GLAST Large Area Telescope: 

LAT Pre-Ship Review

Performance & Safety Assurance

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LAT QA Overview

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LAT QA Documentation

- LAT program requirements are defined in GSFC Mission Assurance Requirements document 433-MAR-0001 rev. A
- These documents define the LAT Quality System and implement LAT QA requirements:
  - LAT-MD-00039, Performance Assurance Implementation Plan
  - LAT-MD-00091, LAT Quality Manual
  - LAT-MD-00404, LAT Contamination Control Plan
  - LAT-MD-00078, System Safety Program Plan
  - LAT-MD-00099, EEE Parts Control Program Plan
  - LAT-SS-00107, Mechanical Parts Plan
  - LAT-MD-03474, Redline/Blackline Engineering Documents Procedure
  - LAT-TD-02635, Supplier Quality Assurance Requirements Document
  - SOWs for vendor supplied hardware
- Additional documents that define and implement QA requirements for NRL operations:
  - LAT-PS-06898, Environmental Test Implementation Plan
  - LAT-MD-08139, LAT Environmental Test Hazard Analysis
  - LAT-PS-07728, LAT Environmental Test Handling Procedures
  - 433-PLAN-0018, LAT Instrument Transportation Plan
**QA process for hardware assembly, integration and test**

- Drawings, procedures, test plans, SOWs, requirements documents define design and QA requirements for LAT hardware
  - collaborator built (ACD, CAL, TKR)
  - vendor built (electronics assemblies, cables, Grid, thermal control system, fabricated parts)
  - Suppliers (mechanical and EEE parts, raw materials)

- LAT QA performs incoming parts/hardware inspection, parts kitted and shipped for build to print
  - Collaborator and vendor QA system and oversight consistent with program requirements
  - QA support at vendors provided by on-site source inspectors and in-process/final inspections by LAT QA

- Receiving inspection of finished hardware at SLAC
  - Pre-ship review performed for collaborator-provided hardware
    - Open nonconformances from pre-ship review carried up to LAT level for continued evaluation as required
    - ATDP reviewed and approved by LAT Subsystems, I&T, Systems Engineering, QA and collaborator
    - Hand-off to I&T after successful post-ship performance test at SLAC
  - Vendor built electronics assemblies complete subsystem and environmental testing at SLAC
    - LAT QA performs in process inspection, maintains nonconformance reports, verifies documentation
    - Review of ATDP and nonconformances is performed by LAT QA, ELX, I&T and Systems Engineering for each assembly prior to acceptance by I&T

- ATDPs for collaborator hardware complete and available on-line
- ATDPs for vendor-built hardware complete and on record at SLAC (hardcopy and on-line)
QA process for hardware assembly, integration and test (cont)

- Integration of subsystem assemblies
  - LAT QA process ensures oversight, documentation and approval of:
    - integration procedures and AIDS
    - data review, inspections, witnessing, nonconformance reporting/closure
    - software test script development/verification.
    - system commissioning on LAT

- Environmental test readiness at NRL
  - LAT QA process and requirements will be maintained at NRL
  - LAT and NRL QA supported Pathfinder activities
    - No open QA issues at NRL following Pathfinder
  - Testing, hardware handling, inspections, data collection, documentation, review and approval to be performed to LAT procedures and AIDS
  - LAT and NRL QA and Contamination Control personnel will provide on-site support for duration of LAT testing at NRL
  - NRL QA personnel have been trained on the use and application of the LAT NCR and AIDS databases, and will have access to create and update NCRs
  - NRL test personnel have the expertise to fully support all phases of LAT environmental testing
Parts/Materials Control

- Process has been established for parts procurement, handling, inspection, inventory control and storage in environmentally controlled bonded stores
  - Supplier Quality Assurance requirements are included on purchase orders to ensure required parts/materials certifications and traceability documentation is delivered with hardware
  - All incoming hardware is inspected to relevant drawings, SOWs and requirements defined on purchase order.
  - Receiving documentation for all parts is maintained on file in bonded stores
  - Discrepant, downgraded or scrap hardware is labeled and stored in locked MRB cabinet
- Materials and Processes List
  - All parts, materials and processes were approved by the Materials and Processes Control Board
  - Materials and Processes List is complete
  - Material Usage Agreements (MUA) document the use of non-compliant materials
    - Total of 6 MUAs have been submitted and approved by GSFC
- EEE Parts Lists
  - All EEE parts have been approved by the Parts Control board
  - Expect to complete EEE Parts Lists prior to PER (date and lot code information is being added from records to these lists per GSFC requirement)
- GIDEP and NASA Alerts
  - All GIDEP and NASA alerts are reviewed to verify any impact on the LAT
  - No impact of GIDEP and NASA alerts to date on any approved LAT materials or EEE parts
Document Control Process

- LAT QA reviews and approves documents for release into LATDocs
  - These include drawings, process specifications, test procedures, test plans, SOWs, management documents, requirements documents, ICDs.
  - QA is responsible for ensuring that all work is performed to a released document.
    - Procedure for redline and blackline changes to assembly and test documents is controlled by LAT-MD-03474
    - Redlined documents are revised to incorporate changes
  - Any nonconformance report that initiates a document revision will remain open until the new document revision is released.
- LAT QA reviews and approves each AIDS created for assembly, integration and test
  - AIDS sequences signed off as completed
  - After final Engineering and QA review, completed AIDS are archived
- This document control process will be maintained throughout environmental testing at NRL
Nonconformance Reporting Process

• Nonconformance Reports (NCRs) document hardware related anomalies and are captured in an online database maintained by LAT QA
  • Material Review Board (MRB) is convened to disposition and close NCRs
  • MRB minutes are captured in NCRs
  • NCRs are reported to GSFC per the MAR for concurrence to close

• JIRAs are nonconformances documented against flight and test software
  • JIRA Online database documents test software discrepancies and is maintained by I&T
  • JIRA FSW database documents flight software discrepancies and is maintained by the FSW group
  • Software changes implemented through JIRAs are first reviewed and approved by the respective FSW and I&T CCB with LAT QA participation
  • Verification and validation with LAT QA approval is performed for all SW changes

• SLAC NCR and JIRA databases will be the nonconformance reporting system used at NRL
**LAT NCR summary metrics**

LAT NCRs created during SLAC operations

8-1-03 through 4-24-06

<table>
<thead>
<tr>
<th>Affected Hardware</th>
<th>DAQ</th>
<th>TKR</th>
<th>ACD</th>
<th>CAL</th>
<th>Mechanical</th>
<th>I&amp;T *</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td>Flight</td>
<td>300</td>
<td>240</td>
<td>2</td>
<td>2</td>
<td>39</td>
<td>194</td>
<td>777</td>
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<tr>
<td>Non-Flight</td>
<td>51</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>13</td>
<td>98</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>351</td>
<td>271</td>
<td>2</td>
<td>2</td>
<td>42</td>
<td>207</td>
<td>875</td>
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<tr>
<td><strong>TOTAL OPEN</strong></td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>38</td>
<td>44</td>
</tr>
</tbody>
</table>

* includes all ACD related NCRs created after ACD was delivered
Software QA process

• FSW Builds
  • LAT QA participates in FSW CCB to track and document approved changes to FSW, test script or test procedures
  • FSW build list is audited and checked for expected results
  • QA witnesses formal tests and builds data
  • FQT of FSW has been successfully completed

• I&T Test Scripts and Test Software (LICOS, LATTE, ELogbook)
  • LAT QA participates in I&T CCB to review changes
  • Participates in tabletop reviews for test script code development
  • QA reviews/approves test procedure, witnesses test and creates data package to complete V&V of script or test software application
System Safety

- SLAC Systems Safety has documented the following plans and analyses for LAT:
  - LAT-MD-00366, LAT Preliminary Hazard Analysis
  - LAT-MD-00078, LAT Systems Safety Program Plan
  - LAT-MD-08139, LAT Environmental Test Hazard Analysis

- Supported Pathfinder activities at NRL with GSFC Systems Safety
  - SLAC and GSFC will cooperate to provide direct monitoring by safety personnel during critical phases (LAT lifts and moves, table & chamber installations, ODH-controlled chamber entries, etc.)
  - No open System Safety issues at NRL

- LAT has implemented and documented SLAC personnel safety requirements during hazardous operations (crane ops, energized circuits, etc) as part of I&T operating procedures

- Systems Safety has supported crane and lift fixture proof load verification and annual proof load recertification for SLAC and NRL operations

- LAT Environmental Test Hazard Analysis creates a system safety validation matrix of assessed risks and proposed mitigation during NRL operations
  - Will be used as a System Safety verification checklist before and during each test and handling operation at NRL
Contamination Control and ESD

- Requirements are specified in LAT Contamination Control Plan
  - Class 100K cleanroom environment have been established and maintained at SLAC and collaborator facilities
  - Verification of LAT surface cleanliness to Level 650B prior to shipment to NRL is complete
  - Use of grounding wrist straps, dissipative smocks and hardware grounding has been implemented throughout hardware production to minimize risk of ESD damage
  - Helium monitoring has been implemented at SLAC per the ACD He Monitoring Plan
    - Changes to Contamination Control Plan currently being incorporated
- Contamination control for environmental testing at NRL
  - GSFC Transportation Plan 433-PLAN-0018 defines contamination control and purge requirements for LAT transport from SLAC to NRL
  - LAT to remain bagged during vibration and acoustic testing at NRL (NRL test facilities are not certified to Class 100K)
  - Class 100K clean tent will be used at NRL as required when bagging has to be removed.
  - Static dissipative bagging will affect EMI/EMC testing at NRL, so alternate bagging or draping of LAT will be required for this test.
  - Certified nitrogen purge will be used as required at NRL to maintain relative humidity requirements of bagged LAT (certification currently in process)
  - Helium monitoring will continue throughout testing at NRL
Training and Certifications

- SLAC and collaborators received training in contamination control, cleanroom operations and ESD prior to working with flight hardware.

- SLAC and collaborator personnel were certified to NASA soldering and wire strip/crimp workmanship standards when required to perform these operations.
  - Select personnel also received NASA soldering instructor certification and ESD instructor certification.

- LAT QA inspectors were experienced in NASA workmanship standards and inspected hardware to these requirements.
Remaining Items

- Work to resolve open NCRs
- Finalize bagging plan for LAT during EMI/EMC test at NRL
- Complete purge gas certification at NRL (in process)
- Update/release Contamination Control Plan with latest changes (in process)
Conclusions

- An acceptable quality system has been established for the LAT
- The quality system in place at SLAC will be implemented at NRL
  - NRL and SLAC personnel are capable of implementing the quality system consistently and successfully throughout environmental testing
  - All testing and handling at NRL will be performed to LAT documentation
  - No open System Safety or Quality Assurance issues at NRL
- PSA is ready to ship LAT to NRL
  - Nonconformances that arise during final operations at SLAC will be addressed and dispositioned through the established quality process prior to shipment