

# **LAT Transport Container Design Review**

8 September 2005

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The logo for the GLAST LAT Project, featuring a stylized satellite or space station with a large antenna and a circular base, set against a background of a starry sky.

## General Design Requirement

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- The LAT Transport Container shall be capable of transporting and storing the LAT without damage per the requirements stated in:
  - LAT-PS-06349, LAT Transport Container Statement of Work
  - LAT-DS-05992, LAT Transport Container Source Control Drawing

# Design Requirements

- **Transportation Environment**
  - **Transportation Acceleration**

Mode	Longitudinal Acceleration	Lateral Acceleration	Vertical Acceleration
LAT Max Allowable	+/- 1.25 g	+/- 1.25 g	+/- 3.0 g
Air	+/- 3.0 g	+/- 1.5 g	+/- 3.0 g
Truck	+/- 3.5 g	+/- 2.0 g	+/- 6.0 g
Max Mass	6750 lbs (LAT in Shipping Configuration)		

- **Temperature and Humidity**

Mode	LAT Limit (Internal Environment)	External Environment
Temperature	+5 deg C to +35 deg C	-15 deg C to +50 deg C
Humidity	0% to 50%	0% to 100%
LAT Limit must be maintained for 12 hours when exposed to extreme external environments		

## Design Requirements - continued

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- **Construction Requirements**

- Adequate clearance between LAT and inside of the cover to allow for:
  - 1) Safe cover removal and installation (6 inches min)
  - 2) Predicted dynamic motion of the LAT
- Permanent provisions for Fork Lift interface
- Provisions for mounting of Air Bearings
- Corner Hoist Rings used for cover removal
  - Any two of the four rings may be used to rotate the cover onto its side for interior cleaning
- Sectioned or One-Piece Cover, which is removable down to below the LAT interface
- Tie-Down Points for Transport
- External surfaces protected against corrosion
- Container must shed water
- External ground point on Base
- External connector with cap for nitrogen purge of interior
- Accommodate rapid depressurization of the aircraft during flight

## Design Requirements - continued

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- **Internal Requirements**
  - **Mounting Interface as defined in LAT-DS-05992, Transport Container Source Control Drawing**
  - **Cover has a gasketed air-tight seal with a 2-way pressure relief valve**
  - **2-way pressure relief valve vents through HEPA filters into the container**
  - **Dessicant container – provides up to 4 weeks of useable life**
  - **Ground point on mounting plate**
  - **Internal surfaces shall tolerate alcohol cleaning**
  - **Internal surfaces shall be free of trapped volumes**
  - **Internal finishes shall not corrode and shall be low outgassing**
  - **Environment recorders**
    - **3-axis shock recorder**
      - **mounted on the LAT-side mounting plate**
      - **Shock recorder shall have a 10-day battery life**
    - **Temperature recorder**
    - **Humidity recorder**
  - **Provide access to the environment recorders**

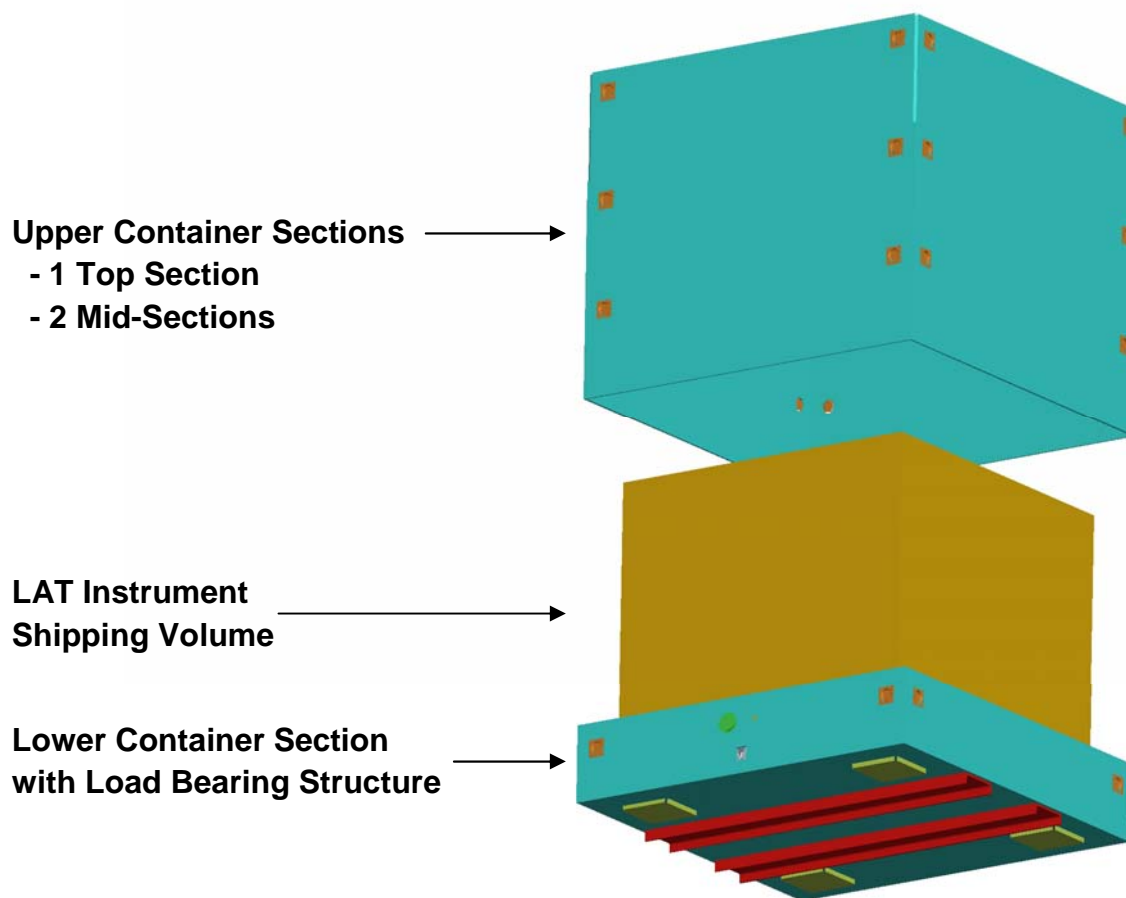
A logo for the GLAST LAT Project, featuring a stylized satellite dish or antenna structure with a yellow and blue color scheme, set against a dark background with a star.

# LAT Transport Container – Overall Design

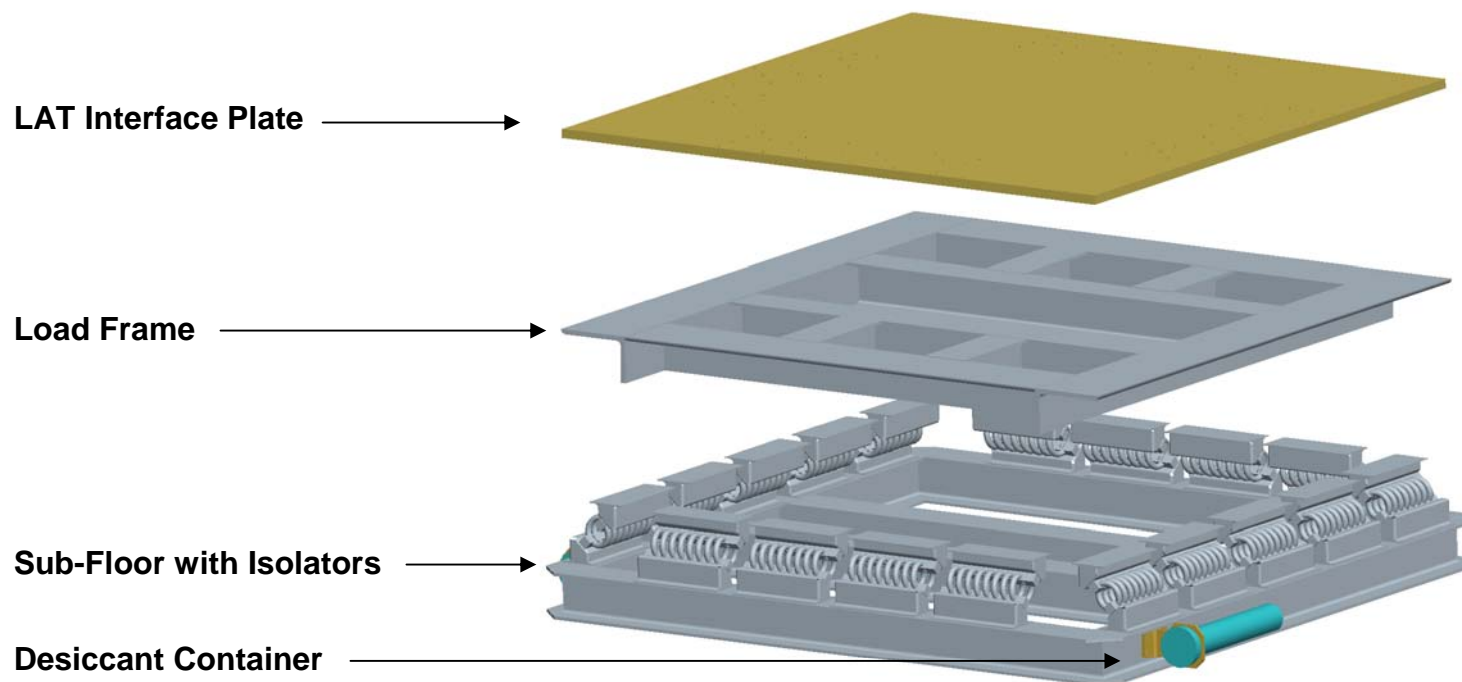
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- LAT Transport Container Design
  - Existing Design:
    - Outer container is constructed of aluminum-clad plywood panels with tie-down rings.
    - Bottom section of outer container is currently load-bearing.
      - Capability is light-duty
      - Wire rope load isolation system is fastened directly to plywood floor panel
      - Plywood floor panel is subjected to bending load during fork lift operation
  - NRL Shipping Container to be modified to meet LAT Requirements
    - Outer Container
      - Treated as a protective cover and does not carry the LAT load
      - Minimal modifications required
    - Load Frame
      - Redesigned to be compatible with the LAT interface and loads
      - Sub-Floor added to provide proper load path from the load frame to the forklift and air bearing interfaces

# LAT Transport Container – Overall Design

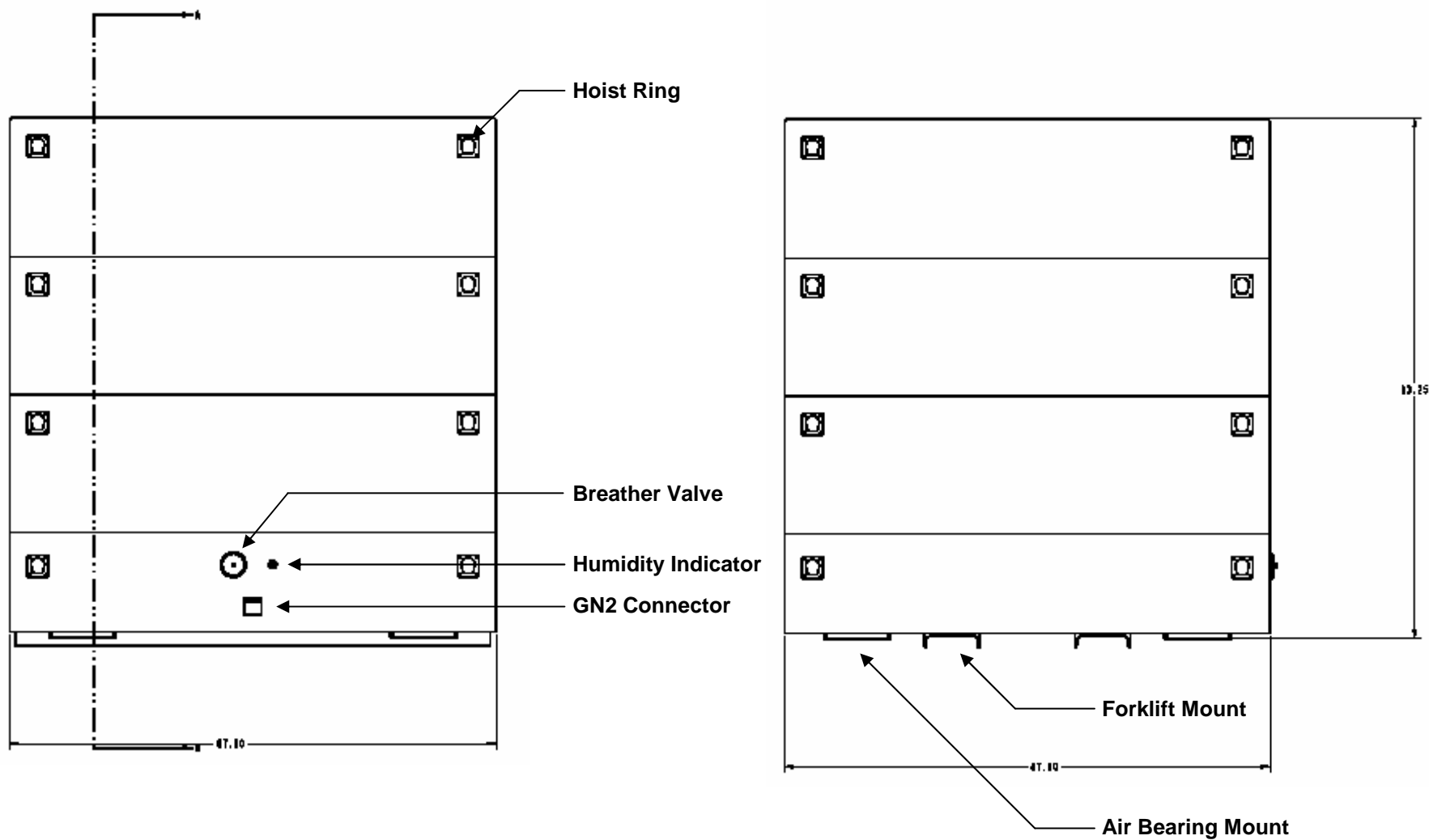


# LAT Transport Container – Overall Design

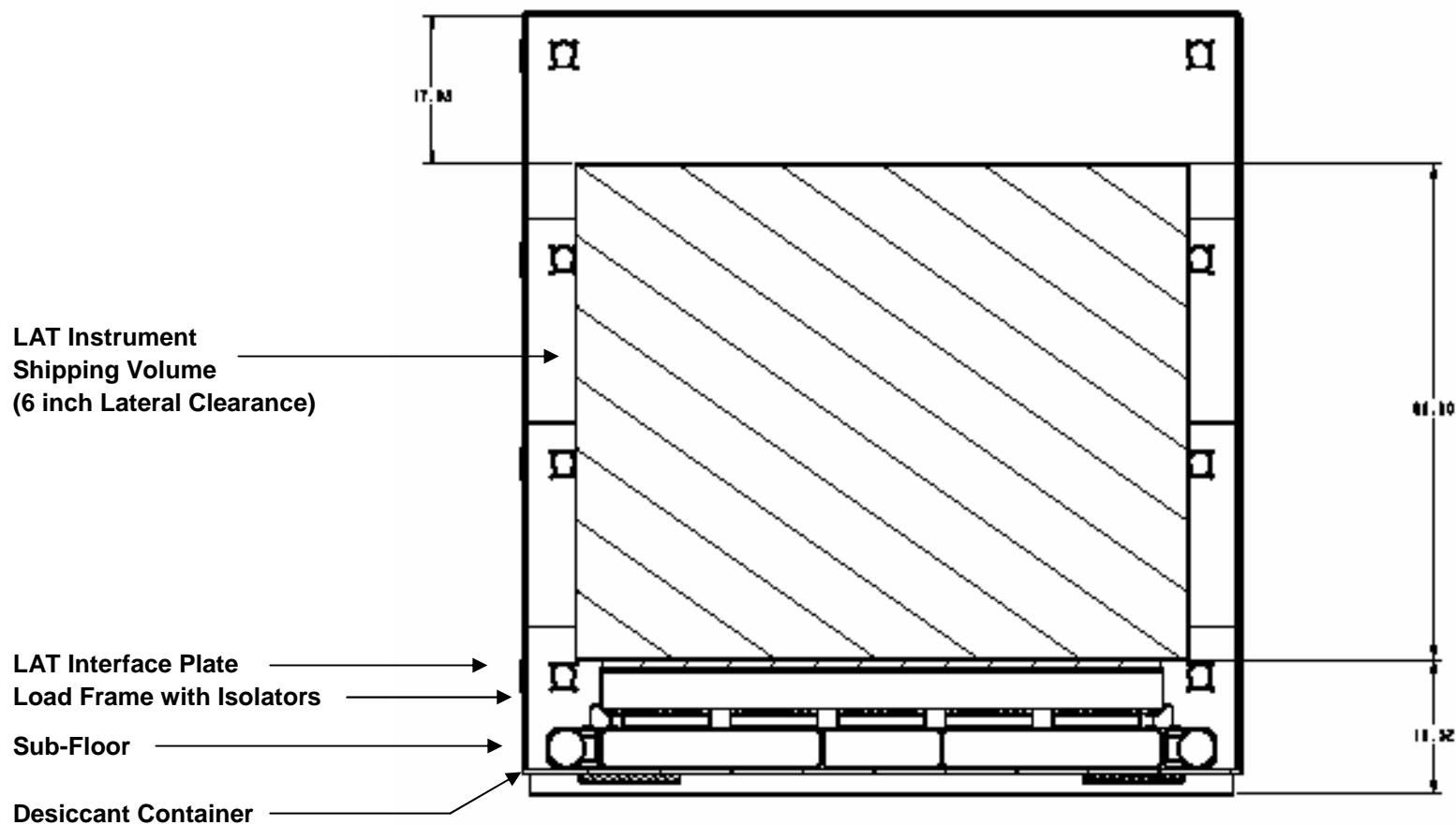




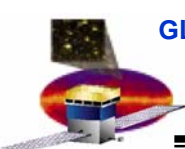
# LAT Transport Container – External



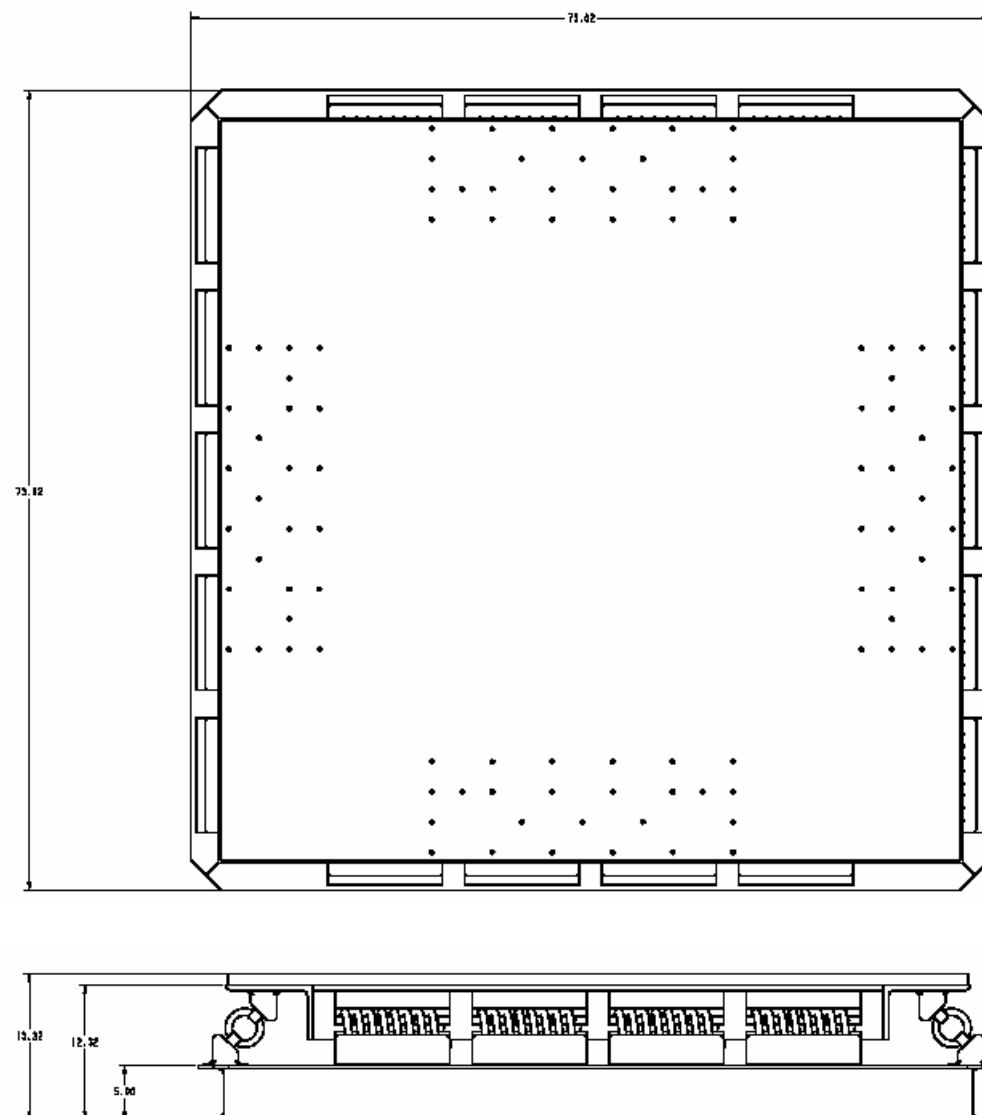
# LAT Transport Container – Internal



## Internal Cut-Away View



# LAT Transport Container – Internal



# Requirement Compliance

DESIGN REQUIREMENTS	COMPLIANCE
<b>TRANSPORT REQUIREMENTS</b>	
Meet maximum allowable transportation requirement	Additional Wire Rope Isolators required for existing load frame (16 total)
Meet Internal Temperature Limits	Thermal insulation added to the existing design
Meet Internal Humidity Limits	Properly sized Desiccant Containers added to existing design
<b>CONSTRUCTION REQUIREMENTS</b>	
Adequate Clearance between LAT and inside of the cover to allow for 1) Safe cover removal and installation 2) Predicted dynamic motion of the LAT	5.9 inch clearance
Permanent provisions for fork lift mount	Existing provision redesigned
Provisions for mounting air bearings	Modification added to existing design
Corner Hoist Rings for cover removal and rotation	Current design has corner hoist rings
Section or one-piece cover, which is removable below the LAT interface	Current design has sectional cover
Tie down points for shipping (transport loads per 5.1.1)	Additional tie-down points should be installed on base of container
External surfaces shall be protected against corrosion	Current design is painted
Container must shed water	Current design is water resistant
External ground point on Base	Modification added to existing design
External connector with cap for nitrogen purge of interior	External GN2 purge connector of current design has been replaced
Accommodate rapid depressurization of the aircraft during flight	High-Flow 2-way Breather Valve (140 cfm) added to existing design

# Requirement Compliance

DESIGN REQUIREMENTS	COMPLIANCE
<b>INTERNAL REQUIREMENTS</b>	
Mounting interface for the LAT is defined in Ref (1)	Modification added to existing design Wire rope isolators realigned with the LAT interface line of action
Cover has a gasketed, airtight seal with a 2 way pressure relief valve	Current seal design meets requirement High-Flow 2-way Breather Valve (140 cfm) added to existing design
2-way relief valve vents through HEPA filters into container	Modification added to existing design
Desiccant container - provides up to 4 weeks of useable life	Modification added to existing design
Ground point on mounting plate	Modification added to existing design
Internal surfaces shall tolerate alcohol cleaning	Current design meets requirement
Internal surfaces shall be free of trapped volumes	Current design meets requirement
Internal finishes shall not corrode and shall be low outgassing	Current design meets requirement
3 axis shock recorder	NRL furnished shock recorder available
- mounted on the LAT side of the mounting plate	
- 10 day battery life,	
Temperature Recorder	NRL furnished temperature recorder available
Humidity Recorder	NRL furnished humidity recorder available
Provide access to all Environment Recorders	Modification added to existing design (connector feed-through)

## Status

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- Preliminary wire rope isolator sizing complete
- Relief valve sizing complete
- Desiccant container sizing complete
- Thermal Analysis ongoing
- Stress Analysis of Load Frame and Sub-Floor ongoing
- Components have been purchased
  - Breather Valve
  - Dessicant Containers
  - Humidity Indicator
- Fabrication Drawings are schedule for completion by September 26 – October 3
- Welded Structure and Container Modifications will be done in-house (TBD)

# Schedule

WORK	WEEK	LOAD FRAME REDESIGN	SUBFLOOR DESIGN	OUTER CONTAINER MODIFICATION
01-Aug-05	05-Aug-05			
08-Aug-05	12-Aug-05			
15-Aug-05	19-Aug-05			Order Components (8/15/05)
22-Aug-05	26-Aug-05			
29-Aug-05	02-Sep-05	Redesign Complete (9/02/05)	Redesign Complete (9/02/05)	Redesign Complete (9/02/05)
05-Sep-05	09-Sep-05	Shipping Container Design Review (9/8/05)		
12-Sep-05	16-Sep-05		I/F Plate Drwg Complete (9/16/05)	
19-Sep-05	23-Sep-05			
26-Sep-05	30-Sep-05	Load Frame Drwg and Analysis Complete (9/26/05)	Subfloor Drwg and Analysis Complete (9/26/05)	
03-Oct-05	07-Oct-05			Outer Container Drwg Complete (10/03/05)
10-Oct-05	14-Oct-05			
17-Oct-05	21-Oct-05			
24-Oct-05	28-Oct-05		Fabrication Complete (10/28/05)	Modification Complete (10/24/05)
31-Oct-05	04-Nov-05			
07-Nov-05	11-Nov-05	Modification Complete (11/07/05) Installation Complete (11/09/05) Proof Load Complete (11/10/05)	I/F Plate Mfg Complete (11/07/05) Installation Complete (11/09/05) Proof Load Complete (11/10/05)	Installation Complete (11/09/05)
14-Nov-05	18-Nov-05	Deliver Shipping Container to SLAC		

The logo for the GLAST LAT Project, featuring a stylized satellite dish or antenna structure with a yellow and orange glow, set against a dark background with a small image of a satellite in the upper left corner.

## Analysis Methodology

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- Shipping Container treated as protective enclosure, not as primary structure
- Load Frame and Sub-Floor act as primary structure carrying load of LAT
- Assume applied environmental load occurs simultaneously in all three axes
- FEA Model and Hand Calculations used to determine loads and/or stresses in the following
  - Load Frame
  - Sub-Floor
  - Interface Plate
  - Bolted Joints
  - Welded Joints



## Analysis Criteria

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- **Design Limit Loads (per LAT-PS-06349)**
  - **Axial**  $\pm 6.0$  g
  - **Longitudinal**  $\pm 2.0$  g
  - **Lateral**  $\pm 3.5$  g
- **Mass Properties of Payload**
  - **Mass** 6750 lbs, MAX
  - **CG** (0 in, 0 in, 24 in) from Interface Plate
- **Factors of Safety**
  - **Yield Design Load** FS = 3.0
  - **Ultimate Design Load:** FS = 5.0
- **Structural Margins of Safety Must be Positive**
- **Rotation of Interface Plate at LAT Interface (Line of Action)**  $\pm 1.0$  deg
- **Maintain Static and Dynamic Clearance Between Payload and Container**

## Conclusions and Open Analysis

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- Preliminary selection of wire-rope isolators and sizing of frame
  - Fabrication of Load Frame and Sub-Floor can begin as soon as fabrication drawings are released
- Detailed Analysis to be completed as design matures