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	Subsystem/Office **Integration and Test Subsystem**	
Document Title **LAT I&T Facilities**		

DRAFT

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Integration and Test Subsystem

Facilities

Change History Log

Revision	Effective Date	Description of Changes
1	March 11, 2003	Initial Release

Contents

1. PURPOSE

This note describes the facilities used for Integration and Test of the GLAST LAT instrument.

2. SCOPE

This document covers the facilities which support Integration and Test activities that occur at SLAC, during transport, and at NRL. This document clarifies the configuration and the test methodologies for each facility, and hardware/software provisional responsibility/schedule.

The document is divided into sections defining the components of the facilities and how they fulfill the requirements for integration and test process that is planned. The required components are described in Section 6 along with which organization will provide the components. The SLAC Integration facility is described in Section 7, the SLAC Calibration Unit Beam Test Facility is described in Section 8, the LAT Transport Container and associated transport vehicles are described in Section 9, the Payload Checkout Facility is described in Section 10.

3. ACRONYMS / DEFINITIONS

3.1. ACRONYMS

ACD	Anticoincidence Detector Subsystem
CAL	Calorimeter Subsystem
EGSE	Electrical Ground Support Equipment
EMI	Electromagnetic Interference
ESA	End Station A
GLAST	Gamma-ray Large Area Space Telescope
I&T	Integration and Test Subsystem
LAT	Large Area Telescope
MGSE	Mechanical Ground Support Equipment
NRL	Naval Research Laboratory
SLAC	Stanford Linear Accelerator Center
TBD	To Be Determined
TKR	Tracker Subsystem

3.2. DEFINITIONS

End Station A	Location of LAT Calibration Beam Test (SLAC)
Building 33	Location of LAT Integration Facility (SLAC)
Building A59	Location of LAT Environmental Test Facility (NRL)

4. APPLICABLE DOCUMENTS

Documents relevant to the LAT I&T Facilities:

- LAT-MD-00404 LAT Contamination Control Plan
- LAT-MD-00649 LAT Handling and Transportation Plan
- LAT-TD-00440 LAT Beam Test Plan
- LAT-TD-00550 Airplane Test Plan
- LAT-PS-01055 LAT I&T Electrical Performance Tests
- LAT-PS-00676 LAT Assembly Sequence

5. OVERVIEW

The GLAST LAT Performance and Safety Assurance Manager is responsible for verifying that the LAT Contamination Control Plan is followed and that all contamination control requirements will be met. The LAT I&T Facilities Manager is responsible for implementing contamination control procedures during LAT I&T and monitoring their effectiveness. Non-conformance reports will be generated by the LAT I&T Facilities Manager or other personnel, when an out of tolerance condition is detected, and sent to the GLAST LAT Performance and Safety Assurance Manager for appropriate action. The LAT I&T Facilities Manager will designate the personnel who will operate and maintain the SLAC-Bldg.33 cleanroom, SLAC-ESA cleanroom, and LAT shipping container.

6. REQUIRED COMPONENTS

This section describes the required components and is organized into the following categories: training, LAT assembly traveler, I&T flight hardware database, mate/de-mate log, and electronic logbook.

6.1. TRAINING

The LAT I&T Facilities Manager will designate, verify training, and authorize LAT I&T personnel performing integration and tests on the LAT in the SLAC-Bldg.33 cleanroom, SLAC-ESA cleanroom, and NRL Payload Checkout Facility. The LAT I&T Facilities Manager will verify training requirements and authorize all personnel working in the SLAC-Bldg.33 and SLAC-ESA cleanrooms. The GLAST LAT Performance and Safety Assurance Manager will define what training these people will receive and approve the training personnel. The LAT I&T Facilities Manager will maintain updated training records and authorize assignment of access codes to the SLAC-Bldg.33 cleanroom for approved personnel who have met the necessary training requirements. Training records are available for viewing from the LAT I&T Facilities Manager upon request. Training for personnel working in the SLAC-Bldg.33 and SLAC-ESA cleanrooms include:

a) SLAC EOESH "Employee Orientation to Environment, Safety, and Health," Course 219

b) NASA ESD Certification (per NASA STD-8739.7)

c) LAT Flight Hardware Handling and Cleanroom Protocol (LAT Performance and Safety Assurance)

In addition, personnel designated for crane operations need:

d) SLAC OS02 "Basic Material Handling and Crane Operations Training ," Course 280

6.2. ACCEPTANCE AND I&T FLIGHT HARDWARE DATABASE

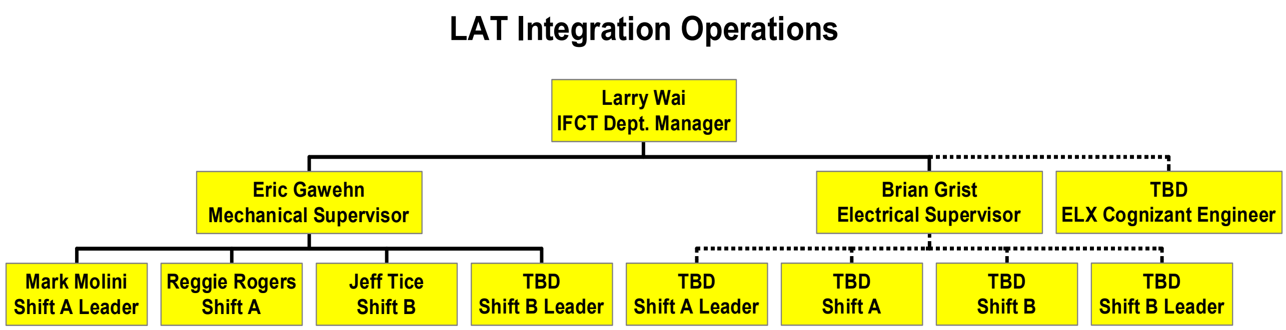
All flight hardware must pass an acceptance review of Acceptance Data Package, defined in LAT-MD-01555. Note that acceptance electrical performance tests may need to be performed, defined in LAT-MD-01055. Upon receipt of flight hardware the flight hardware will be entered into the I&T Flight Hardware database. The IFCT Department Manager will maintain the LAT Assembly Configuration Log using the I&T Flight Hardware Database and report on location and status of all flight hardware.

6.3. ASSEMBLY SEQUENCE AND LAT ASSEMBLY TRAVELER

The assembly of the LAT will follow the LAT Assembly Sequence (LAT-MD-00676). Assembly steps which require electrical test are defined in LAT I&T Electrical Performance Tests (LAT-MD-01055). The LAT Manufacturing Engineer will administer and, with the GLAST LAT Performance and Safety Assurance Manager, approve the LAT Assembly Travelers. The form, usage, and processing of the assembly traveler is defined in TBD.

6.4. INTEGRATION OPERATIONS AND LOGBOOKS

The Integration Operations organization is summarized in the following chart:



The Mechanical and/or Electrical Integration Supervisor will update the LAT Integration Traveler, located in the I&T integration room, and concisely update the Electronic Logbook throughout the shift. The Electrical Integration Supervisor will ensure that flight cables are checked for proper grounding, resistance, and continuity. ESD procedures are defined in section 7.14 below. Once safe-to-mate tests are completed, the Electrical Integration Supervisor will ensure that flight cables are mated and update the Flight Mate Log using the I&T Flight Hardware Database.

7. LAT INTEGRATION FACILITY

The LAT Integration Facility supports the assembly of the LAT, defined in the LAT Assembly Sequence (LAT-MD-00676). The location of the facility is SLAC, Building 33.

7.1. SAFETY

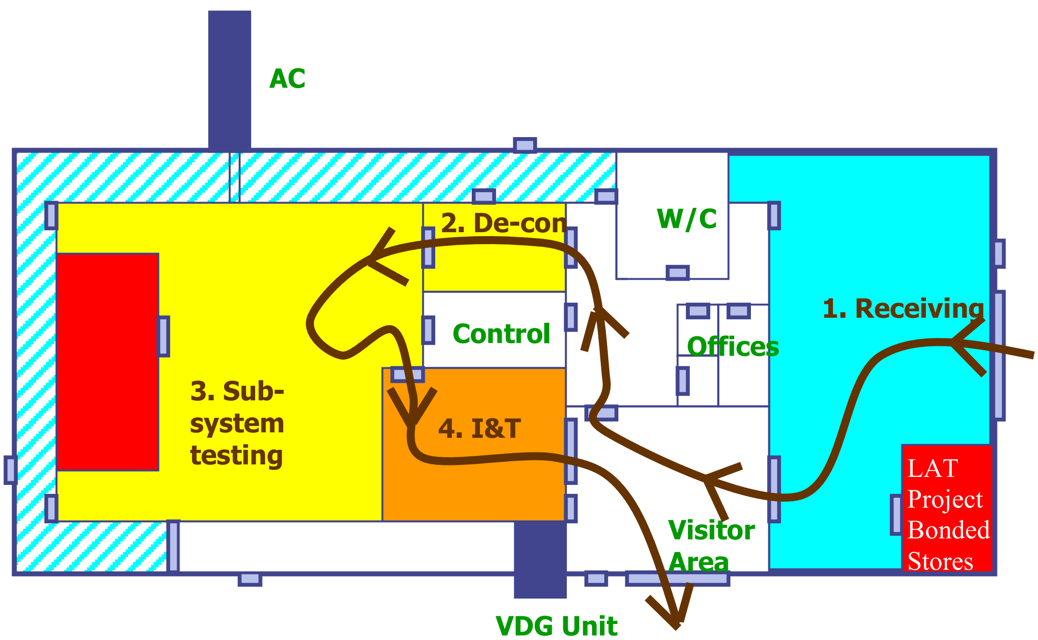
SLAC Safety Oversight Committee (SOC) review of as-built Building 33:

a) **Fire Safety**. Dry pipe double interlock pre-action sprinkler system was approved by Robert Reek, SLAC's Fire Marshall. The fire alarm system and emergency exits have been reviewed and revamped as necessary.

b) **Earthquake Safety**. Seismic Review Board (SLAC-SEM) is consulted during development of Mechanical GSE. Cabinets and other standing equipment are tied down according to standard earthquake safety practice.

c) **SLAC ES&H**. Technicians are trained for safe use of 5-ton and 15-ton cranes in Building 33, as per SLAC OS02 "Basic Material Handling and Crane Operations Training ," Course 280.

7.2. HARDWARE FLOW



As shown in the above diagram, the flow of hardware will be as follows:

1. Receiving – inspection of exterior of shipping container, completion of receiving paperwork; then hardware will be stored in LAT Project Bonded Stores (manager is Jerry Clinton, LAT Manufacturing Engineer) until checked out by I&T.
2. De-con – Requires level 1 access authorization to enter; upon entrance cleanroom protocol begins
3. Sub-system checkout – Storage of sub-system test equipment; final checkout before assembly into LAT

4. I&T – Requires level 2 access authorization to enter; LAT assembly, functional tests, and some calibration occurs here; preparation for shipping of LAT occurs here

7.3. SECURITY ENFORCEMENT

7.3.1. Keys and Omni-lock codes

The color-coding in the hardware flow diagram above is as follows:

a) White – low security, SLAC keys 4L2CB (Group K) and 4Y68 (Low security access)

b) Blue – medium security, SLAC key 4Y67 (I&T and sub-systems)

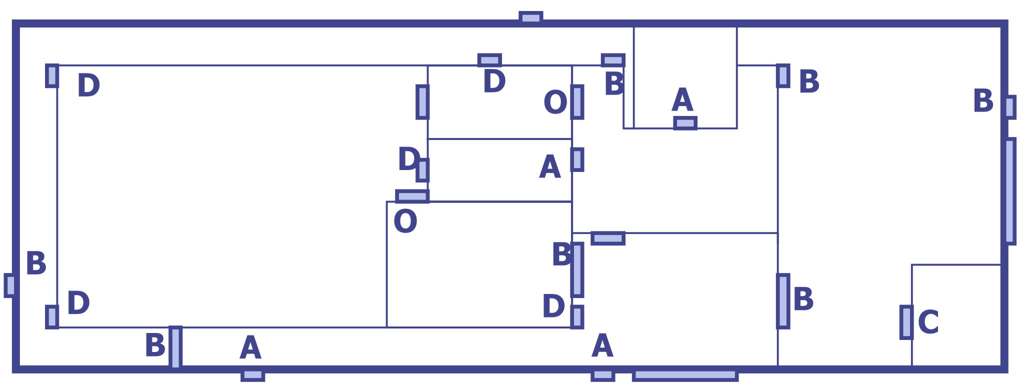
c) Blue/white striped – As for Blue, except in case of fire escape

d) Red – high security, SLAC key 4Y66 (ITAR restricted systems)

e) Yellow – cleanroom training requirements, level 1 access authorization (sub-systems)

f) Orange – cleanroom training requirements, level 2 access authorization (I&T)

These security zones are enforced by the following lock scheme:



A – Opened by 4Y68, Group-K (4L2CB), 4Y67/4Y66, 4E300
B – Opened by 4Y67/4Y66 and 4E300 keys
C – Opened by 4Y66
D – Emergency exit w/alarm; door opened by 4E100, alarm by 4Y67/4Y66
O – Omni lock; opened by assigned security code

7.3.2. Video Camera Monitoring

Internet addressable video cameras will provide continuous monitoring of the entire facility through a GUI maintained by Lighthouse. All video data is recorded in snapshots separated by 2-sec (TBR) intervals and full 30 frames-per-second can be viewed online at the following internet address: TBD

7.4. ENVIRONMENTAL MONITORING

The environmental monitoring system and sensors are maintained by Lighthouse. Sensors are calibrated according to NIST standards and maintained by Lighthouse. The sensors include:

a) Temperature/humidity – Lighthouse product (7 units)

b) Airborne Particle counters – Lighthouse product (4 units)

c) Oxygen monitors (2 units)

All sensor data is recorded in real time and can be viewed online at the following internet address: TBD

Sensor conformance limits are pre-defined and programmed into the monitoring system. When non-conformance occurs the Building 33 Manager is notified and NCR is sent to GLAST LAT Performance and Safety Assurance Manager.

7.5. ELECTRICAL PERFORMANCE TEST SUPPORT

Flight hardware will undergo acceptance tests, intermediate system level functional tests, and post-assembly tests, defined in LAT I&T Electrical Performance Tests (LAT-MD-01055). EGSE Workstations will be located in the Control room (room 102) and the Integration room (room 104). Workstations will communicate with the EGSE test stands located in room 104. The Electrical Performance Test Manager will perform tests and validate the test reports. The validated test reports will be transferred to the LAT I&T Traveler as soon as the tests are completed.

7.6. FACILITY POWER REQUIREMENTS

Total power going into Building 33 is: 400A @ 480V, of which 300A is inside cleanroom, 100A outside cleanroom.

Survey of power needs is TBR:

- Two types of test stands will be used for electrical performance tests of flight hardware: GASU Test Stand (G3) and Spacecraft Interface Simulator (SIS). For each test stand, a power converter will be built to transform from 120W A/C building power source to 28W D/C LAT power source. The total power of the LAT is limited to 650W so the SIS will require 5.5A from 120W A/C building power source. Electronics Subsystem will deliver the power converter to I&T.
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7.7. ENVIRONMENTAL CONTROL SYSTEMS

a) **ESD Tiles.** Certification was performed by Ion Systems (ionsys@ion.com) on Feb. 4, 2002. All the samples were performed with the PROSTAT PRS-801 Resistance System. All samples were taken RTG (Resistance to Electrical Ground) reference. The first data capture series was performed on Room 104 of the GLAST Integration Area. The second data capture was performed on Room 103 of the same Area. The Test Method is based on the ANSI/ESD-S20.20 for Protected Area/Flooring (ANSI ESD S 7.1 <1X10E9 Ohms). The samples were taken considering at least 10% of the total of floor tiles, 5 readings on each tile, four tiles per row on Room 104, 6 rows in total. Room 103 has an irregular distribution area, on the smaller space of this room the samples were taken on 3 tiles of 2 rows then for the largest space the samples were taken on 5 tiles of 5 rows, 7 rows in total for room 103. The samples were strategically chosen trying to cover the different areas from both rooms. All samples are point to electrical ground referenced (PTG).

   The analysis confirms that the floor complies with the requirements of ANSI/ESD Association Standard 2020 (ANSI/ESD-S20.20) Section 6.2.3.- Protected Areas-Flooring-recommended range <1X10E9 ohm-.

b) **High Volume Air Conditioning (HVAC) System.** Des Champs Laboratories installed the cleanroom HVAC system. The SLAC expert is Kingston Chan, HVAC Engineer in SEM. Final acceptance test data were completed February 2003. Cleanroom Air Balance and Cleanroom Certification was performed by AIRTEK (PO Box 904, Pleasanton, CA 94566). HVAC was certified at 8234cfm, which provides one change of air volume in 8 minutes (6000 sq ft). Empty cleanroom was certified at class 200.

c) **Nitrogen Purge Lines.** We have installed a dewar and purge lines to a desiccant locker (48cu.ft.) which requires 10cfm to maintain 20% humidity. Estimate for dewar replacement is once per 2 weeks. No foreseeable need to purge bagged LAT during I&T except during functional testing when we will have auxiliary cooling plates attached to Flight Grid. In case of greater flow needs, nitrogen can be piped in from big dewar used by cryogenics across parking lot using existing covered trench.

d) **Dry Air Purge.** TBR

7.8. CRANES

7.8.1. 5-Ton Overhead Traveling Crane

Building 33, room 104, has a Top Riding Double Girder 5-ton Overhead Electric Traveling (OET) crane. The crane has a low headroom under running double girder trolley. In addition, the crane is completely self supported with a four-post tube frame that is designed for the existing floor.

The rated capacity (100 percent), in tons (2000 pounds), and rated speeds, in feet per minute, are as follows:

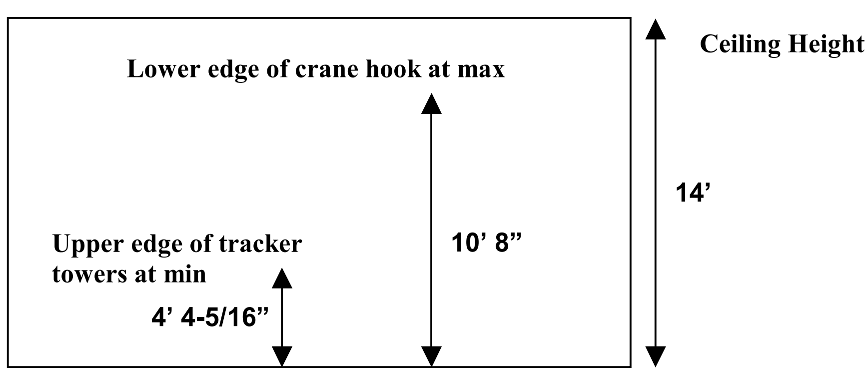
Component	Capacity in Tons	High Speed (ft/min minimum)	Low Speed (ft/min maximum)
Bridge	5	30	1/20 of high speed
Trolley	5	30	1/20 of high speed
Hoist	5	19	1/50 of high speed

	Along 35' 4" dimension of room	Across 23' 8" dimension of room
Hook Minimum Travel	21'	12' 8"
Hook Minimum Height	10'	
Crane Room Dimension	23' 4" wide x 35' 4" long x 14'(ceiling height)	

The two distances critical for integrating the ACD to the LAT in the LAT Assembly Room are given as follows:

1. Distance from the floor to the lower edge of the 5-ton overhead crane hook at maximum height is 10’8”.
2. Maximum distance from the top surface of the tracker towers to the bottom surface of the cross-LAT thermal plate (from **LAT-DS-00038**) is 640mm (tracker) + 236mm (grid) + 300mm (cross-LAT thermal plate limit) = 1176mm = 3' 10-5/16 "

Note that the location of the bottom surface of the cross-LAT thermal plate is limited by the fixed boundary of the spacecraft. We keep 6” for clearing MGSE support fixtures sitting on the floor below the LAT. The resulting distance from the top of the tracker towers to the floor is then 4’ 4-5/16”. We summarize this note with a pictorial representation of the integration room vertical clearances.



7.8.2. 15-ton Overhead Traveling Crane

TBR

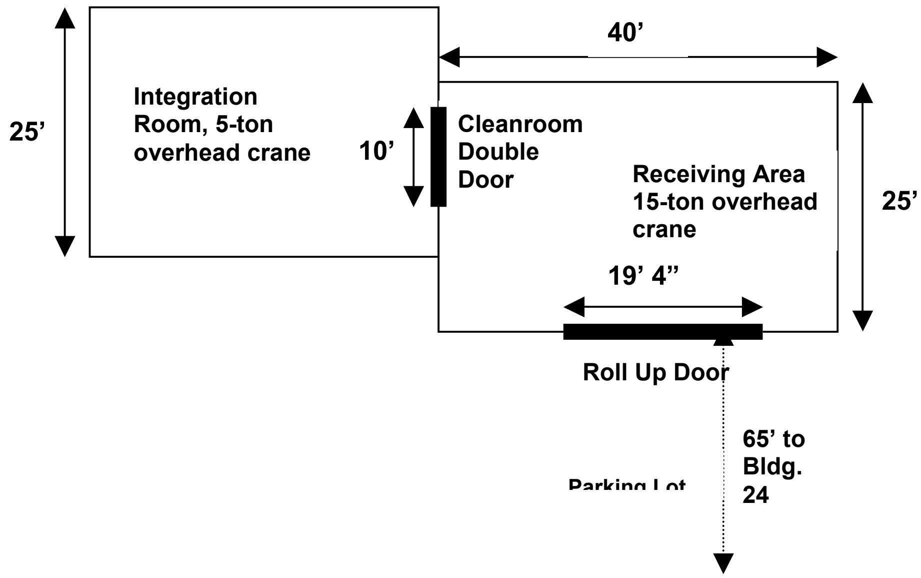
7.8.3. Gantry Crane

TBR

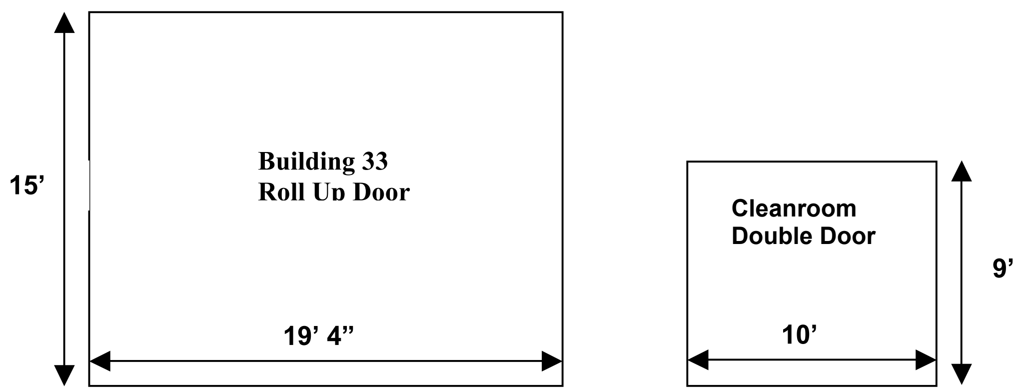
7.9. DOOR CLEARANCES

This section contains the floor layout and door clearances relevant for receiving the ACD and moving it into the LAT Integration Room.

Floor layout:



Door clearances:



7.10. CONTAMINATION CONTROLS

The contamination control requirements are defined in the LAT Contamination Control Plan (LAT-MD-00404). The cleanroom cleaning is performed by Controlled Contamination Services. The relevant contamination sources, requirements, control methods, monitoring methods, and calibration/certification methods are summarized in the following table:

Source	Requirements	Control Method	Monitoring Method	Calibration and Certification
Airborne particulate	Class 100,000	Cleanroom construction, high volume HEPA filtered air flow	Laser counter with real-time monitoring	NIST certified counter; cleanroom certification
Surface particulate	Visibly clean	Gowning procedure	Tape Lift, Witness Plates	Cleanroom cleaning service
Temperature and Humidity	30% <R.H <45%	High volume air conditioning	Temp/humidity sensors	NIST certified
ESD	No ESD	ESD dissipative floor tiles, grounding straps	Ground resistance meters	ESD tile certification
Nitrogen	No asphyxiation, no other contamination	High volume air flow, restricted nitrogen outlets, purchase of certified dewars	Oxygen sensors	NIST certified oxygen sensors, nitrogen dewar certification
Helium	Less than 10 ppm (double the normal atmospheric concentration)	High volume air flow	Helium sensor (supplied by ACD subsystem)	TBD
Fire, smoke	No fire or smoke	Water, high volume air flow	Smoke detectors, temperature dependent sprinkler caps	Annual pre-action system tests

7.11. CONTAMINATION ANALYSIS PROCEDURES

The following contamination analyses are performed by outside contractor, Technical Safety and Services (TBR):

a) Witness plate analysis

b) Tape lift analysis

c) Solvent analysis

7.12. DE-CON PROCEDURES

Vacuum shoe brush and lockers for personal belongings are provided for use at entryway to cleanroom. Personnel shall wear the following protective garments upon entering the de-con area:

a) 100% polyester, static charge dissipative smock with zipper front, consistent with ASTM E-1549.
b) Bouffant (soft) style hair covers. Personnel with shaved heads also required to wear hair covers to contain excessive skin flakes from scalp. Head cover must cover all exposed hair.
c) Latex, nitrile or polyethylene gloves are required when handling flight hardware. Gloves are not required but are recommended for all personnel in cleanroom areas.
d) Wrist strap for proper electrical grounding is required for personnel within 3 ft. of ESD sensitive hardware.
e) All support equipment and tools shall be cleaned by wiping, vacuuming, washing or other means best suited to the equipment involved before being brought into the cleanroom. Visually inspect cleaned equipment for cleanliness.

7.13. CLEANROOM PRACTICES

Personnel shall follow these practices for consistent and effective contamination control:
a) Smoking, eating, drinking beverages, chewing gum, chewing tobacco, or consuming candy shall be prohibited in the cleanroom and changing room/area.
b) Cleanroom approved hand lotions and creams may be used with care to prevent contaminating flight hardware.
c) Fingernail polish is prohibited in the cleanroom.
d) Cosmetics, colognes and perfumes shall not be worn by any personnel in the cleanroom.
e) Only cleanroom approved mops and wipers may be used inside a cleanroom. There shall be no wooden handles or cellulose mop materials.
f) Wood boxes are not allowed in cleanroom unless treated or covered with approved paint or finish to prevent particle shedding. Cardboard boxes are prohibited from cleanroom.
g) Pencils, erasers, and dry erase markers are prohibited from cleanroom.

7.14. ESD CONTROL

Flight hardware, MGSE, and test stands are grounded and resistance of ground connections is verified by measurement.

ESD control procedures are: TBD

7.15. EMERGENCY PROCEDURES

Even in the rare case of power loss, Building 33 is large, and cleanroom is another building inside, so will cool/heat slowly. In extremely rare case of power loss + high humidity, we can run dry air purge to maintain humidity until power to HVAC is restored and/or atmospheric humidity goes back down.

Procedure for case of loss of High Volume Air Conditioning (HVAC) unit TBR:

a) Bag the Flight Hardware

b) Circulate dry air through the bags

8. CALIBRATION BEAM TEST FACILITY

The Calibration Beam Test Facility supports the LAT Beam Test Plan (LAT-TD-00440). Details are TBD.

9. TRANSPORT CONTAINER AND VEHICLES

Requirements for the transport container and vehicles are found in the LAT Handling and Transportation Plan (LAT-MD-00649). Details are TBD.

10. PAYLOAD CHECKOUT FACILITY

The payload checkout facility is located in Building A59, Naval Research Laboratory.

10.1. ANECHOIC / EMC TEST CHAMBER (SMALL ONE).

Floor is level with external walkway; LAT can roll into chamber on Universal Support Stand wheels. Door size is 10' width, 9'11" tall; width few inches above floor / below top of door extends to 10'10". Inner dimensions of chamber is 21'x15'. Need 3' from walls; additional 3' on one side for antennae. LAT assembly should occupy no more than approximately 12'x9' floor space. Note: there is a larger chamber which has a floor not level with external walkway; requires operation pushing up a ramp. Note: NRL has plans to build a 3rd chamber. EMC/EMI test expert is Michael Obara.

10.2. VIBE TEST ROOM.

12'x12' door. 10 ton crane inside. Existing shaker is 35,000 force-lb, +/-1/2" stroke. (Another smaller shaker is 18,000 force-lb, +/-1/2" stroke.) Horizontal configuration shaker table is 4" thick magnesium plate, 2000 lbs, 68"x72". OK to extend out beyond edge of table by 6". Vertical expander head is 1100 lbs. Note: NRL is currently in the funding cycle for a 50,000 Force-lb shaker with +/ 1" stroke. The new shaker should be in place by the time LAT arrives, but will have more confidence in this after Oct. budget allocation. Also affected is the slider table due to the longer stroke path. The agreement was that LAT would plan on using the same attach footprint as required for the 35, 000 lbf system. LAT has a drawing of the vertical and side load attach interfaces for the 35,000 lbf system. NRL will keep LAT in the loop as the new systems interface matures. The Safety Review Process, to ensure readiness to proceed for vibration test was discussed. They indicated that NRL did not have its own safety requirements document and indicated that they piggy-backed off of the East-West Range Safety Requirements document, EWR 127-1. We asked Michael Lovellette to review the sections applicable to the four point mount scheme of the LAT and define what we'll need to provide to ensure a clean readiness review. Bob Hanes is vibe test facility expert; does not run tests beyond normal working hours (weekends OK). Jim Haughton is dynamics analysis expert; he says typical random vibe for payload test does not exceed 2g RMS in horizontal and vertical directions.

10.3. ACOUSTIC CHAMBER

10,000 cu.ft. 155dB. 12'x12' door. Metal ridge across floor, about 0.5" high, in doorway probably requires forklift to help roll LAT assembly inside. 3-ton crane inside chamber. Facility would not support larger capacity crane without significant effort (i.e., current crane attaches to non-structural roof joists) Acoustic test expert is Jim Haughton (haughton@ccf.nrl.navy.mil); using Universal Support Stand to hold LAT+radiators during acoustic test is OK. He wants to see drawing of Universal Support Stand.

10.4. THERMAL VACUUM CHAMBER (BIG BLUE)

Individually controlled liquid nitrogen/heater sectors on 4 quadrants and 2 ends of chamber. 3 tables of 10'x10' size slide into chamber for total floor space of 10'x30'. 15-ton crane lifts LAT assembly onto table in a different room and a large forklift is used to insert the LAT-Table Assembly into the vacuum chamber. The height of the chamber will allow use of the Universal Support Stand if it can be designed to be vacuum chamber tolerant (this is the current plan). The test article may extend beyond edge of table by approximately 1'. Liquid nitrogen/heater walls can be set up inside chamber. Standard copper path (electrical) feed throughs are via hermetically sealed 37 pin-D connectors (6 cables x 8 portals) and BNC, 1553 tri-axial connectors. Mike van Herb is the Building A59 T-Vac test expert.