GLAST LAT PROCEDURE	Document # **LAT-PS-04237-01**	Date Effective 18 August 2004
	Prepared by(s) Paul Dizon	Supersedes None
	Subsystem/Office Calorimeter Subsystem	
Document Title **CAL Module Handling Procedure**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT) Calorimeter

Calorimeter Module Handling Procedure

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	18 August 2004	Initial Release

Table of Contents

List of Figures

1 INTRODUCTION

1.1 PURPOSE

This document describes the procedures required to safely handle of the Calorimeter (CAL) Module to during assembly, test and shipping.

1.2 SCOPE

This document contains detailed procedures for operations involving lifting, handling, transport between assembly station or test facilities, as well as packing and unpacking, for shipping of the CAL Module.

2 APPLICABLE DOCUMENTS

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

2.1.1 Documents

GSFC-433-MAR-0004	GLAST Mission Assurance Requirements for the Large Area Telescope Phase C/D/E
NASA-STD-8739.7	Electrostatic Discharge Control
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-03929	CAL Electromagnetic Interference (EMI) Test Procedure
LAT-PS-04454	CAL Flight Module Thermal-Vacuum Test Procedure
LAT-PS-04455	CAL Module Handling Procedure

2.1.2 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-	Tower Electronics Module-Power Supply Assembly
LAT-DS-04138	CAL Lifting Fixture Assembly
LAT-DS-02795	Hoist Plate, Calorimeter
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-03395	Shipping Container Assembly
LAT-DS-03381	Plate, Base, Enclosure Seal
LAT-DS-03382	Enclosure, Calorimeter
LAT-DS-03388	Manifold Assembly
LAT-DS-03391	Pin, Alignment
LAT-DS-03392	Pillow Block
	Bushing

2.2 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
TBD	To Be Defined
TEM	Tower Electronics Module
TPS	TEM Power Supply

3 GENERAL REQUIREMENTS

3.1 PERSONNEL

All handling operations shall be performed by a qualified operator knowledgable in the use of the overhead crane, A-Frame hoist, CAL Lifting Fixture, and Shipping Container specified in these procedures. Furthermore, only personnel trained in proper ESD procedures shall be allowed to participate in handling activities.

3.2 ENVIRONMENT

Environmental conditions are defined in the Calorimeter, Tracker, & Data Acquisition Contamination Control Plan, LAT-MD -00228. All handling operations involving assembly shall be performed in a clean room environment with the conditions defined below:

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

All handling operations taking place during environmental test shall be performed in the following environmental conditions defined below:

- Temperature: 20°C to 25°C
- Relative Humidity: 35% RH to 50% RH (50% RH to 55% RH for up to 3 hours)
  Test Article to be bagged where RH requirements cannot be met)
- Cleanliness: Test Article to be bagged where Class 100,000 is not available

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

3.3 OUTGASING AND CONTAMINATION

All materials used during handling 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. For environmental test, all personnel shall wear, at a minimum, power-free gloves during handling.

3.4 HANDLING AND SAFETY

All ESD precautions per NASA-8739.7 will be followed. Only personnel trained in proper ESD procedures shall be allowed to participate in handling activities. Personnel wrist straps shall be worn during all handling of the CAL Module or its components. The CAL PEM, CAL Module, CAL Tower Module and/or tables and fixtures must be grounded to a common point.

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 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 tools and supplies are required for this procedure:

- Calibrated Torque Wrench
- Square drive Hex Bit for the following fasteners
  - M4 Socket-Head Cap Screws
  - 5/16-18 Socket-Head Cap Screws
  - ½-13 Socket-Head Cap Screws
- Miscellaneous Hand Tools
- Powder-Free Gloves and Clean Room Garments
- Lint-Free Wipes and Swabs
- Acetone
- Isopropyl Alcohol

3.6 PARTS LIST

DRAWING NUMBER PART NUMBER	PART DESCRIPTION	QUANTITY
LAT-DS-04138	CAL Lifting Fixture Assembly	1
LAT-DS-02795	Hoist Plate, Calorimeter	1
LAT-DS-02859	Bracket, Lock-Down	2
LAT-DS-04537	CAL Handling Fixture Assembly	1
LAT-DS-01524	Base Plate, Handling Fixture	1
LAT-DS-05952	Post, Handling Fixture	4
LAT-DS-03395	Shipping Container Assembly	1
LAT-DS-03381	Plate, Base, Enclosure Seal	1
LAT-DS-03382	Enclosure, Calorimeter	1
LAT-DS-03388	Manifold Assembly	1
LAT-DS-03391	Pin, Alignment	2
LAT-DS-03392	Pillow Block	2
NA0069-040020	Screw, Socket-Head, MJ4 x 0.45 (TBD mm)	16
	Screw, Socket-Head, ½-13, (in L)	4
	Screw, Socket-Head, 5/16-18, (in L)	4
	Washer, Flat, 5/16	4
	Bushing	4

4 ASSEMBLY AND TEST SEQUENCE

The following assembly and test sequence applies to each of the Calorimeter Modules. A flow chart of this sequence is shown in Figure 4-1, where it is divided into six general themes:

1) PEM assembly
2) Electronics integration
3) Calibration and characterization
4) Environmental testing
5) Pre-ship verification
6) Shipment and sign-off

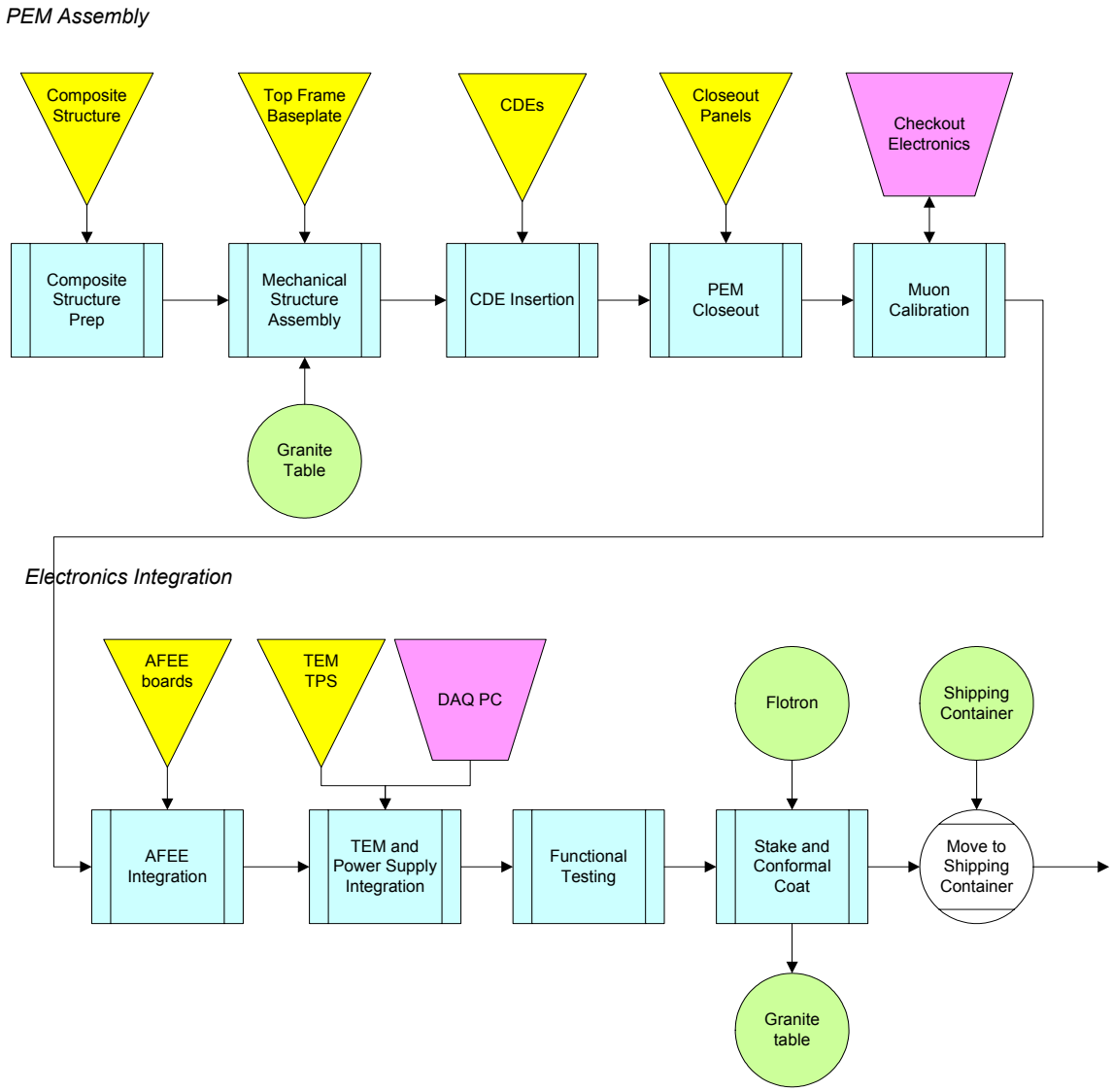

Figure 4-1: CAL Assembly and Test Sequence

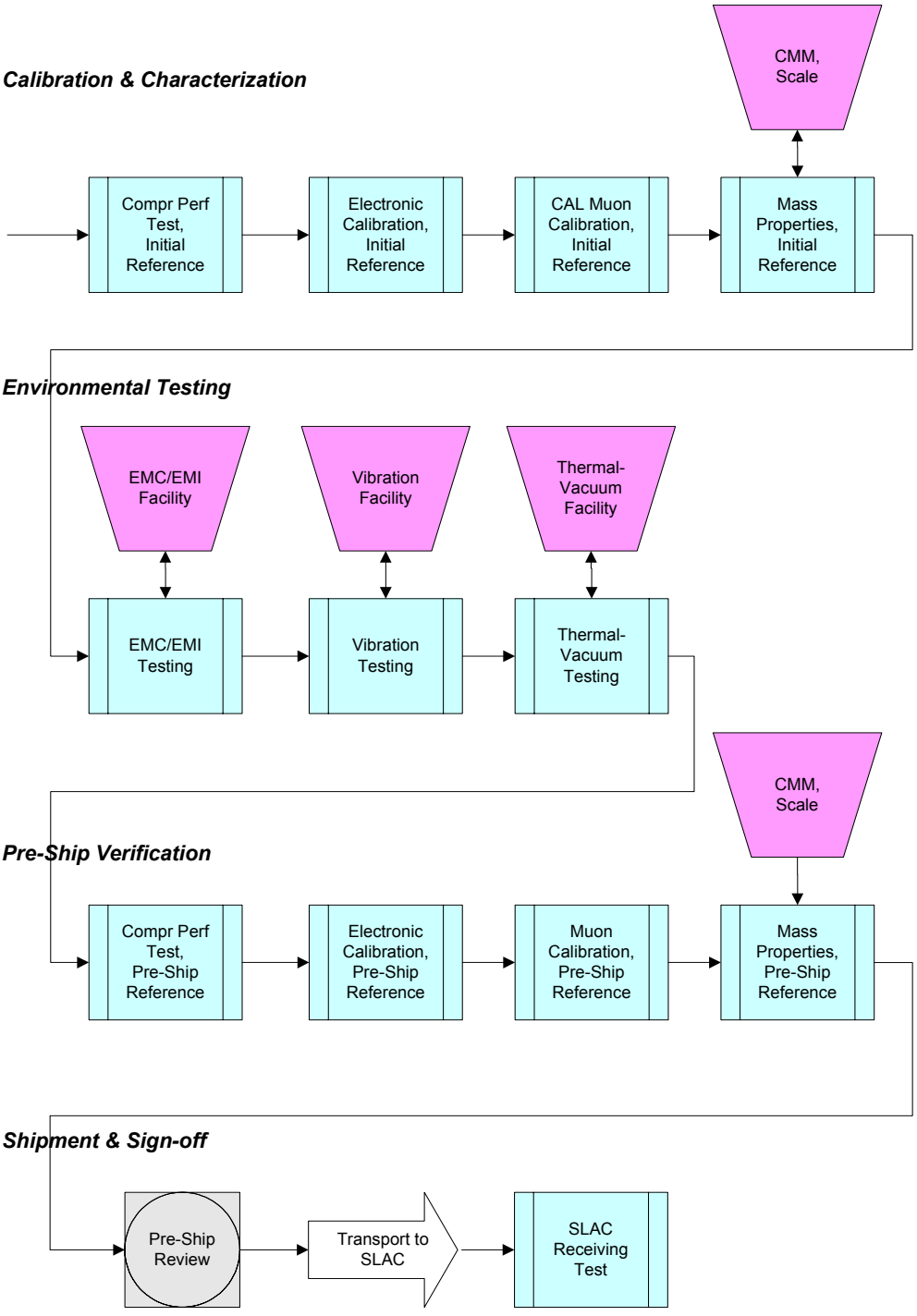

Figure 4-1: CAL Assembly and Test Sequence - Continued

5 ASSEMBLY AND TEST HANDLING FLOW

Handling operations are required during the following activities during the CAL assembly and test flow:

ASSEMBLY AND TEST ACTIVITY	REQUIRED HANDLING OPERATION	CALORIMETER CONFIGURATION
PEM Assembly	Lift	PEM
Electronics Integration	Lift	CAL Module
Calibration and Characterization	Lift	CAL Tower Module
Environmental Testing	Lift Transport	CAL Tower Module
Pre-Ship Verification	Lifting Transport	CAL Tower Module
Shipment	Pack-Unpack	CAL Tower Module

6 CAL HANDLING PROCEDURES

This document contains details concerning the procedures for lifting, moving, packing/unpacking, and shipping of the CAL Module. The procedure is divided into three primary operations:

- Lift operations
- Transport operations
- Packing and Unpacking for shipment

Thoughout the following section detailing the handling procedures:

- **CAL Assembly** will indicate the CAL in any one of its configurations:
  - PEM Assembly
  - CAL Module
  - CAL Tower Module
- **Base Fixture** will indicate the assembly fixture, test fixture or platform securing the CAL Assembly, such as:
  - CDE Insertion Tooling Base Plate
  - Turn-over Fixture
  - Handling Fixture
  - EMI Test Fixture Interface Plates
  - Vibration Test Fixture Interface Plates
  - Thermal-Vacuum Test Fixture

6.1 LIFT OPERATIONS

Lifting is required throughout most phases of assembly, test, and shipping. Lifting is accomplished by using either the A-frame hoist in the CAL clean-room, or any of the overhead cranes at NRL or SLAC.

Required Equipment:

- CAL Lifting Fixture Assembly (LAT-DS-04138) with Hoist Plate (LAT-DS-02795)
- M4 Socket-Head Cap Screws
- Certified Grounding Strap
- Calibrated Torque Wrench
- Square Drive 3 mm Hex Bit
- Miscellaneous Hand Tools
- Powder-Free Gloves
- Personal Wrist Strap

6.1.1 Clean-Room Lift Operations

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 Handling Operations.

WARNING

During Lift Operations, a controlled area must be established to ensure that personnel are clean of the load at all times

1. Verify that a certified grounding strap is connected to the CAL Assembly
2. Attach personal wrist strap to the Base Fixture
3. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
4. Attach the Hoist Plate to the Top Frame of the CAL Assembly using 16 MJ4 fasteners. Tighten each fastener to 35 $\pm$ 1 in-lb
5. Attach the Hoist Ring of the Lifting Fixture Assembly to the hook of the A-Frame hoist
6. Position the A-Frame hoist over the CAL Assembly
7. Lower the Lifting Fixture Assembly and attach it to the Hoist Plate
8. Verify that the Base Fixture securing the CAL Assembly has been disconnected from its associated assembly or test fixture.
9. Slowly lift the CAL Assembly from its associated assembly or test fixture

6.1.2 Overhead Crane Lift Operations

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 Handling Operations.

WARNING

During Lift Operations, a controlled area must be established to ensure that personnel are clean of the load at all times

1. Verify that a certified grounding strap is connected to the CAL Assembly
2. Attach personal wrist strap to the CAL Assembly
3. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
4. Attach the Hoist Plate to the Top Frame of the CAL Assembly using 16 MJ4 fasteners. Tighten each fastener to 35 $\pm$ 1 in-lb
5. Attach the Hoist Ring of the Lifting Fixture Assembly to the hook of the hoist
6. Position the hoist of the Overhead Crane over the CAL Assembly
7. Lower the Lifting Fixture Assembly and attach it to the Hoist Plate
8. Verify that the Base Fixture securing the CAL Assembly has been disconnected from its associated assembly or test fixture.
9. Slowly lift the CAL Assembly from its associated assembly or test fixture

6.2 TRANSPORT OPERATIONS

Transport is required throughout most phases of assembly and test. Transportation within the assembly facilities or between the test facilities usually involves the Shipping Container. This section only addresses installation and removal of the CAL Tower Module into the

Required Equipment:

- Shipping Container (LAT-DS-03395)
- CAL Lifting Fixture Assembly (LAT-DS-04138) with Hoist Plate (LAT-DS-02795)
- 5/16-18 Socket-Head Cap Screws
- Certified Grounding Strap (2)
- Calibrated Torque Wrench
- Square Drive Hex Bit for 5/16 Socket-Head Cap Screw
- Miscellaneous Hand Tools
- Powder-Free Gloves
- Personal Wrist Strap

6.2.1 Installation of CAL Tower Module into Shipping Container

This procedure assumes that the CAL Tower Module is suspended from the hoist of the A-Frame or Overhead crane.

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 Handling Operations.

WARNING

During Lift Operations, a controlled area must be established to ensure that personnel are clean of the load at all times

1. Verify that the certified grounding strap is still connected to the CAL Tower Module
2. Attach personal wrist strap to CAL Tower Module
3. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
4. Unlatch Plastic Top Cover of the Shipping Container
5. Remove Plastic Top Cover from the Base of the Shipping Container
6. Position the open Shipping Container below the suspended CAL Tower Module.
7. Attach another certified grounding strap to the grounding lug on the Shipping Container
8. Verify that the Enclosure Seal Base Plate of the Shipping Container (LAT-DS-03381) and the Base Plate of the Handling Fixture (LAT-DS-01524) are clean of debris.
9. Slowly lower the CAL Tower Module onto the Enclosure Seal Base Plate

10. Secure the Handling Fixture Base Plate to the Shipping Container with the four 5/16-18 socket-head cap screw, associated bushings and washers. Tighten the fasteners to 48 ± 2 in-lb
11. Remove personal wrist strap from the CAL Tower Module and attach it to the grounding lug on the Shipping Container
12. Loosen and remove the sixteen MJ4 socket-head cap screws securing the Hoist Plate (LAT-DS-02795) to the Top Frame of the CAL Tower Module. Bag and store fasteners.
13. Using the hoist, slowly lift the Lifting Fixture Assembly away from the Shipping Container
14. If so instructed by the controlling Work Order, carefully place the Plastic Top Cover onto the the Base of the Shipping Container Be careful not to contact the CAL Tower
15. Latch the Plastic Top Cover to the Base of the Shipping Container

6.2.2 Removal of CAL Tower Module from Shipping Container

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 Handling Operations.

WARNING

During Lift Operations, a controlled area must be established to ensure that personnel are clean of the load at all times

1. Verify that the certified grounding strap is still connected to the grounding lug on the Shipping Container
2. Attach personal wrist strap to the grounding lug on the Shipping Container
3. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
4. Unlatch Plastic Top Cover of the Shipping Container
5. Carefully Remove Top Plastic Cover from the Base of the Shipping Container so that it does not contact the CAL Tower Module
6. Attach the Hoist Plate to the Top Frame of the CAL Tower Module using 16 MJ4 fasteners. Tighten each fastener to 35 ± 1 in-lb
7. Loosen and remove the four 5/16-18 fasteners securing the base plate (LAT-DS-1524) of the Handling Fixture to the Shipping Container to the Enclosure Seal Base Plate of the Shipping Container (LAT-DS-03381). Bag and store fasteners.
8. Attach the Hoist Ring of the Lifting Fixture Assembly to the hook of the hoist
9. Position the hoist of the A-Frame or Overhead Crane over the CAL Tower Module
10. Attach the Lifting Fixture Assembly to the Hoist Plate
11. Verify that the Base Fixture securing the CAL Tower Module has been disconnected from its associated assembly or test fixture.
12. Attach another certified grounding strap to the CAL Tower Module

13. Remove personal wrist strap from the grounding lug on the Shipping Container and attach it to the CAL Tower Module
14. Slowly lift the CAL Tower Module from the Enclosure Seal Base Plate
15. Roll the Shipping Container from beneath the suspended CAL Tower Module

6.2.3 Transport Between Test Facilities

During transportation between test facilities, proper grounding procedures are imperative.

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 Handling Operations.

1. Fully extend certified grounding cable from its spool and verify that it is still connected to the grounding lug on the Shipping Container.
2. Attach personal wrist strap to the grounding lug on the Shipping Container
3. Roll the Shipping Container to the next grounding cable spool.
4. As the Shipping Container is moved to the next grounding cable spool, have an assistant check the slack in the cable.
5. Fully extend certified grounding cable from the next spool and connect it to the grounding lug on the Shipping Container.
6. Retract the cable from the previous grounding cable spool.
7. Continue Step 2 through Step 6 until the Shipping Container has reached the next test facility.

6.3 PACKING-UNPACKING OPERATIONS

Proper packing and unpacking procedures are required for shipment between NRL and SLAC or any other off-premisis test facility.

Required Equipment:

- Shipping Container (LAT-DS-03395)
- CAL Lifting Fixture Assembly (LAT-DS-04138) with Hoist Plate (LAT-DS-02795)
- 5/16-18 Socket-Head Cap Screws
- Certified Grounding Strap (2)
- Calibrated Torque Wrench
- Square Drive Hex Bit for 5/16 Socket-Head Cap Screw
- Miscellaneous Hand Tools
- Lint-Free Wipes
- Isopropyl Alcohol
- Powder-Free Gloves
- Personal Wrist Strap

6.3.1 Packing Procedure

This procedure assumes that the CAL Tower Module is suspended from the hoist of the A-Frame or Overhead crane.

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 Handling Operations.

WARNING

During Lift Operations, a controlled area must be established to ensure that personnel are clean of the load at all times

1. Verify that the certified grounding strap is still connected to the CAL Tower Module
2. Attach personal wrist strap to CAL Tower Module
3. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
4. Unlatch Plastic Top Cover of the Shipping Container
5. Remove Plastic Top Cover from the Base of the Shipping Container
6. Position the open Shipping Container below the suspended CAL Tower Module.
7. Attach another certified grounding strap to the grounding lug on the Shipping Container
8. Verify that the Enclosure Seal Base Plate of the Shipping Container (LAT-DS-03381) and the Base Plate of the Handling Fixture (LAT-DS-01524) is clean of debris.

9. Slowly lower the CAL Tower Module onto the Enclosure Seal Base Plate
10. Secure the Handling Fixture Base Plate to the Shipping Container with the four 5/16-18 socket-head cap screw, associated bushings and washers. Tighten the fasteners to 48 $\pm$ 2 in-lb
11. Remove personal wrist strap from the CAL Tower Module and attach it to the grounding lug on the Shipping Container
12. Loosen and remove the sixteen MJ4 socket-head cap screws securing the Hoist Plate to the Top Frame of the CAL Tower Module. Bag and store fasteners.
13. Using the hoist, slowly lift the Lifting Fixture Assembly away from the Shipping Container
14. Roll the Shipping Container from beneath the suspended Lifting Fixture Assembly
15. Disconnect the Hoist Plate from the Lifting Fixture Assembly
16. Attach the hoist rings of the Shipping Container Enclosure (LAT-DS-03382) to the Lifting Fixture Assembly.
17. Using the hoist, lift the Enclosure, if necessary
18. inspect the inner surfaces of the Enclosure for particles or contamination
19. Moisten a clean-room cloth with isopropyl alcohol and wipe the inner surfaces of the Enclosure to clean any debris or contamination
20.
21. Moisten a clean-room cloth with isopropyl alcohol and wipe the flange of the Enclosure to clean the surface of any debris or contamination
22. Moisten a clean-room cloth with isopropyl alcohol and wipe the o-ring seal of the Enclosure Seal Base plate to clean off any debris or contamination
23. Roll the Shipping Container beneath the suspended Enclosure.
24. Lower the Enclosure so that the two Pillow Blocks (LAT-DS-03392) engage the two Alignment Pins (LAT-DS-03391) of the Shipping Container
25. Continue lowering the Enclosure until the small corner alignment pins on the Enclosure Seal Base plate engage the flange of the Enclosure.
26. Verify that the flange of the Enclosure has properly seated against the o-ring of the Enclosure Seal Base
27. Secure the Enclosure against the Enclosure Seal Base Plate with the toggle clamps (24 clamps)
28. Attach a dry gaseous nitrogen source to the quick-disconnect fill port of the Manifold Assembly (LAT-DS-03388)
29. Attach a flow meter to the plug valve.
30. Open the plug valve on the Enclosure so that it can vent
31. Open the valve on the dry nitrogen source and allow it to free-flow (1 cfm) to purge all moisture from the inside of the Enclosure.
32. After 8-12 hours, lower the nitrogen flow and and close the plug valve
33. Close the dry nitrogen regulator when the gauge on the manifold reads 1.5 psig.
34. Disconnect the dry nitrogen source from the quick-disconnect fill port of the Manifold Assembly
35. Verify that the Enclosure is still holding pressure after 2 - 8 hours
36. Carefully place the Top Plastic Cover onto the the Base of the Shipping Container. Be careful not to contact the Enclosure
37. Latch the Plastic Top Cover to the Base of the Shipping Container

6.3.2 Unpacking Procedure

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 Handling Operations.

WARNING

During Lift Operations, a controlled area must be established to ensure that personnel are clean of the load at all times

1. Attach a certified grounding strap to the grounding lug on the Shipping Container
2. Attach personal wrist strap to the grounding lug on the Shipping Container
3. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
4. Unlatch Plastic Top Cover of the Shipping Container
5. Carefully Remove Plastic Top Cover from the Base of the Shipping Container so that it does not contact the Shipping Container Enclosure (LAT-DS-03382)
6. Check the gauge on the Manifold Assembly (LAT-DS-03388) and record the pressure. The pressure should be 0 psig if the Container has been shipped via air freight. (The pressure relief valve in the Enclosure is designed to vent at altitude and hold a slight underpressure at return to sea level.)
7. Open the plug valve on the Enclosure and allow it to vent. There will be a slight underpressure (approximately 1.5 psi) in the Enclosure if the Container has been shipped via air freight.
8. Attach the Lifting Fixture Assembly to the hoist of the Overhead Crane
9. Position the hoist of the Overhead Crane over the open Shipping Container
10. Disengage the toggle clamps (24) securing the Enclosure to the Enclosure Seal Base Plate (LAT-DS-03381)
11. Verify that the flange of the Enclosure is free
12. Attach the Lifting Fixture Assembly to the hoist rings of the Enclosure.
13. Using the crane, slowly lift the Enclosure away from the Enclosure Seal Base Plate
14. Roll the Shipping Container from beneath the suspended Enclosure.
15. Disconnect the Enclosure from the Lifting Fixture Assembly and temporarily place the Enclosure on a work surface so that its flange does not get damaged
16. Attach the Hoist Plate (LAT-DS-02795) to the Top Frame of the CAL Tower Module using 16 MJ4 fasteners. Tighten each fastener to 35 $\pm$ 1 in-lb
17. Loosen and remove the four 5/16-18 fasteners securing the base plate (LAT-DS-1524) of the Handling Fixture to the Shipping Container. Bag and store fasteners.
18. Attach the Hoist Ring of the Lifting Fixture Assembly to the hook of the hoist
19. Position the hoist of the Overhead Crane over the CAL Tower Module

20. Attach the Lifting Fixture Assembly (LAT-DS-04138) to the Hoist Plate
21. Attach another certified grounding strap to the CAL Tower Module
22. Remove personal wrist strap from the grounding lug on the Shipping Container and attach it to the CAL Tower Module
23. Slowly lift the CAL Tower Module from the Enclosure Seal Base Plate
24. Roll the Shipping Container from beneath the suspended CAL Tower Module