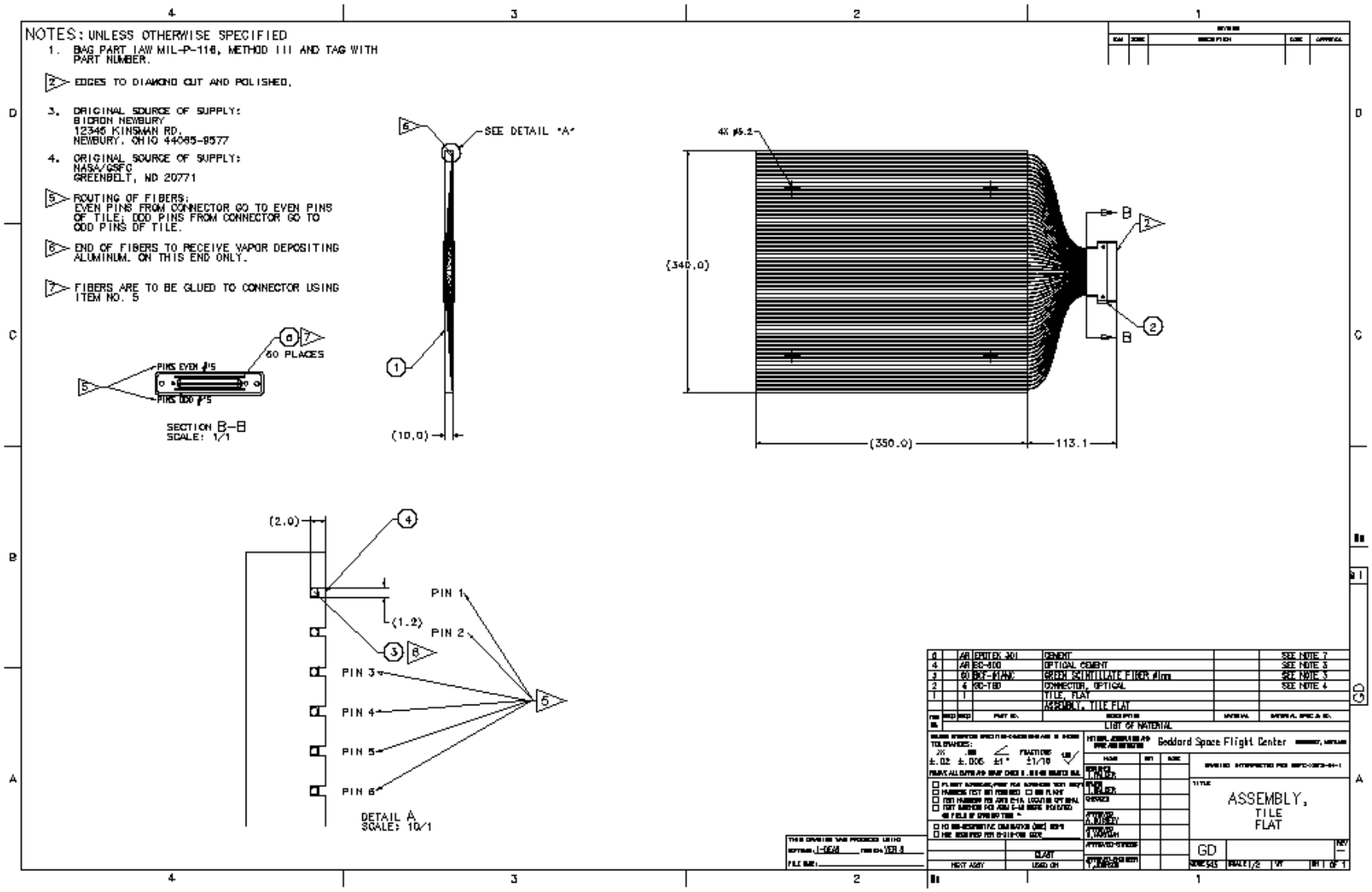


Figure 1. Assembly, Flat

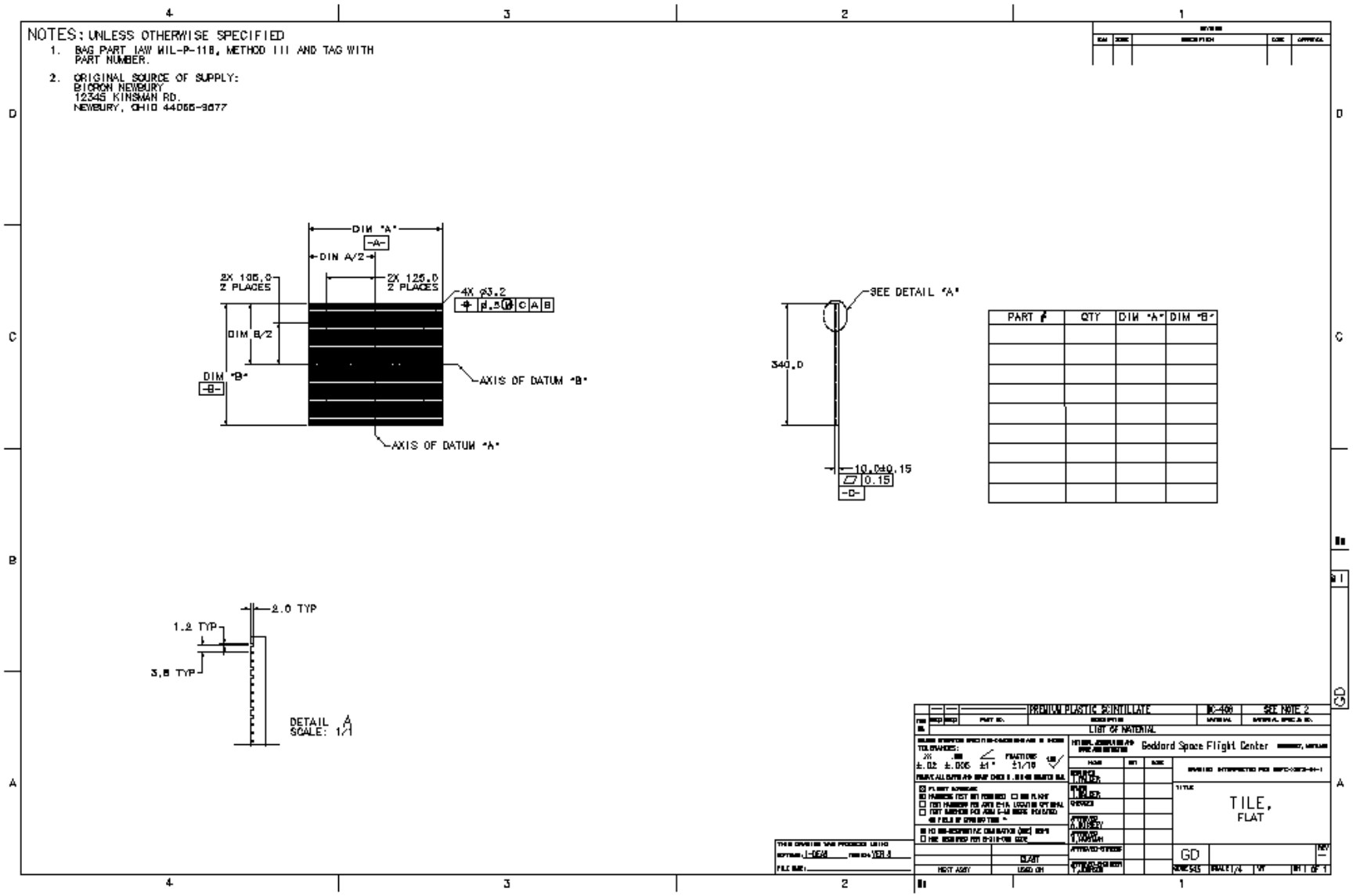


Figure 2. Flat

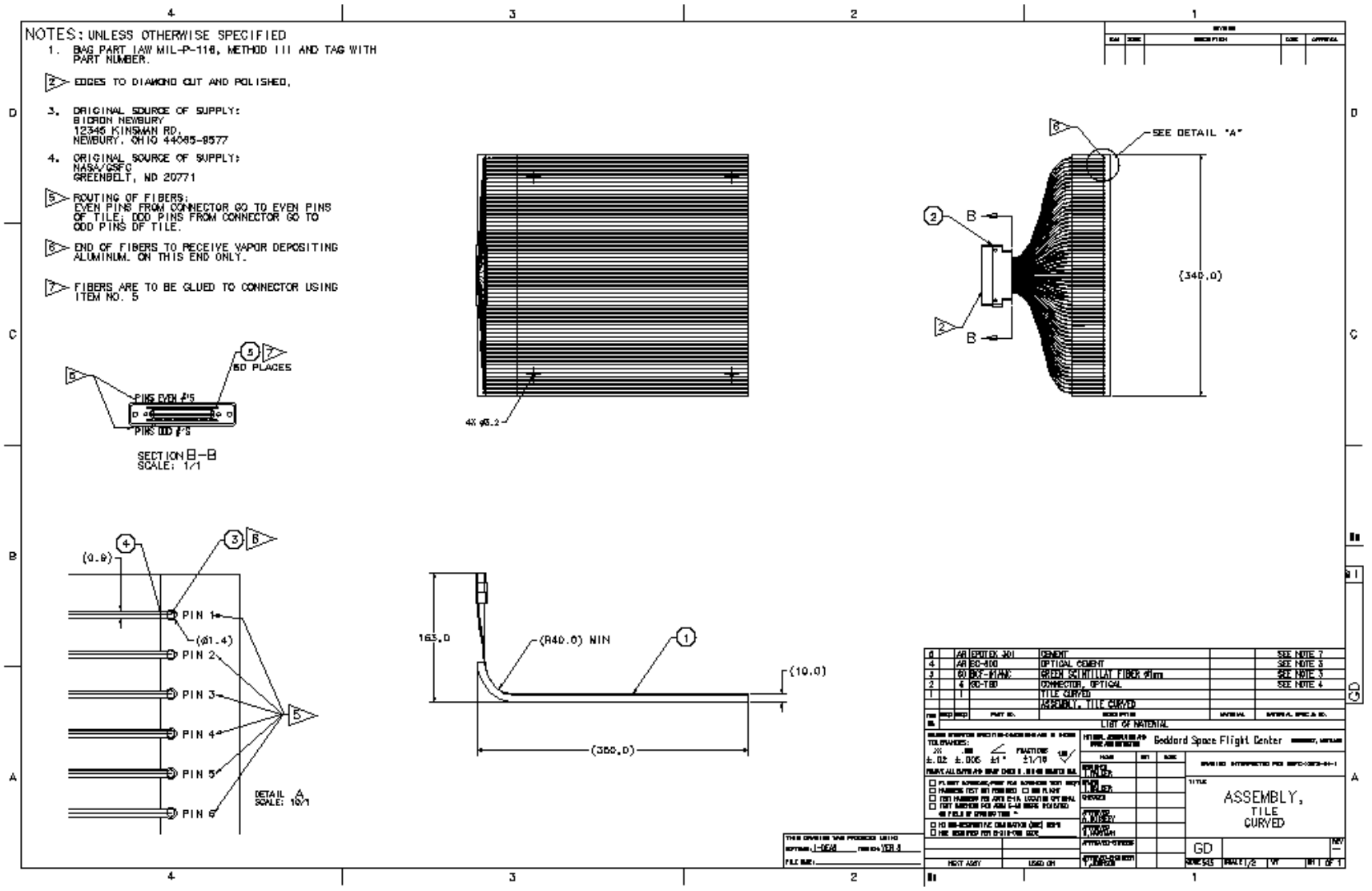


Figure 3. Assembly, Bent

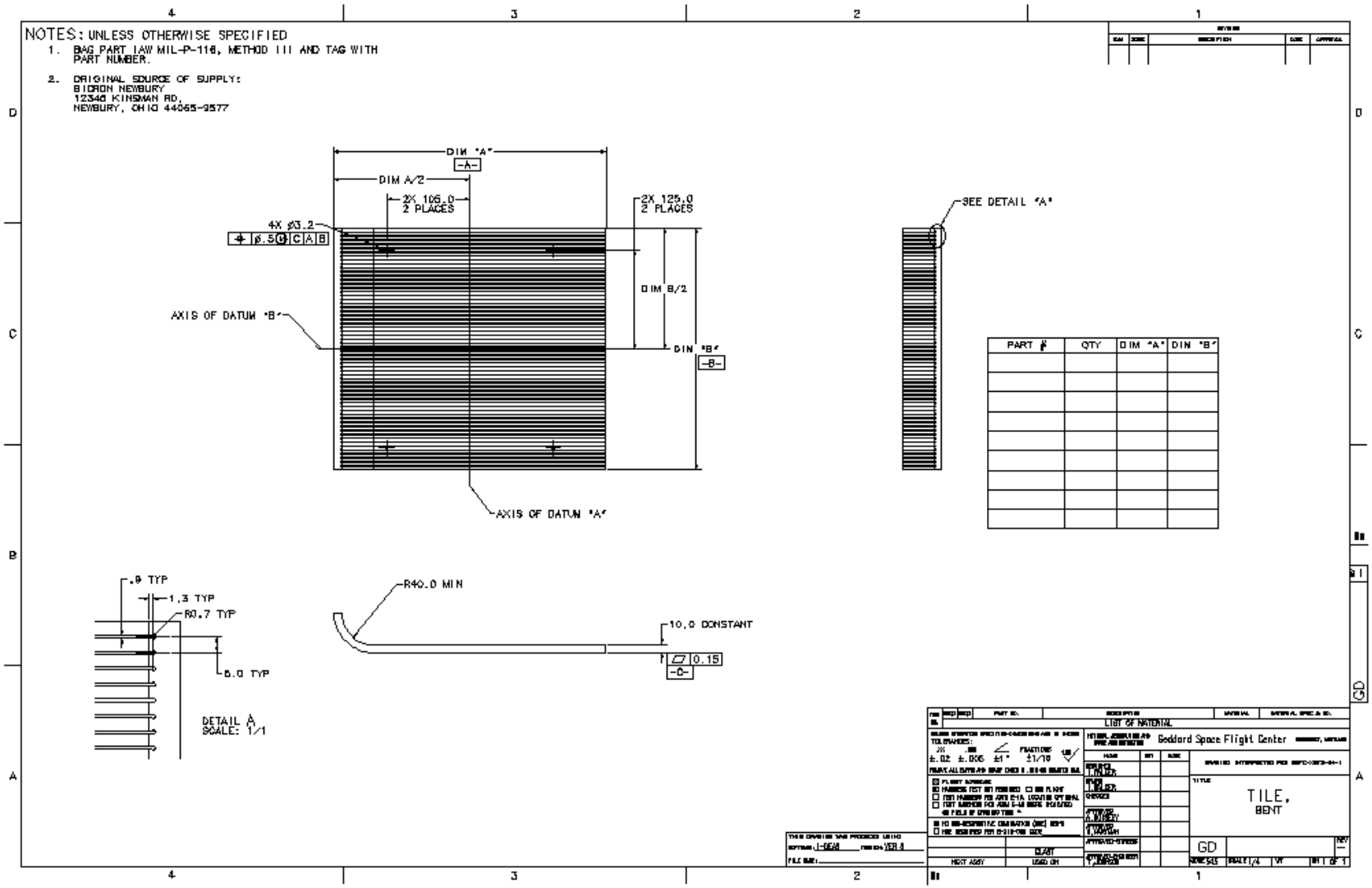
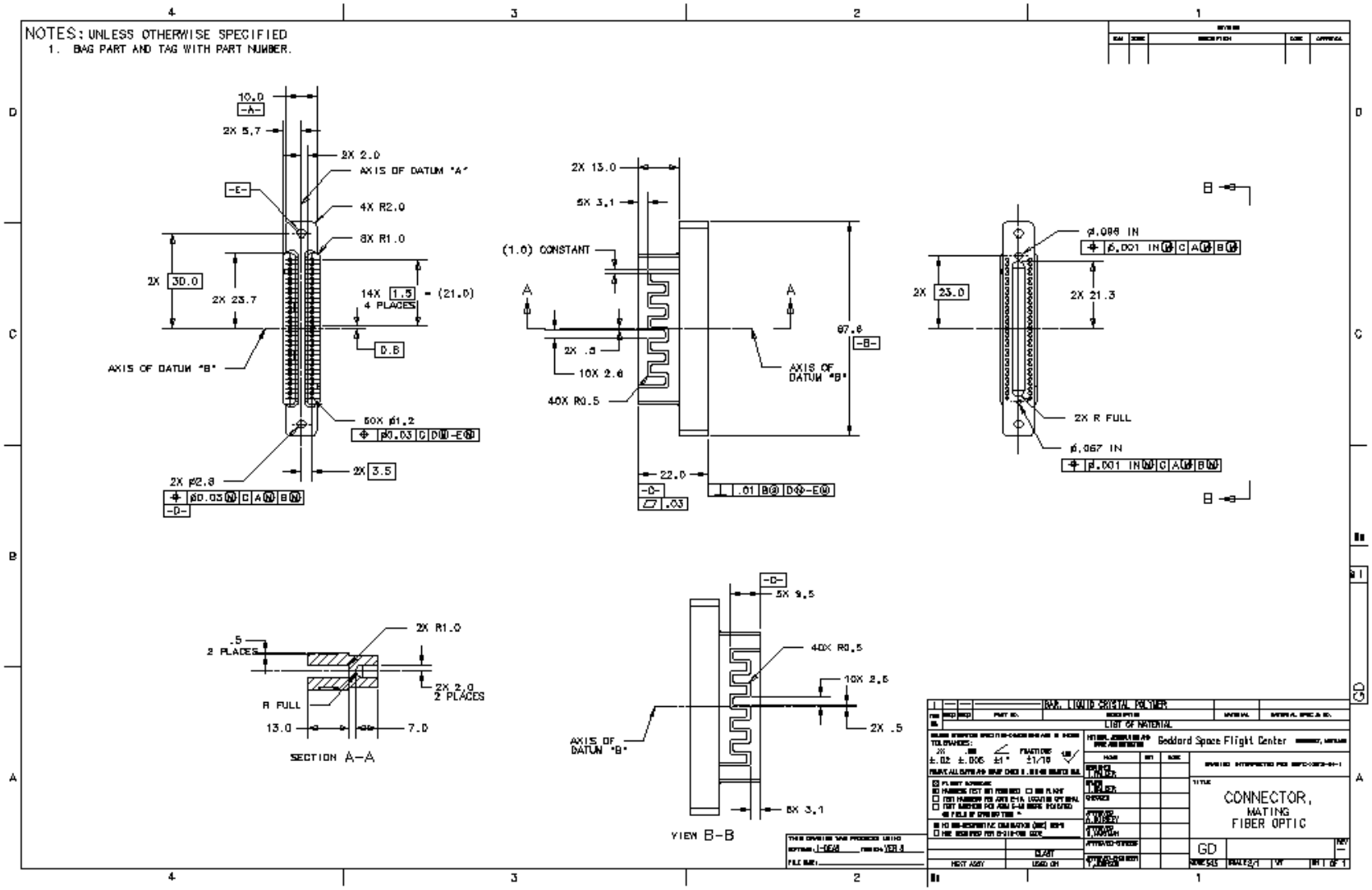


Figure 4. Bent Tile


NOTES: UNLESS OTHERWISE SPECIFIED
1. BAG PART AND TAG WITH PART NUMBER.
10.0
-A-
2X 5.7
2X 2.0
AXIS OF DATUM "A"
-E-
4X R2.0
8X R1.0
2X 30.0
2X 23.7
14X 1.5 = (21.0)
4 PLACES
0.8
AXIS OF DATUM "B"
50X ø1.2
ø0.03 C D M -E M
2X ø2.8
ø0.03 M C A M B M
-D-
2X 3.5
2X 13.0
5X 3.1
(1.0) CONSTANT
A
2X .5
10X 2.6
40X R0.5
67.8
-B-
AXIS OF DATUM "B"
22.0
-D-
.03
.01 B@ D@ -E@
ø.096 IN
ø.001 IN M C A M B M
2X 23.0
2X 21.3
2X R FULL
ø.067 IN
ø.001 IN M C A M B M
.5
2 PLACES
2X R1.0
2X 2.0
2 PLACES
R FULL
13.0
7.0
SECTION A-A
-D-
5X 9.5
40X R0.5
10X 2.5
2X .5
AXIS OF DATUM "B"
5X 3.1
VIEW B-B
BAR, LIQUID CRYSTAL POLYMER
LIST OF MATERIAL
Goddard Space Flight Center
CONNECTOR, MATING FIBER OPTIC
GD

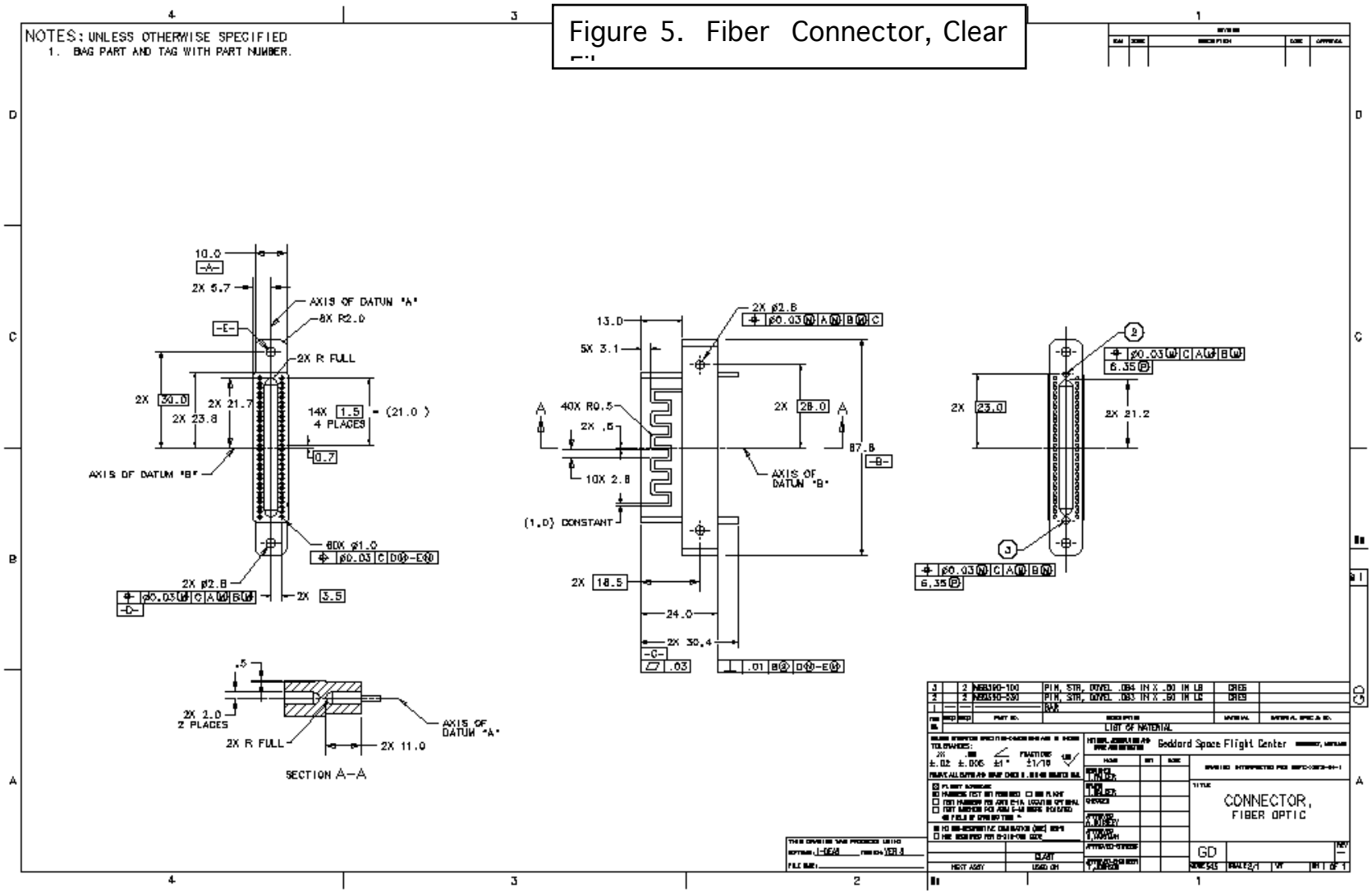


Figure 5. Fiber Connector, Clear Fi

Figure 6. Fiber Connector, WSF