	Document #	Date Effective
GLAST LAT PROCEDURE	**LAT-PS-03683-01**	25 August 2004
	Prepared by(s) Paul Dizon	Supersedes None
	Subsystem/Office Calorimeter Subsystem	

Document Title

CAL PEM to Tower Module Assembly Procedure

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT) Calorimeter

Calorimeter PEM to Tower Module Assembly Procedure

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	25 August 2004	Initial Release

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1 INTRODUCTION

1.1 PURPOSE

This document describes the procedure required for the final assembly of the Calorimeter (CAL) Tower Module for the GLAST Large Area Telescope (LAT) instrument. The assembly procedure is divided into four primary operations:

- Mechanical and electrical installation of the AFEE (Analog Front-End Electronics) circuit Cards
- Mechanical and electrical installation of the EM2 (Engineering Model 2) TEM-TPS (Tower Electronics Module –TEM Power Supply) Assembly
- Mechanical installation of the Side Panels
- Functional testing and calibration of the CAL Module

1.2 SCOPE

This document contains details concerning the assembly procedures for integration of the electronics onto the Pre-Electronics Module (PEM), close-out the CAL Module, and final assembly of the CAL Tower Module.

1.3 APPLICABLE DOCUMENTS

Documents and drawings that are applicable to this procedure are listed below.

1.3.1 Documents

ANSI/J-STD-006	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications
GSFC-433-MAR-0004	GLAST Mission Assurance Requirements for the Large Area Telescope Phase C/D/E
LAT-MD-00039	LAT Performance Assurance Implementation Plan
LAT-MD-00228	GLAST LAT CAL, TKR, & DAQ Contamination Control Plan
LAT-MD-01370	CAL Comprehensive and Limited Performance Test Definition
LAT-PS-04187	CAL Muon Calibration Procedure
LAT-PS-04237	CAL Module Handling Procedure
LAT-PS-04626	Procedure for Co57 Calibration of CAL AFEE Electronics Gain
NASA-STD-8739.1	NASA Technical Standard, Stacking and Conformal Coating
NASA-STD-8739.3	NASA Technical Standard, Soldered Electrical Connections
NASA-STD-8739.7	NASA Technical Standard, Electrostatic Discharge Control
QQ-S-571	Solder, Tin Alloy, Tin Lead Alloy and Lead Alloy

1.3.2 Drawings

LAT-DS-04536	CAL Tower Module Assembly Drawing
LAT-DS-00916	CAL Module Assembly Drawing
LAT-DS-01224	Pre-Electronics Module Assembly Drawing
LAT-DS-00923	Side Panel X
LAT-DS-00924	Side Panel Y
LAT-DS-00927	Titanium Insert, Side
LAT-DS-02269	Side Panel Gasket
LAT-DS-01554	CAL-TEM Stand-Off
LAT-DS-03763	Bracket, AFEE Cable Mount
LAT-DS-03764	Support, AFEE Harness
LAT-DS-03844	Shield, Harness, AFEE Cable
LAT-DS-	Tower Electronics Module-Power Supply Assembly
LAT-DS-04138	CAL Lifting Fixture Assembly
LAT-DS-02795	Hoist Plate, Calorimeter
LAT-DS-02851	Cradle, Turn-Over Dolly, Calorimeter Assembly
LAT-DS-02858	Interface Plate, Handling Fixture
LAT-DS-02859	Bracket, Lock-Down
LAT-DS-04537	CAL Handling Fixture Assembly
LAT-DS-01524	Base Plate, Handling Fixture
LAT-DS-05952	Post, Handling Fixture
LAT-DS-04647	Shim, Handling Fixture
	PEM Assembly Platform

1.4 ACRONYMS

AFEE	Analog Front End Electronics of the Calorimeter
CAL	Calorimeter Subsystem of the LAT
CDE	Crystal Detector Element of the PEM
GLAST	Gamma-Ray Large Area Space Telescope
LAT	Large Area Telescope
PDA	Pin Diode Assembly
PEM	Pre Electronic Module of the CAL
PWA	Printed Wiring Assembly
TBD	To Be Defined
TEM	Tower Electronics Module
TPS	TEM Power Supply

2 CALORIMETER (CAL) TOWER MODULE

The Calorimeter (CAL) Tower Module consists of the CAL Module with its TEM-TPS Assembly.

2.1 CALORIMETER (CAL) MODULE

The Calorimeter (CAL) Module consists of the Pre-Electronics Module (PEM) with its four AFEE Cards and four Side Panels. An AFEE Card and side panel are attached to each face X and Y of the PEM.

2.2 PRE-ELECTRONICS MODULE (PEM)

The Pre-Electronics Module (PEM) consists of the PEM Mechanical Structure with 96 Crystal Detector Elements (CDEs) secured by four Close-Out Plates.

2.3 ANALOG FRONT-END ELECTRONICS (AFEE)

The Analog Front-End Electronics (AFEE) consists of four circuit Cards that are electrically connected to the CDEs and mechanically attached to the Close-Out Plates of the PEM Mechanical Structure.

The AFEE Cards are electrically connected to each end of the 96 Crystal Detector Elements (CDEs) by means of wire pairs from the Pin Diode Assembly (PDA) on each end of the CDE. These wire pairs pass through access holes on the Close-Out Plates. These same wires also pass through the access slots on the AFEE Cards, where the ends of the wires are soldered to the GCFE connection of the AFEE Card.

2.4 SIDE PANELS

Four Side Panels are mechanically attached to the PEM to provide physical protection to the AFEE Cards as well as EMI shielding.

2.5 TOWER ELECTRONICS MODULE

The Tower Electronics Module (TEM) is the read-out electronics for the AFEE. It is attached to the Base Plate of the CAL Module by means of four titanium stand-offs.

2.6 TEM POWER SUPPLY

The TEM Power Supply (TPS) provides power to the TEM and CAL Module. It is attached directly below the TEM.

3 REQUIREMENTS

3.1 TOOLING AND FIXTURES

Tooling for CAL Module Assembly must be certified and proof loaded to twice the working load in accordance with LAT-PS-04237, CAL Module Handling Procedure. This tooling includes the

- CAL Handling Fixture Assembly (LAT-DS-04537)
- CAL Turn-Over Fixture Assembly (LAT-DS-02851)
- CAL Lifting Fixture Assembly (LAT-DS-04138)

3.2 ASSEMBLY ENVIRONMENT

All CAL Module assembly operations shall be performed in a clean room environment with the conditions defined below, as defined in the Calorimeter, Tracker, & Data Acquisition Contamination Control Plan, LAT-MD-00228:

- Temperature: 20°C to 25°C
- Relative Humidity: 35% RH to 50% RH
- Cleanliness: Class 100,000 or better

Soldering, staking, and conformal coating operations will be performed in an enclosed facility maintained at a slightly positive air pressure.

When humidity decreases below 35% RH, electrostatic discharge sensitive devices and assemblies will be protected using extraordinary controls, such as air ionizers, for the protection of electrostatic sensitive ASICs and microcircuits and assemblies. Work must stop until the humidity level is in the range of 35% RH to 50% RH.

Work areas and tools will be maintained in a clean and orderly condition. There will be no visible dirt, grime, grease, flux, or solder splatter, nor other contaminating foreign materials at any workstation. Eating, smoking or drinking in the work area will be prohibited. Hand creams, ointments, perfumes, cosmetics and other materials unessential to the assembly operation are also prohibited at the workstation or in the work area.

Light intensity will be a minimum of 100 foot-candles (1077 Lm/M^2) on the surface used for soldering or inspection. Supplemental lighting may be used to assist these operations.

The Quality Assurance Engineer will control these conditions on a regular basis. Temperature and humidity shall be continuously monitored and recorded. Assembly operations shall be halted if conditions fail to meet the above requirements.

3.3 OUTGASING AND CONTAMINATION

All materials used during CDE insertion activities shall meet the outgassing and contamination requirements specified in LAT-MD-00228. All personnel participating in assembly activities shall be trained in proper clean room etiquete as defined in the above mentioned plan. During assembly, all personnel shall wear clean-room garments and powder-free gloves.

3.4 HANDLING AND SAFETY

All ESD precautions as specified in NASA-8739.7 will be followed. Once the CAL Module assembly activities commence, only personnel trained in proper ESD procedures shall be allowed to participate. Personnel wrist straps or ankle/foot straps shall be worn during all handling of the CAL Module or its components. The CAL Module and/or tables and fixtures must be grounded to a common point.

Handling of PDA wires and AFEE Cards from assembly, staking, conformal coating and inspection requires special precautious as defined below.

- Electronic assemblies, which are subject to electrostatic discharge (ESD) degradation, will be protected throughout the processing by the use of wraps, bags or rigid containers fabricated from materials having sufficient and permanent conductivity on all surfaces to permit bleed-off of static charge without producing a spark. Removal of the electrostatic-protective material and the subsequent handling of the electrostatically sensitive parts will be done at the electrostatic discharge (ESD) control workstation using NASA standard electrostatic discharge control procedures.
- Identification of the wires from the dual PIN photodiode and CDE assembly will be maintained throughout assembly, inspection and test process.

Care must be taken so that no equipment or tools are allowed to rest, strike or bump any part of the CAL Module or its components. All loose objects such as pens, pencils, badges, etc, shall be removed from open pockets when working on or around the CAL Module.

All lifting operation shall be performed in accordance with LAT-PS-04237, CAL Module Handling Procedure.

- A qualified operator is required for operations involving the use of the overhead crane, CAL Turn-Over Dolly, and CAL Lifting Fixture.
- All lifting equipment must have a current certified proof load test.
- During all overhead crane operations, a controlled area must be established to ensure that personnel are clear of the load at all times

In Section 5 of this document CAUTION and WARNING notes appear. In each case, the note appears above the section or step to which it refers. A CAUTION note describes a condition, which can be detrimental to flight hardware. A WARNING note describes a condition, which can present a risk to personnel.

3.5 EQUIPMENT AND SUPPLIES

The following equipment and supplies are required for the procedure:

- Equipment:
  - Ultrasonic Cleaning Unit
  - Calibrated Torque Wrench
  - Soldering Iron, Pace TW-100
  - Thermal Wire Stripper, Teledyne StripAll
  - Tie-Wrap Tightening Tool
  - Regulator for Nitrogen Source
  - Nozzle for Nitrogen Source

- Miscellaneous Hand Tools:
  - Square drive Hex Bit for MJ2.5 Socket-Head Cap Screws
  - Square drive Apex Bit for MJ2.5 Pan-Head (Offset Cruciform) Cap Screws
  - Driver Handles
  - Side Cutter
  - Clinching Tools or Devices
  - Holding Devices or Fixtures
  - Brushes – medium stiff natural bristles
  - Syringes and 22 gauge needles

- Supplies:
  - Alpha 6337 Solder wire - solder composition (Sn 63%, Pb 37%, eutectic solder), conforming to ANSI/J-STD-006.
  - Rosin based fluxes will be only type RMA (mildly activated). Liquid flux used in conjunction with core flux will be of the same manufacturer's type.
  - Powder-Free Gloves and Clean Room Garments
  - Lint-Free Wipes and Swabs
  - Acetone
  - Isopropyl Alcohol
  - Ethyl Alcohol, Anhydrous (200 Proof)
  - ESD Bags

3.6 PARTS LIST

Part	Drawing Number Part Number	Quantity	Material
Pre-Electronics Module	LAT-DS-01224	1	
AFEE, X	LAT-DS-00896	2	
AFEE, Y	LAT-DS-00897	2	
Side Panel, X	LAT-DS-00923	2	Aluminum
Side Panel, Y	LAT-DS-00924	2	Aluminum
Side Panel Gasket	LAT-DS-02269	4	Silver/Copper-Silicone
Bracket, AFEE Cable Mount	LAT-DS-03763	4	Aluminum
Support, AFEE Harness	LAT-DS-03764	4	Aluminum
Shield, Harness, AFEE Cable	LAT-DS-03844	4	Aluminum
TEM-TPS Assembly		1	
Screw, Pan-Head, MJ2.5 x 0.45 (6 mm)	NA0068-A025006	144	A-286 Alloy
Screw, Pan-Head, MJ2.5 x 0.45 (8 mm)	NA0068-A025008	40	A-286 Alloy
Screw, Socket-Head, MJ2.5 x 0.45 (6 mm)	NA0069-025006	124	A-286 Alloy
Screw, Flat Head, MJ2 x 0.45 (6 mm)	NA0070-020006	8	A-286 Alloy
Screw, Socket-Head, M6 (30 mm)	AIC 3353	4	Titanium 6Al-4V
M2.5 (0.4 mm THK), Washer, Flat	722-95-029-025-0.4B	124	A-286 Alloy
M6 Washer, Flat		4	Titanium 6Al-4V
M4 6 mm Hex M-F Stand-off (32 mm)	19981-SS-0470	8	
Vibra-Tite, Thread Lock	NSN-8030-00-163-5792	AR	Acrylic Co-Polymer Adhesive

4 CAL ASSEMBLY PLAN

The assembly procedure is divided into seven primary operations as outlined in this section. These operations are detailed in Section 5.0.

- Preparation of the Fasteners
- Installation of the AFEE Cards
- Electrical Installation of the AFEE Cards
- Mechanical Installation and Test of the TEM-TPS Assembly
- Final Close-out and Test of AFEE Cards
- Installation of the Side Panels
- Final Systems Test

4.1 FASTENER PREPARATION

Cleaning and application of thread lock adhesive onto the fasteners is required prior to installation of the AFEE Cards and Side Panels onto the PEM. A detailed procedure for the preparation of the fasteners is found in Section 5.1.

4.2 AFEE CARD INSTALLATION

A detailed procedure for installation of the AFEE Cards onto the PEM is found in Section 5.2. Installation consists of the following:

- Mechanical Installation
  - Initial Preparation of PDA wires (remove test connector and label PDA wires)
  - Installation of AFEE Cards onto the PEM
- Electrical Installation
  - Electrical Installation for CDE rows (cutting, stripping, and tinning of PDA wires)
  - Electrical Installation for PDA (bleeding charge, soldering, and inspection of soldered PDA wires)

4.3 AFEE SAFE-TO-MATE VERIFICATION

A detailed procedure for installation of the verifying that the AFEE is safe-to-mate is found in Section 5.3.

4.4 TEM-TPS INSTALLATION AND TEST

Installation and test of the TEM-TPS to the CAL Module consists of mechanical attachment and a functional test of the CAL Tower Module assembly. A detailed procedure for installation and testing of the TEM-TPS Assembly is found in Section 5.4. Installation and testing consists of the following:

- Mechanical installation of the TEM-TPS and AFEE-TEM Harness Bracket
- Electrical connection of the AFEE Cards to the TEM
- Functional Testing of the CAL Tower Module

4.5 AFEE CARD FINAL CLOSE-OUT AND TEST

A detailed procedure for completing installation and functional testing of the AFEE Cards is found in Section 5.5. Installation and testing consists of the following:

- Tightening all AFEE Card fasteners to specified torque
- Stake PDA wires onto the AFEE Cards
- Conformal-coat PDA solder joints on the AFEE Cards
- Calibrate detector system using the Co57 source

4.6 SIDE PANEL INSTALLATION

A detailed procedure for installation of the Side Panels onto the PEM is found in Section 5.6 and consists of the following:

- Seating the Side Panel Gaskets onto the Side Panel mating surfaces of the PEM Mechanical Structure.
- Place Side Panels on top of the Side Panel Gaskets
- Secure Side Panels to the PEM Mechanical Structure.

4.7 FINAL SYSTEM TEST AND CLOSE-OUT

A detailed procedure for final system test and CAL Module close-out is found in Section 5.6 and consists of the following:

- Running System Tests
  - Comprehensive Functional Test
  - Electronic Calibration
  - Muon Calibration (MuC)
- Tightening all Side Panel fasteners to specified torque

5 CAL MODULE ASSEMBLY PROCEDURE

5.1 FASTENER PREPARATION

Cleaning and application of thread-lock onto the fasteners is required prior to installation of the AFEE Cards and Side Panels onto the PEM.

1. Pull the following fasteners from inventory:
   - MJ2, 6 mm L, flat-head (100 deg) screws (NA0070-020006)
   - MJ2.5, 6 mm L pan-head cap screws (NA0068-A025006)
   - MJ2.5, 8 mm L pan-head cap screws (NA0068-A025008)
   - MJ2.5, 6 mm L, socket-head cap screw (NA0069-025006)
   - M2.5, 0.4 mm THK, washer, flat (722-95-029-025-0.4B)

2. Using an ultrasonic cleaning unit, clean the screws and washers in an acetone bath for 15 minutes:

   NOTE: Keep parts of different lot numbers separated during cleaning.

3. Rinse fasteners with fresh isopropyl alcohol and allow them to air-dry.

   NOTE: After cleaning, do not touch the threads of the screws with an ungloved hand, or allow any foreign substances, other than Vibra-Tite, to come in contact with the threads

4. Apply a uniform coat of Vibra-Tite thread-lock onto the threads in the fastener engagement area of the screws:
   - MJ2 screws = 5 threads, MIN
   - MJ2.5 screws = 6 threads, MIN

5. Allow Vibra-Tite to dry for a minimum of 30 minute before assembly or bagging.

   NOTE: When dry, the fasteners can be installed immediately or stored for later installation. If fasteners are to be stored, store all fasteners in ESD bags, which are clearly marked with the proper quantities required for each kit.

6. Bag the fasteners into kits with the following quantities:

   AFEE Card Installation Kit
   - MJ2, 6 mm L, flat-head (100 deg) screws (NA0070-020006), QTY 9 for each kit
   - MJ2.5, 6 mm L, socket-head cap screw (NA0069-025006), QTY 130 for each kit
   - M2.5, 0.4 mm THK, washer, flat (722-95-029-025-0.4B), QTY 130 for each kit

   Side Panel Installation Kit
   - MJ2.5, 6 mm L pan-head cap screws (NA0068-A025006), QTY 150 for each kit
   - MJ2.5, 8 mm L pan-head cap screws (NA0068-A025008), QTY 45 for each kit

5.2 AFEE CARD INSTALLATION

Installation of the AFEE Cards requires the skills of both the mechanical and electrical assembly technicians as described in the following subsections.

- Initial Set-Up
- Mechanical Installation
- Electrical Installation

5.2.1 Initial Set Up

Initial Set-up of the PEM Prior to AFEE Card installation consists of the following operations:

- Installation of the PEM onto the Turn-Over Dolly
- Rotating CAL Module About its Z-Axis on the Turn-Over Dolly

5.2.1.1 Installation PEM onto the Turn-Over Dolly

Prior to starting the mechanical assembly of the CAL Module, the PEM must be removed from the Base Platform of the PEM Insertion Tool and installed onto the Turn-Over Dolly using the following procedural steps:

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed.
Work Table and Fixtures shall be grounded.
Only personnel wearing ESD straps should be present during assembly activities.

1. Attach the CAL Lifting Fixture Assembly (LAT-DS-04138), minus the Hoist Plate (LAT-DS-02795) onto the hook of the hoist
2. Position the PEM underneath the A-Frame and Hoist.
3. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the PEM Assembly Platform
4. Attach personal wrist strap to the PEM Assembly Platform
5. Attach CAL Lifting Fixture Hoist Plate (LAT-DS-02795) to the Top Frame of the PEM using M4 socket-head cap screws. Tighten fasteners to 18 in-lb $\pm$ 1 in-lb
6. Attach another certified grounding strap to the Hoist Plate
7. Disconnect the grounding strap from the PEM Assembly Platform
8. Loosen and remove the nylon nuts securing the Shear Pins of the PEM onto the Corner Support of the PEM Insertion Tooling (LAT-DS-03321)
9. Attach the Lifting Fixture Assembly onto the Hoist Plate. Reduce the slack in the shackles, but do not load the hoist.
10. Loosen and remove the socket-head cap screws securing the Corner Support (LAT-DS-03321) to the Base Platform (LAT-DS-03322) of the PEM Insertion Tooling
11. Using the hoist, slowly lift the PEM from the Base Platform of the PEM Insertion Tooling and verify that the Shear Pins of the PEM are not binding in the holes of the Corner Supports.
12. Lift the PEM above the table and remove all components of the PEM Insertion Tooling

13. Install the Posts of the Handling Fixture (LAT-DS-05952) onto the Shear Pins of the PEM. Place mylar shims (LAT-DS-04647) between the post and the PEM Base Plate. Tighten the Posts to 100 in-lb ± 5 in-lb
14. Install the Base Plate of the Handling Fixture (LAT-DS-01524) onto the Handling Fixture Posts using the 5/16-18 socket-head cap screws and 5/16 washers from the fastener kit. Tighten the fasteners to 100 in-lb ± 5 in-lb
15. Move the table away from the A-frame and position the Turn-Over Dolly directly below the suspended PEM.
16. Connect a certified grounding strap (with 1 – 10 MOhm resistor) to the Turn-Over Dolly
17. Remove the 5/16-18 Lock-Down Bolts of the Turn-Over Dolly
18. Using the hoist, lower the PEM onto the Turn-Over Dolly until the Base Plate of the Handling Fixture mates with the Interface Plate (LAT-DS-02858) of the Turn-Over Dolly.
19. Secure the Handling Fixture onto the Interface Plate using four 1/2-13 socket-head cap screws. Tighten the fasteners to 30 ft-lb ± 2 ft-lb
20. Transfer personal ground wrist strap from the Lift Fixture Assembly to the Turn Over Dolly
21. Reinstall the 5/16-18 Lock-Down Bolts of the Turn-Over Dolly and tighten to 100 in-lb ± 5 in-lb
22. Remove M4 socket-head cap screws securing the Hoist Plate to the Top Frame of the PEM.
23. Using the overhead crane, lift the CAL Lifting Fixture Assembly from the test article.
24. Move the Turn-Over Dolly away from the A-frame.
25. Disconnect the hoist from the CAL Lifting Fixture Assembly and store

5.2.1.2 Rotating PEM or CAL Module About its Z-Axis

To rotate the PEM or CAL Module about its Z-Axis in the horizontal orientation, the Turn-Over Dolly is operated using the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Remove the four 5/16-18 fasteners securing the Interface Plate of the Turn-Over Dolly to the Lock-Down Bracket (LAT-DS-02859).
4. Rotate the Interface Plate so that the PEM or CAL Module is positioned for the next operation.
5. Reinstall the 5/16-18 fasteners into the Lock-Down Bracket and tighten to 48 in-lb ± 2 in-lb

5.2.2 Initial Mechanical Installation

The following events occur during the mechanical installation of the AFEE Cards:

- Initial preparation of the PDA wires
- Installation of the AFEE Cards onto the PEM

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

5.2.2.1 Initial Preparation of the PDA Wires

Initial preparation of PDA wires is tasked to the electrical assembly technician. Each of the 384 PDA wire pairs is prepared using the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Cut the shortening plugs attached to the ends of the PDA wires and discard shortening plugs in a separate ESD bags (marked non-flight parts). Be careful to hold the wires in one hand and grasp by the thumb and forefinger while cutting the shortening plugs.
4. Verify the twist of the wire.
5. Mark the wires with respect to the PDA/crystal assembly so that even and odd columns are distinguishable

5.2.2.2 Installation of the AFEE Cards onto the PEM

Installation of the AFEE Cards is tasked to the mechanical assembly technician. Each AFEE Card is installed onto each Close-Out Plate using the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Select AFEE Card and associated Close-Out Plate location in accordance with Work Order instruction. Verify that the proper AFEE Card will be installed onto the proper Close-Out Plate
   - X AFEE Card (LAT-DS-00896) attaches to Close-Out Plate X (LAT-DS-00920)
   - Y AFEE Card (LAT-DS-00897) attaches to Close-Out Plate Y (LAT-DS-00921)
4. Position the bottom edge of the AFEE Card against the Base Plate (LAT-DS-00919) above the Base Plate tabs.
5. Beginning with the bottom row of CDE twisted wire pairs protruding from the Close-Out Plate face, thread the wire pairs from each of the CDEs through their respective slots on the AFEE Card.

   CAUTION: During installation of the Close-Out Plate, special attention to the PDA wires is required to prevent excessive pulling, excessive bending, or crushing of the wires.
6. After the wire pairs from the bottom row of CDEs have been threaded through the AFEE Card, tilt the Card closer to the structure and move on to the next higher row of CDEs. Thread the wire-pairs of those CDEs through the appropriate holes on the AFEE Card.

7. Using the technique described in Step 5 and Step 6, continue to thread the remaining CDE wire pairs on the next higher row of the PEM structure, until the wire pairs from all 48 CDEs have been threaded through the AFEE Card.
8. Slide the AFEE Card against the Close-Out Plate. Verify that the wires do not bind between the AFEE Card and the stiffener or threaded boss of the Close-Out Plate as the AFEE Card is drawn toward the structure. Verify that the wires do not bind at the through-holes of the AFEE Card after the Card is seated against the Close-Out Plate.
9. Check the length of each wire against TBD minimum length
10. Obtain 31 M2.5, 6 mm L, socket-head cap screws (NA0069-025006) and 31 M2.5 flat washers (722-95-029-025-0.4B) from the AFEE Card Installation Kit. Install all screws with their associated flat washers to lightly secure the AFEE Card to the Close-Out Plate in accordance with assembly drawing, LAT-DS-00916. Record running torque and do not tighten.
11. Obtain two M2, 6 mm L, flush-head cap screws (NA0070-020006) from the AFEE Card Installation Kit. Install both screws to lightly secure the AFEE Card to the Base Plate in accordance with assembly drawing, LAT-DS-00916. Record running torque and do not tighten.
12. If geometry of work area permits to install the next AFEE Card on the side of the PEM opposite to the installed AFEE Card, continue to Step 14.
13. If the PEM must be rotated about its Z-Axis to install another AFEE Card, rotate as required, in accordance with the procedure in Section 5.2.1.2
14. Repeat repeat the installation procedure in Section 5.2.2.1 through Section 5.2.2.2 until all four AFEE Cards are attached to the PEM.

5.2.3 Electrical Installation

The following events occur during the electrical installation of each AFEE Card.

- Cutting the PDA wires to their appropriate length
- Stripping the PDA wires
- Tinning the PDA wires
- Bleeding the charge from the PDA wires
- Soldering the PDA wires onto the GCFE
- Inspection of the Solder Joints

Cutting, stripping, and tinning of PDA wires are completed one row at a time in accordance with Section 5.2.3.1. Upon completion of these operations, each PDA in the completed CDE row must have their charge bled, wire soldered, and solder joints inspected in accordance with Section 5.2.3.2 and Section 5.2.3.3 before continuing the Electrical Installation for the next CDE row.

5.2.3.1 Electrical Installation for CDE Rows

The following operations are completed for each PDA of the CDE Row.

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

5.2.3.1.1 PDA Wire Cutting

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Using a side cutter, trim each PDA wire in the CDE row to its appropriate length.

5.2.3.1.2 PDA Wire Stripping

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Thermally strip each PDA wire in the CDE row using a thermal wire stripper
4. Inspect each wire for the following accept/reject criteria using 4x to 10x power magnification. A problem report shall be generated for each rejection.
   - Nicks, cuts, and crushing or charring of the insulation (slight discoloration from thermal stripping is acceptable) are not acceptable and will be cause for rejection
   - After insulation removal, nicks, cuts, scrapes, and stretching of the exposed base metal (except smooth impression marks resulting from bending tool holding forces) are not acceptable and will be cause for rejection

5.2.3.1.3 PDA Wire Tinning

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Heat the wire lead using a soldering iron and hand-feed wire solder to the wire lead of each PDA wire in the CDE row. Allow a smooth, even coat of tinning to cover entire area of the wire lead.
4. Clean the wire using ethyl alcohol.
5. Inspect each wire for the following accept/reject criteria using 7x to 10x power magnification. A problem report shall be generated for each rejection.
   - Wires shall be solder-coated with a continuous new coat of solder, which covers at least 95% of the solder area. Small pin holes or voids are permitted in 5% of the solder area, provided they are not concentrated in one area. Wires not meeting this coating requirement are not acceptable and will be cause for rejection.
   - Solder splashes, points, peaks or icicles are not acceptable and will be cause for rejection.
   - Wires were damage or deformation has resulted of the tinning operation are not acceptable and will be cause for rejection
   - Wires where solder has wicked under the wire insulation by more than one insulated wire diameter are not acceptable and will be cause for rejection.

5.2.3.2 Electrical Installation for PDA

Upon completion of cutting, stripping, and tinning of the wires for the last PDA of the completed CDE row, each PDA of this CDE row must have their charge bled and wire soldered before continuing the Electrical Installation for the next CDE row.

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

5.2.3.2.1 PDA Charge Bleed Operation

Bleed charge from each PDA using the following procedure:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Verify that the braided grounding strap with the 1 MOhm terminal is in place near the PEM
4. Touch each of the four wires of the PDA to the 1 MOhm grounding strap to bleed the charge
5. Continue to Soldering Operations for this PDA

5.2.3.2.2 Soldering Operation

The soldering of each PDA wire to its corresponding GCFE connector pad on the AFEE Card will be performed in accordance with NASA-STD-8739.3, NASA Technical Standard, Soldered Electrical Connection. Prior to proceeding, review Section 6, Soldering Guidelines, and Section 7, Inspection and Acceptance Criteria for Solder Joints.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Solder each wire of the PDA to its corresponding GCFE connector pad on the AFEE Card using NASA-STD-8739.3 practices. Refer to Section 6 for guidelines.
4. Clean residue from each solder joint within one-half hour after soldering. Use ethyl alcohol and a natural hair brush
5. Repeat Section 5.2.3.2.1 and Step 1 through Step 4 of this section until completion of PDA electrical installation for the CDE row. Upon completion of PDA electrical installation for the CDE row, inspect solder joints in accordance with Section 5.2.3.2.3

5.2.3.2.3 Inspection of Solder Joints

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Using 10x power magnification, inspect each solder joint in accordance with the acceptance/rejection criteria found in Section 7, Inspection and Acceptance Criteria for Solder Joints. A problem report shall be generated for each rejection.
4. Upon completing the inspection of the CDE row, repeat Section 5.2.3.1 and Section 5.2.3.2 for the next lower CDE row on the PEM face.
5. Upon completing the inspection of the last CDE row, the electrical installation of the next of the AFEE Card can take place.
   - If geometry of work area permits, solder the next AFEE Card on the side of the PEM opposite to the completed AFEE Card.
   - If the PEM must be rotated about its Z-Axis to solder another AFEE Card, rotate as required, in accordance with the procedure in Section 5.2.1.2
6. Repeat the installation procedure in Section 5.2.3.1 through Section 5.2.3.2 until the PDA solder connections for all four AFEE Cards are complete.

5.3 AFEE SAFE-TO-MATE VERIFICATION

Run Safe-to-Mate procedure for AFEE Cards in accordance with LAT-PS-XXXXX.

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

5.4 TEM-TPS INSTALLATION AND TEST

Installation of the TEM-TPS Assembly requires the skills of both the mechanical and electrical assembly technicians as described in the following subsections. After installation, a functional test of the CAL Tower Module Assembly, in its present form, is required.

5.4.1 Initial Set-Up

The CAL Module assembly, in its present form, remains on the Turn-Over Dolly (Z-Axis - vertical orientation) for installation of the TEM-TPS assembly.

5.4.2 Installation and Test

Installation of the TEM-TPS Assembly is divided into two events:

- Mechanical installation of the TEM-TPS Assembly and associated harness hardware
- AFEE-TEM Connection and Functional Test

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

5.4.2.1 Mechanical Installation of the TEM-TPS and Associated Hardware

Mechanical installation of the TEM-TPS assembly is tasked to the mechanical assembly technician. Installation is in accordance with the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Place a scissor-jack platform onto the Handling Fixture Base Plate
4. Place the TEM-TPS Assembly below the CAL Module and let it rest on the scissor-jack platform
5. Verify that the +X and +Y axes of the TEM-TPS Assembly are properly oriented with the CAL Module in accordance with LAT-DS-04536
6. Using the scissor-jack, lift the TEM-TPS Assembly so its top surface almost touches the CAL-TEM Stand-Offs (LAT-DS-01554)
7. Obtain four M6, 30 mm L, socket-head cap screws (AIC 3353) and four M6 flat washers (TBD) from the TEM-TPS Installation Kit. Verify that Nytemp patch has been applied to each fastener. Install all screws and their associated flat washers through each countersunk hole in the TEM-TPS Assembly to engage the threads of each CAL-TEM Stand-Off.
8. Using the fasteners, draw the TEM-TPS Assembly against the CAL-TEM Stand-Offs
9. Tighten each fastener to 107 in-lb $\pm$ 5 in-lb.
10. Install four AFEE Cable Brackets (LAT-DS-03763) onto the Base Plate of the CAL Module. Secure each bracket using the M4 Male-Female Stand-Offs (19981-SS-0470). Tighten each Stand-Off to TBD in-lb $\pm$ TBD in-lb.

5.4.2.2 AFEE-TEM Connection and Functional Test

Connection of the AFEE Cards to the TEM is tasked to the electrical assembly technician. Each AFEE Card is connected and tested in accordance with the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Attach the two AFEE-side Connectors of the AFEE-TEM Harness to their corresponding sockets on the AFEE Card. Verify if they are properly seated.
4. Alternately tighten both socket-head cap screws of each connector until the connector is fully seated. Tighten fastener to TBD in-oz $\pm$ TBD in-oz.
5. Position the two AFEE-side legs of the AFEE-TEM Harness against the support of the AFEE-TEM Harness Bracket in such a way that it does not stress the soldered connectors on the AFEE Card. Once this position is achieved, secure the harness to the bracket support using flight tie wraps. Tighten to TBD using a tie-wrap tightening hand-tool.
6. Position the AFEE-TEM Harness around the support of the AFEE-TEM Harness Bracket.
7. Attach the TEM-side connector of the AFEE-TEM Harness to its corresponding socket on the TEM. Verify if it is properly seated.
8. Alternately tighten both socket-head cap screws of the connector until the connector is fully seated. Tighten fastener to TBD in-oz $\pm$ TBD in-oz.
9. Position the TEM-side leg of the AFEE-TEM Harness against the support of the AFEE-TEM Harness Bracket in such a way that it does not stress the soldered connector on the TEM. Once this position is achieved, secure the harness to the bracket using flight tie wraps. Tighten to TBD using a tie-wrap tightening hand-tool.
10. Repeat Step 3 through Step 9 for the remaining AFEE-TEM Harnesses
11. Start functional test of electrical subsystem in accordance with LAT-MD-01370, CAL Comprehensive and Limited Function Test Definition.

5.5 AFEE CARD FINAL CLOSE-OUT AND CALIBRATION

The completion of the AFEE Card installation and function test requires the skills of both the mechanical and electrical assembly technicians as described in the following subsections. After installation, a calibration of the detector system is required.

5.5.1 Initial Set-Up

The CAL Module assembly in its present form remains on the Turn-Over Dolly in the following orientations:

- Z axis - vertical orientation for completion of AFEE Card installation
- Z axis - horizontal orientation for staking/conformal coat operations and calibration

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

5.5.1.1 Rotating CAL Module About its Z-Axis when Z-Axis is Vertical

To rotate the CAL Module about its Z-Axis in the vertical orientation, the Turn-Over Dolly is operated in accordance with procedures outlined in Section 5.2.1.2.

5.5.1.2 Rotating Turn-Over Dolly to Orient Z-Axis of CAL Module Horizontally

To position the CAL Module with the Z-Axis in the horizontal orientation, the Turn-Over Dolly is operated using the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Verify that the ½-13 socket-head cap screws securing the Base Plate of the Handling Fixture to the Interface Plate (LAT-DS-02858) of the Turn-Over Dolly is properly tightened to 30 ft-lb $\pm$ 2 ft-lb
4. Verify 5/16 socket-head cap screws of the Lock-Down Bracket (LAT-DS-02859) is properly tightened to 48 in-lb $\pm$ 2 in-lb.
5. Remove the pin from the index plate of the Turn-Over Dolly
6. Turn the handle of the gear box to rotate the Cradle (LAT-DS-02851)
7. When the Z-Axis of the CAL Module is in the horizontal orientation, replace the pin into the index plate of the Turn-Over Dolly.

5.5.1.3 Rotating CAL Module About its Z-Axis when Z-Axis is Horizontal

WARNING

Interface Plate (LAT-DS-02858) can only be rotated while its rotating axis (Z) is VERTICAL.

DO NOT REMOVE the fasteners securing the Interface Plate to the Lock-Down Bracket (LAT-DS-02859) when the rotating axis (Z) of the Interface Plate is HORIZONTAL.

When the CAL Module has its Z-Axis in the horizontal orientation, it cannot be rotated about the Z-axis until it is returned to the vertical orientation using the following procedural steps:

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Remove the pin from the index plate of the Turn-Over Dolly
4. Turn the handle of the gear box to rotate the Cradle (LAT-DS-02851)
5. When the Z-Axis of the CAL Module is in the vertical orientation, replace the pin into the index plate of the Turn-Over Dolly.
6. Remove the four hold-down bolts of the Lock-Down Bracket (LAT-DS-02859) and rotate the Interface Plate to its desired 90 degree orientation
7. Replace the four hold-down bolts and tighten to 48 in-lb $\pm$ 2 in-lb
8. Remove the pin from the index plate of the Turn-Over Dolly
9. Turn the handle of the gear box to rotate the Cradle
10. When the Z-Axis of the CAL Module is in the horizontal orientation, replace the pin into the index plate of the Turn-Over Dolly.

5.5.2 Final AFEE Close-Out and Calibration

Final close-out of the AFEE Cards is tasked to the mechanical and electrical assembly technician. While the staking and conformal coating encapsulant is curing, the detector system may be calibrated using a Co57 source. Calibration is tasked to the lead scientist.

5.5.2.1 Final Mechanical Close-Out of AFEE Cards

Final mechanical installation of the AFEE Card is completed in accordance with the following procedural steps:

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Verify that the Z-Axis of the CAL Module is in the vertical orientation
4. Using the torquing sequence shown in Figure 5-1, tighten each MJ2.5 screw to 3 in- lb + running torque
5. Using the torquing sequence shown in Figure 5-1, tighten each MJ2 screw to 1.5 in-lb + running torque
6. Remove the .312-18 fasteners securing the Interface Plate of the Turn-Over Dolly to the Lock-Down Bracket (LAT-DS-02859).
7. Rotate the Interface Plate so that the CAL Module is positioned work on the next AFEE Card.
8. Reinstall the .312-18 fasteners into the Lock-Down Bracket and tighten to 48 in-lb $\pm$ 2 in-lb
9. Repeat Step 2 through Step 8 until the fasteners of all AFEE Cards are properly tightened.

5.5.2.2 Final Electrical Close-Out of AFEE Cards

Final electrical installation of the AFEE Card is divided into two separate activities:

- Staking of PDA wires
- Conformal Coating of PDA solder joints

Staking and conformal coating will be performed in accordance with NASA-STD-8739.1, NASA Technical Standard, Staking and Conformal Coating. Prior to proceeding, review Section 9, Prerequisites for Optimum Staking and Conformal Coating Performance.

5.5.2.2.1 Staking of PDA Wires

Staking of PDA wires on the AFEE Card is completed in accordance with the following procedural steps:

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

WARNING

Interface Plate (LAT-DS-02858) can only be rotated while its rotating axis (Z) is VERTICAL.

DO NOT REMOVE the fasteners securing the Interface Plate to the Lock-Down Bracket (LAT-DS-02859) when the rotating axis (Z) of the Interface Plate is HORIZONTAL.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Verify that the Z-Axis of the CAL Module is in the vertical orientation
4. Using ethyl alcohol to remove residues, thoroughly clean PDA solder joints and areas on each AFEE Card which will be staked and conformal coated. Rotate the CAL Module about its Z-Axis, as required, in accordance with the procedure in Section 5.5.1.1

   PRECAUTION: Prevent the washing/cleaning material from entering onto the existing conformal coating or any other parts
5. Dry AFEE board to remove all traces of wash and rinse materials
6. Rotate Turn-Over Dolly, in accordance with procedures outlined in Section 5.5.1.2 and Section 5.5.1.3, so that the surface of the AFEE Card to be staked and conformal coated is facing upward.
7. Mix the staking material, TRA-CON TRA-BOND 2151, in accordance with the manufacturer instructions
8. Load syringe with staking material and attach a 22 gauge needle to the syringe
9. Stake each PDA wire onto the AFEE Card using NASA-STD-8739.3 practices

   NOTE: Pot Life: 45 minutes (working life 90 minutes)
   Cure Schedule: 24 hours at 25ºC or 4 hours at 65ºC.
10. After staking material is allowed to dry for 2 hours, rotate the Turn-Over Dolly, in accordance with procedure outlined in Section 5.5.1.2 and Section 5.5.1.3, so that the next AFEE Card opposite to the completed AFEE Card is facing upward
11. Repeat repeat Step 7 through Step 10 until staking of all PDA wires on all four AFEE Cards is complete.

5.5.2.2.2 Conformal Coating of PDA Solder Joints

Conformal coating of the PDA solder joints on the AFEE Card is completed in accordance with the following procedural steps.

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

WARNING

Interface Plate (LAT-DS-02858) can only be rotated while its rotating axis (Z) is VERTICAL.

DO NOT REMOVE the fasteners securing the Interface Plate to the Lock-Down Bracket (LAT-DS-02859) when the rotating axis (Z) of the Interface Plate is HORIZONTAL.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Apply conformal coat encapsulant (Uralane 5750 LV-A/B, pre-mixed material) to the PDA solder joints of each AFEE Card using NASA-STD-8739.3 practices. During the brushing application, solvents will evaporate from the resin. It may be necessary to use the resin mixture within 30 minutes.
   a. Prior to the resin application blow the surfaces of the AFEE Card with clean dry nitrogen, 5 PSIG maximum, to remove any dust and/or dirt particles.
   b. With a clean camel hair or sable brush approximately one-quarter to three-eighths inch diameter, begin brush coating from left to right over the PDA solder joints. Continue from top to bottom until the AFEE Card has been completed, making sure that all PDA solder joints have been coated. Care must be taken to ensure that the resin is carefully applied around wires such that none touches or flows by capillary action. Add or remove resin as necessary to obtain a thickness between 0.003 to 0.005 inches.
   c. Excess resin buildup beneath and around electrical wires must not be allowed. Excess resin can be removed by brush. Measure the thickness of the wet resin and add or remove as necessary to provide thickness between 0.003 and 0.005 inches.
   d. After completion of the brush coating, check the surface of the AFEE Card for complete resin coverage and any contamination, such as brush hair. Break entrapped air bubbles within approximately one to two minutes.
   e. Using 10x power magnification and the inspection methods described in Section 8.3, inspect final staking and conformal coat per Section 8.2, Acceptance/Rejection Criteria for Conformal Coating. A problem report shall be generated for each rejection.
4. Allow the conformal coat encapsulant to dry for 2 hours

   NOTE: Cure Schedule: 24 hours at 25ºC, full cure in 5 to 7 days
5. After the encapsulant has been allowed to dry for two hours, rotate the Turn-Over Dolly, in accordance with procedure outlined in Section 5.5.1.2 and Section 5.5.1.3, so that the next AFEE Card opposite to the completed AFEE Card is facing upward

6. Install the heater plate so that it is directed toward to the AFEE Card facing downward. Install thermocouple, set the thermostat to 75ºC, and apply power to accelerate cure of encapsulant.
7. After TBD hours, turn-off power to heater plate and remove heater plate assembly
8. Calibrate the detector in accordance with the procedure in Section 5.5.2.3.
9. When calibration is complete, verify that the shutter of the Co57 source container is closed.
10. Repeat repeat Step 1 through Step 9 until conformal coating of all four AFEE Cards is complete.

5.5.2.3 Detector Calibration

Calibration of the detector system is tasked to the science officer, Dr. Groove. Calibration occurs while the staking and conformal coat encapsulant are undergoing cure. Calibration is completed in accordance with the following procedural steps:

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Position Stand and container for the Co57 source below the AFEE Card
4. Open the shutter of the container
5. Initiate calibration in accordance with LAT-PS-04626
6. When calibration is complete, close and lock the shutter of the Co57 source container

5.6 SIDE PANEL INSTALLATION

Installation of the Side Panels requires the skills of the mechanical assembly technician as described in the following subsections.

5.6.1 Initial Set-Up

The CAL Module assembly remains on the Turn-Over Dolly (Z-Axis - horizontal orientation) for installation of the installation of the Side Panels. Reorientation of the CAL Module is required for each Side Panel installation and is accomplished in accordance with the procedure in Section 5.5.1.3.

5.6.2 Installation

Installation of the TEM-TPS Assembly is divided into three events, which is tasked to the mechanical assembly technician:

- Seating Side Panel Gasket onto PEM Structure
- Seating Side Panel onto Side Panel Gasket
- Attaching Side Panel to PEM Structure

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

WARNING

Interface Plate (LAT-DS-02858) can only be rotated while its rotating axis (Z) is VERTICAL.

DO NOT REMOVE the fasteners securing the Interface Plate to the Lock-Down Bracket (LAT-DS-02859) when the rotating axis (Z) of the Interface Plate is HORIZONTAL.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Using the procedure in Section 5.5.1, orient the CAL Module so that a X or Y face of the CAL Module is facing upward (Z-Axis is horizontal)
4. Wipe the surface of the PEM Mechanical Structure where the Side Panel Gasket will sit with ethyl alcohol and allow to dry
5. Wipe both surfaces of the Side Panel Gasket with ethyl alcohol and allow to dry
6. Seat the Side Panel Gasket onto the Side Panel mating surface of the PEM Mechanical Structure. Verify that the gasket sits flat on the mating surface.
7. Verify that the proper Side Panel will be installed onto the proper side of the CAL Module and place it on top of the Side Panel Gasket
    - Side Panel X (LAT-DS-00923) attaches to the X face of the CAL Module
    - Side Panel Y (LAT-DS-00924) attaches to the Y face of the CAL Module

8. Obtain 10 M2.5, 8 mm L, socket-head cap screws (NA0068-A025008) from the Side Panel Installation Kit. Install all screws to lightly secure the Side Panel to the inserts of the PEM Structure in accordance with assembly drawing, LAT-DS-00916. Record running torque and do not tighten.
9. Verify that the Side Panel is seated on the Side Panel Gasket after installing the 10 fasteners
10. Obtain 36 M2.5, 6 mm L, socket-head cap screws (NA0068-A025006) from the Side Panel Installation Kit. Install all screws to lightly secure the Side Panel to the PEM Structure in accordance with assembly drawing, LAT-DS-00916. Record running torque and do not tighten.
11. Verify that the Side Panel is seated on the Side Panel Gasket after installing the remaining fasteners
12. Reorient the CAL Module in accordance with the procedure in Section 5.5.1.3, so that the next Side Panel to be installed will be facing upward
13. Repeat Step 4 through Step 12 until all four Side Panels are attached to the PEM Structure

5.7 FINAL SYSTEM TEST AND CLOSE-OUT

Final system tests are described in the following subsections. Following successful testing, the Side Panels are tightened to their specified torque.

5.7.1 Initial Set-Up

The CAL Module assembly remains on the Turn-Over Dolly in the following orientations:

- Z-Axis - vertical orientation for final systems testing
- Z-Axis - horizontal orientation for final close-out of Side Panels

Reorientation of the CAL Module is required for final close-out of each Side Panel and is accomplished in accordance with the procedure in Section 5.5.1.

5.7.2 Systems Testing

Systems test is tasked to the lead scientist. The following systems testing is required before completion of the CAL Module assembly:

- Comprehensive Function Testing
- Electronic Calibration
- Muon Calibration (MuC)

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

WARNING

Interface Plate (LAT-DS-02858) can only be rotated while its rotating axis (Z) is VERTICAL.

DO NOT REMOVE the fasteners securing the Interface Plate to the Lock-Down Bracket (LAT-DS-02859) when the rotating axis (Z) of the Interface Plate is HORIZONTAL.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Using the procedure in Section 5.5.1, orient the CAL Module so that its Z-Axis is vertical.
4. Initiate comprehensive functional testing in accordance with LAT-MD-01370
5. Initiate electronic calibration in accordance with LAT-PS-01370
6. Initiate Muon calibration in accordance with LAT-PS-04187

5.7.3 Final Side Panel Close-Out

Final close-out of the Side Panels is tasked to the mechanical assembly technician.

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed. Work Table and Fixtures shall be grounded with 1 - 10 MOhm Resistor (QA will verify connection)

Only personnel wearing ESD straps should be present during assembly activities.

WARNING

Interface Plate (LAT-DS-02858) can only be rotated while its rotating axis (Z) is VERTICAL.

DO NOT REMOVE the fasteners securing the Interface Plate to the Lock-Down Bracket (LAT-DS-02859) when the rotating axis (Z) of the Interface Plate is HORIZONTAL.

1. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the Turn-Over Dolly
2. Verify that ESD floor mats and ankle/foot ground straps are in place
3. Using the procedure in Section 5.5.1, orient the CAL Module so that a X or Y face of the CAL Module is facing upward (Z-Axis is horizontal)
4. Using the torquing sequence shown in Figure 5-1, tighten each MJ2.5 screw to 3 in-lb (50% of its final torque specification)
5. Using the torquing sequence shown in Figure 5-1, tighten each MJ2.5 screw to 6 in-lb + running torque, MAX (100% of its final torque specification).
6. Reorient the CAL Module in accordance with the procedure in Section 5.5.1.2, so that the next Side Panel to be secured will be facing upward
7. Repeat Step 4 through Step 6 until all four Side Panels are secured to the CAL Module

Figure 6-1: Torquing Sequence for Securing the Side Panels

6 SOLDERING GUIDELINES

6.1 PRELOADING

During the soldering operation, wire retainment must be consistent with the principle that no preloading of the leads/solder joint is allowed. There will be no relative motion between wire and printed wiring board termination areas during solder application and solidification. The soldering operation will not result in the holding of wire leads against normal spring-back forces or deforming PWA's such that resulting solder joints contain residual stresses.

6.2 HEAT DAMAGE

Due to the small size of soldering pads and the close proximity of circuit components to each other, proper heat dissipation is essential. Excessive heat can damage soldering pads or adjacent components. For this reason, soldering iron tip temperature will not exceed 650^0F (343^0C). Size of the tip (heat capacity) must be selected so that fairly rapid heating is accomplished and the solder connection is made in less than five (5) seconds.

6.3 THERMAL SHUNTS

Thermal shunts will be used where heat during the soldering operations may degrade wire insulation.

6.4 FLUX APPLICATION

If used, liquid flux must be applied to the surfaces to be joined, prior to the application of heat. The use of excess flux will be avoided. When an external liquid flux is used in conjunction with flux-cored solders, the fluxes will be chemically compatible.

6.5 SOLDER APPLICATION

A well-tinned tip will be applied to the joint and the solder introduced at the junction of the tip and the connection for maximum heat transfer. After applying heat and achieving heat transfer, the solder should be applied to the joint and not the soldering iron tip. Heat may be simultaneously applied to both sides of the plated through-hole. Some hand soldering applications may require preheating and will be detailed in the assembly procedure.

NOTE: Timing - it is essential that the total time-temperature cycle is enough to assure a properly wet joint, and small enough to assure that the joint is not overheated, or that heat damage to the PWA has occurred.

a. For proper wetting, the soldering tip will contact both wire lead and PWA pad. Apply enough solder to the tip to start a proper wetting action, then move the solder to outer edges of pad and let solder flow towards the heat source. Once the soldering iron is in position, do not move it. Solder is composed of tin and lead, and tin will burn off faster than lead. When iron is on pad over 5 seconds, delamination or dull grayish solder connections will occur.

b. Movement of wire lead during soldering must be avoided and will result in an unsatisfactory disturbed solder connection.

c. Timing, temperature, tooling, cleanliness, materials and techniques establish proper solder joints.

d. The molten solder will flow around the wire lead and over the termination area of the pad.

6.6 COOLING

Forced cooling will not be used to cool solder joints. Connections will only be cooled at room temperature.

6.7 INTERIM CLEANING

Residues will be removed during interim cleaning within 1/2 hour after soldering using ethyl alcohol and a brush with natural hair bristles.

6.8 INSPECTION

The criteria for acceptability of solder connections will be as specified in Section 7.

6.9 PROCEDURE FOR CLEANING

The proper procedures should be used for the cleaning and cleanliness verification of electronic PWA using the hand cleaning method.

7 INSPECTION AND ACCEPTANCE CRITERIA FOR SOLDER JOINTS

7.1 GENERAL

The acceptance criteria will be based on the requirements outlined in NASA-STD-8739.2 and NASA-STD-8739.3, which will be the governing documents. Illustrations and photographs in these documents will be used to the greatest extent possible in determining acceptance or rejection of soldered connections. Soldering will be performed in such a manner as to be uniform in quality and free from defects. Inspection will be performed at 10x magnification to verify workmanship requirements.

7.2 ACCEPTABLE SOLDER CONNECTIONS

Solder joints are acceptable when characterized by the following:

- Clean, smooth, bright, undisturbed surface
- Solder fillets between wire and GCFE pads are as described and illustrated in NASA-STD-8739.
- Contour of wire sufficiently visible to determine the presence of the wire, the direction of the bend and the termination end of the wire
- Complete wetting on functional pads
- Proper amount and distribution of solder

7.3 REJECTABLE SOLDER CONNECTIONS

Solder joints are not acceptable when any of the following conditions exist. These conditions will be cause for rejection.

- Pits, holes or voids, or exposed base metal in the soldered connection
- Gold, rosin, granular or disturbed solder connection
- Fractured or cracked solder connection or evidence of grain structure change
- Wire pattern separation from board
- More than 5% of functional pad is dewetted
- Insufficient or excessive solder (including peaks, icicles and bridging) on the functional pads

7.4 REJECTABLE DAMAGE CAUSED BY SOLDERING OPERATIONS

Damage caused by soldering operations is not acceptable when any of the following conditions exist. These conditions will be cause for rejection.

- Cut, nicked, gouged or scraped wires or printed wiring conductor pattern
- Improper conductor length or direction of clinch
- Charred, burned or melted insulation or parts
- Burns on base materials
- Discoloration, which is continuous between printed conductors (e.g., measling, delamination, halo effect, etc.)
- Flux residue, solder splatter or other foreign matter on circuitry or adjacent areas

Broken or damaged wires, part leads or printed wiring conductors shall not be spliced.

7.5 WETTING

Wetting is solder that has adhered to both surfaces of a solder connection. If more than 5% of the pad area is dewetted, the connection will be considered a reject.

Dewetting is defined as a connection where the solder first wets the surfaces and then draws back because of improper wetting, leaving behind a thin coat of solder over the base metal. The solder itself then "balls up" on the surface. This condition is usually the result of improper surface preparation and will be rejected.

7.6 BOARD DISCOLORATION

Discoloration, which is continuous between conductors, and caused from the soldering operations, is unacceptable. This discoloration may be in the form of measling, delamination, halo effect, crazing, etc.

Board surfaces that exhibit fractures or have chipped surfaces in the base material or under conductor patterns are also unacceptable.

8 QUALITY ASSURANCE REQUIREMENT FOR CONFORMAL COATING

8.1 DOCUMENTATION

Quality assurance personnel shall verify that all required documentation is current and approved.

The documentation shall include:

1. Records
   - A. Results of the visual examination
   - B. Material purchase data
   - C. Mix record
   - D. Witness sample

2. Procedures
   - A. Conformal coating program as per this specification.
   - B. Tooling and equipment operating procedures as defined herein.
   - C. Calibration system as defined herein.
   - D. In-process storage and handling procedures as defined herein.
   - E. Cleaning procedures as defined herein.

8.2 ACCEPTANCE/REJECTION CRITERIA FOR CONFORMAL COATING

8.2.1 Documentation

All acceptance and rejection criteria for conformal coating shall be clearly defined in the application processing document(s). Reference Figure 10-2 through Figure 10-5 of NASA-STD-8739.1 for conformal coating acceptance and rejection criteria.

8.2.2 Acceptance Criteria

Conformal coated PWA's shall exhibit, as a minimum, the following workmanship characteristics to be acceptable:

- Unless otherwise specified by the approved engineering documentation, the conformal coating, when measured in flat unencumbered areas of the board, or preferably on the witness coupon, shall have a thickness appropriate for the conformal coating material being used.
- Conformal coating shall be uniform in color and texture.
- Conformal coating shall be tack-free when cured.
- Coating shall have good adhesion to the PWA and electrical components with no visible lifting or peeling of the coating.
- Conformal coating shall have a smooth continuous surface, free of air bubbles and follows the contours of the PWA.
- Conformal coating shall be uniform in thickness in the range of 0.003" to 0.005".
- Conformal coating shall cover all areas as specified on the engineering documentation. Pull back from sharp points and edges shall be permitted unless otherwise specified.
- Conformal coating shall be free of contamination such as dust, dirt, or hair.

- Each terminal without a solder ball shall be conformal coating encapsulated to include the insulation gap of the wire.
- Conformal coating material that bridges between adjacent part leads is acceptable.
- Coating shall have no excessive build-up on the PWA's surface and the electrical component stress relief wires must be free of coating.
- Coating shall have no thin or dry spots.
- Coating shall not be allowed to bridge between ceramic-bodied dual-in-line components and the PWA's surface.
- Coating shall not be allowed to coat male/female IC component terminals. (i.e., sockets).

8.2.3 Rejection Criteria

The following are some characteristics of unsatisfactory conditions, any of which is cause for rejection:

- Conformal coating material used after shelf life expiration.
- Conformal coating bridges stress relief areas thereby negating stress relief.
- Conformal coating bridges between the PWA and the bottom of flatpacks.
- Conformal coating exhibits tackiness or soft spots.
- Pinholes, blistering, scratches, whitish spots (measling), wrinkling, or cracking.
- Any signs of contamination (e.g., flux, loose particles, or foreign material).
- Discolored conformal coating.
- Bubbles or bare spots bridging two electrically conductive elements.
- Bubbles larger than 0.76 mm (0.03 inch) in any dimension.
- Conformal coating exhibits lifting or peeling.
- Conformal coating exhibits excess runs, fish eyes, or peeling.

8.3 INSPECTION METHODS FOR CONFORMAL COATING

8.3.1 Visual Inspection of Workmanship and Adhesion Requirements

Workmanship and adhesion requirements shall be verified by visual inspection using 4X to 10X power magnification. Higher magnification may be used, as necessary, to verify suspected anomalies or defects.

8.3.2 UV-Light Inspection

When fluorescent conformal coating materials are used, coverage and location shall be determined by UV-light examination.

8.3.3 Conformal Coating Thickness Inspection

Conformal coating thickness shall be determined using a wet film thickness gauge, micrometer, or other tool on flat surfaces of the PWA or preferably, the coupon required as defined herein.

8.3.4 Tackiness and Soft Spots

Gentle finger pressure shall be used to inspect for tackiness and soft spots. For this purpose, lint-free gloves or finger cots shall be worn.

9 PREREQUISITES FOR OPTIMUM STAKING AND CONFORMAL COATING PERFORMANCE

9.1 CLEANLINESSS OF WIRE, SOLDER JOINTS AND PWA

Wire, solder joints, and PWA must be clean and dry. If not removed, process residues from board fabrication (fluxes and fingerprints), from assembly soldering operations and from testing, will affect wetting of the conformal coating and result in reduced or total loss of adhesion or dewetting of the coating. Water-soluble residues will be activated by absorbed moisture, resulting in vesication ("mealing" of the cured surface), which degrades the coating.

Moisture may become "sealed in" when an assembly to be coated is not dry at the time of coating and may also react with coating materials causing bubbles or inhibiting of UV cures.

Boards must be thoroughly cleaned with ethyl alcohol to remove residues. Cleaned boards must be dried to remove all traces of wash and rinse materials. Precautions must be taken in order to prevent the washing/cleaning material from entering onto the existing conformal coating or any other parts.

9.2 CLEANLINESS OF PROCESSING AREAS

Processing areas must be clean. After cleaning and drying, the assembly must be kept clean and dry until coated. Clean shop coats, hair covers, and gloves for processing personnel are mandatory. Also prohibited in coating areas are hand lotions and cosmetic products with silicones, as well as silicone containing oils, greases, and mold release agents. If cleaned assemblies are not to be coated immediately, they should be protected using anti-static material.

9.3 COATING COVERAGE AND THICKNESS

The applied coating must completely cover the entire assembly. Coating thickness is also an important parameter. Recommended thickness is 0.002” to 0.005”. Thin coating films reduce protection against humidity effects. Thick coatings may contribute to mechanical stresses on components and solder joints causing conformal coating to crack. Thick coatings may not cure completely.

9.4 QUALITY AND STORAGE OF COATING MATERIALS

Coating materials must be stored properly to maintain optimum properties. Liquid coatings should always be stored in their original sealed containers away from fire, open flames, and sparks. Open containers of coatings are sensitive to moisture. "Age control" (use of material within its specified shelf life indicated on documents from the supplier which accompany the coating) of the coating material is important and must be controlled.

9.5 RESIN FORMULATION FOR BRUSH CONFORMAL COATING

Conformal coating for the PWA is Uralane 5750 LV-A/B – pre-mixed material.

9.6 STAKING WIRES ON PRINTED WIRING ASSEMBLIES

Electrical wires, which are attached to the PWA may be subject to high vibration stress levels. To ensure that none of these wires become detached from the PWA, a thixotropic mixture of a thermal conductive electrical insulating compound manufactured by TRA-CON (TRA-BOND 2151), shall be used to stake the wires. Properly applied staking compound will firmly hold the wires in place.

This staking material has a short pot life and should not be used after 45 minutes. Cure schedule is 24 hours at 25ºC or 4 hours at 65ºC.