GLAST Large Area Telescope:

Systems Engineering

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Issues

No.	Title/Description	Description/Status	Due Date	Actionee
3	Technical baseline: Flight Drawing release	-Drawing Tree completion by end of Oct. -All drawings under CM prior to flight build -Flight drawing release plan generated and statused weekly	Mar 04	P. Hascall
10	Tracker EM program completion	-TV test completed -Vibration test with redesigned bottom tray scheduled for TBD	**TBD**	R. Johnson

Issues (Continued)

No.	Title/Description	Description/Status	Due Date	Actionee
13	Tracker MCM attachment and wire bonding process	-Methodology for Tower A with potential improvements identified. -Tests in work to determine if manufacturing rates can be met given hardware tolerances	May 04	R. Johnson
16	Fly away instrumentation not finalized	-Thermistor locations defined, no impacts to current grid design or DAQ. -Accel counts reduced, locations defined.	CR for update by 31 March	Lee
17	New coupled loads results may create negative margins	-Analysis complete, no negative margins found – critical loads went down, -LAT Structural Analysis Report in work ECD TBD. -Environmental Spec update in process	CR for update by TBD	J. Ku

Issues (Continued)

No.	Title/Description	Description/Status	Due Date	Actionee
18	-EMI/EMC requirements and test need definition	-System analysis tool under development, -Radiated emissions and susceptibility defined and in Environmental Specification update -Conducted emissions and susceptibility update TBD	**TBD**	F. Blanchette
20	PMT could be exposured to helium from the heat pipe pinch off tubes	-Have leak rates from vendor and new PMT susceptibility levels -Analysis in work	**TBR**	TBD
21	Three PMT Tubes failed during TV testing	-Mounting redesigned -TV test on tubes successful -additional testing to demonstrate margin planned, ECD TBD	TBD	T. Johnson/ D. Thompson

Issues (Continued)

No.	Title/Description	Description/Status	Due Date	Actionee
22	ASIC radiation sensitivity testing completion	GARC shows sensitivity to laser during radiation testing	**March 15, 2004**	Sadrozinksi
23	ACD bit map parity bit not set correctly in limited situations	-Bit not used by DAQ, so flight operations are not affected -Will add to LAT characteristics document for inclusion in the Operations Handbook. -Reviewing possible impacts to ground software	TBD	Ritz
24	GARC intermittently hangs up on turn-on	-Cause identified (unset flipflop) -Fix identified and verified by test -next steps???	TBD	Thompson
25	High Voltage Cap failed life	-Potential overtest under review. -need current status and next steps	TBD	Thompson

Drawing Release Status

- **Technical Baseline: Flight Drawing Release**
  - **Drawing release is beginning to drive flight hardware build**
  - **Replan is still aggressive and will be further adjusted to support flight hardware schedules**
  - **Mitigation**
    - **Hiring four designers to speed drawing finalization**
    - **Management focused on closing remaining design details**
  - **Design integration assembly drawings**
    - **Deferred to support near term flight hardware design**
    - **Mitigation**
      - **LAT Assembly Sequence defines assembly in sufficient detail to begin integration planning**
      - **Combining efforts with Mechanisms on several of the drawings, which will speed completion**

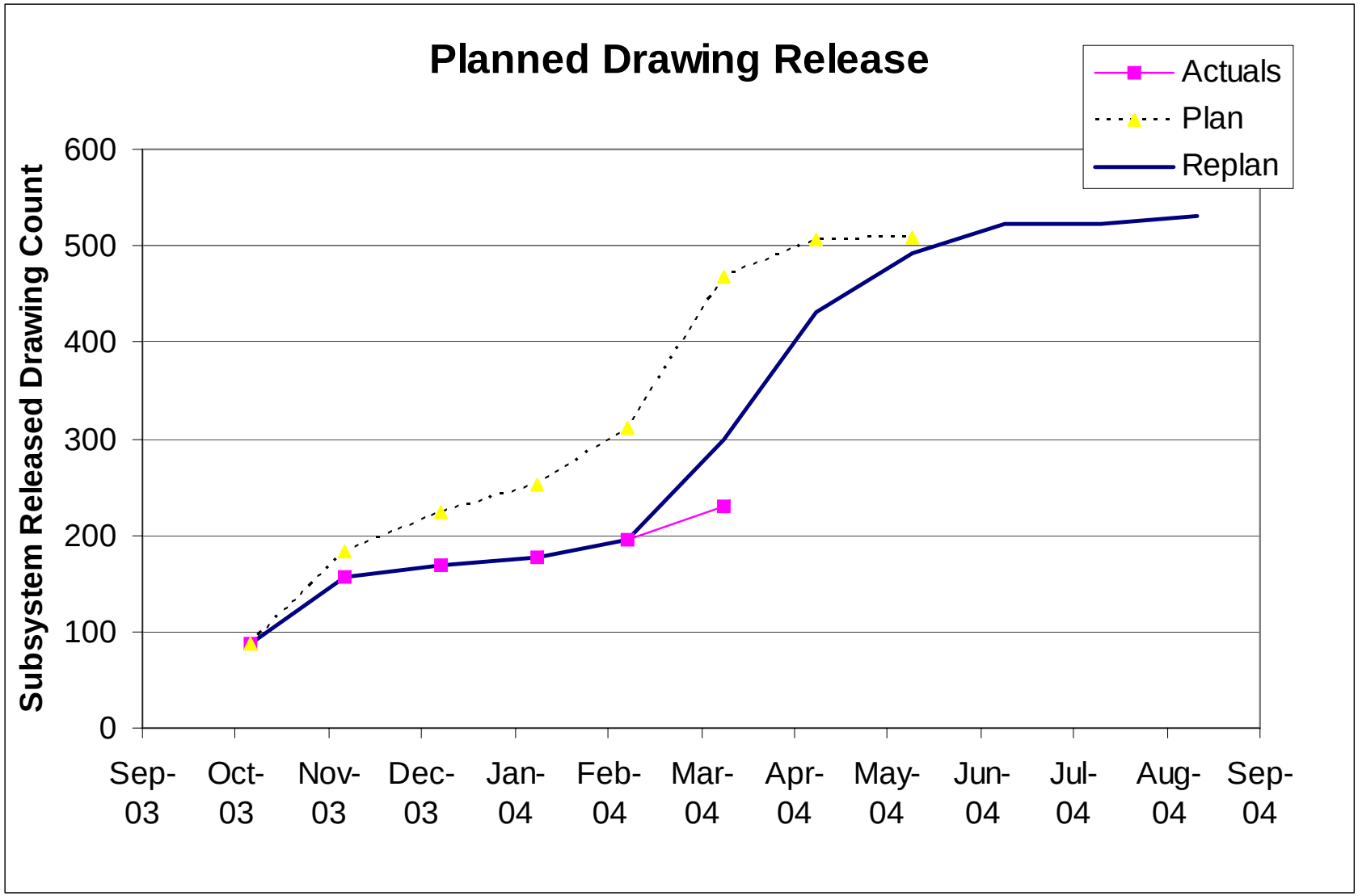
Changes over the last month

- DAQ provided replan to match drawing needs to start of qual build and added 11 drawings
  - Connector to backplane wiring diagrams
  - Additional sizes of thermal shunt cable blocks
- Tracker provided replan and added 12 drawings
  - Flex cables bent configuration
  - Cable restraint
  - Flexure pin and retainer
- Mechanical provided replan and added 1 drawing
  - Wing closeout bar
- ACD provided replan for release

Cumulative Released Drawing Metrics

Subsystem		Oct 03	Nov 03	Dec 03	Jan 04	Feb 04	Mar 04	Apr 04	May 04	Jun 04	Jul 04	Aug 04
Tracker	Plan	28	49	61	62	64	89	122	122	122	122	122
	Actuals	28	49	61	62	64	74					
ACD	Plan	28	41	41	47	57	99	105	105	105	105	105
	Actuals	28	41	41	47	57	74					
Cal	Plan	28	28	28	28	28	36	36	36	36	36	36
	Actuals	28	28	28	28	28	32					
DAQ	Plan	0	0	0	0	0	30	106	151	181	181	190
	Actuals	0	0	0	0	8	8					
Mechanical	Plan	4	39	39	39	39	46	56	63	63	63	63
	Actuals	4	39	39	39	39	42					
Integration	Plan	0	0	0	0	0	0	7	15	15	15	15
	Actuals	0	0	0								
Total	Plan	88	157	169	176	196	300	432	492	522	522	531
	Actuals	88	157	169	176	196	230					

Flight Drawing Release



Interface Documentation Status

- **7 ICD's and 6 IDD's Approved and Released (TBR)**
  - **Working aggressively to close Tracker interface issues**
  - **Ongoing process to track minor issues in Lien list**
- **2 ICD's Still Planned**
  - **Electronics-LAT ICD**
    - **Captures Small Number Of Interface Requirements Not Already Captured In Other ICD's**
    - **These Requirements Are Captured In Level 4 Documents**
    - **This ICD Will Elevate Those To Level 3 Requirements**
    - **ECD April 15**
  - **SAS-LAT ICD**
    - **Purpose Is To Document Monte Carlo Model**
    - **Need Date Coincides With Data Challenge 2**
    - **ECD Dec '04**

Verification and Test Planning

- Implementation based on stable LAT Program Instrument Performance Verification Plan and Science Verification Analysis and Calibration Plan
- Test planning approach
  - Focus on integration planning for first 6 months of testing
  - Test documentation modified to eliminate a layer of test plans
  - Weekly meetings with a cross discipline team to ensure that the defined tests are understood by all and to support maximum use of subsystem test activities, scripts and procedures
  - End-to-end test committee defining tests of the integrated LAT system

Test Planning Documentation

- Near term documents in process
  - LAT Assembly Sequence in signoff
  - Performance & Operations Test Plan (LAT-MD-02730) draft in review
    - Defines test phases and details on the early integration testing
    - Phased release of drafts will continue with initial release in early June to allow parallel effort by I&T
    - Incremental releases planned in TBD to cover initial Comprehensive Test TRR and Environmental Test TRR
- Environmental Test Plans
  - Thermal, Mechanical and EMI/EMC test plans deferred until June, to support the later phases of detailed test implementation effort

Key Design Metrics

LAT Mass Status

LAT Mass Status Report LAT-TD-00564-09

LAT Mass Status
Martin Nordby
Effective Date: 7-Jan-04
Print Date: 7-Jan-04

Jan-04

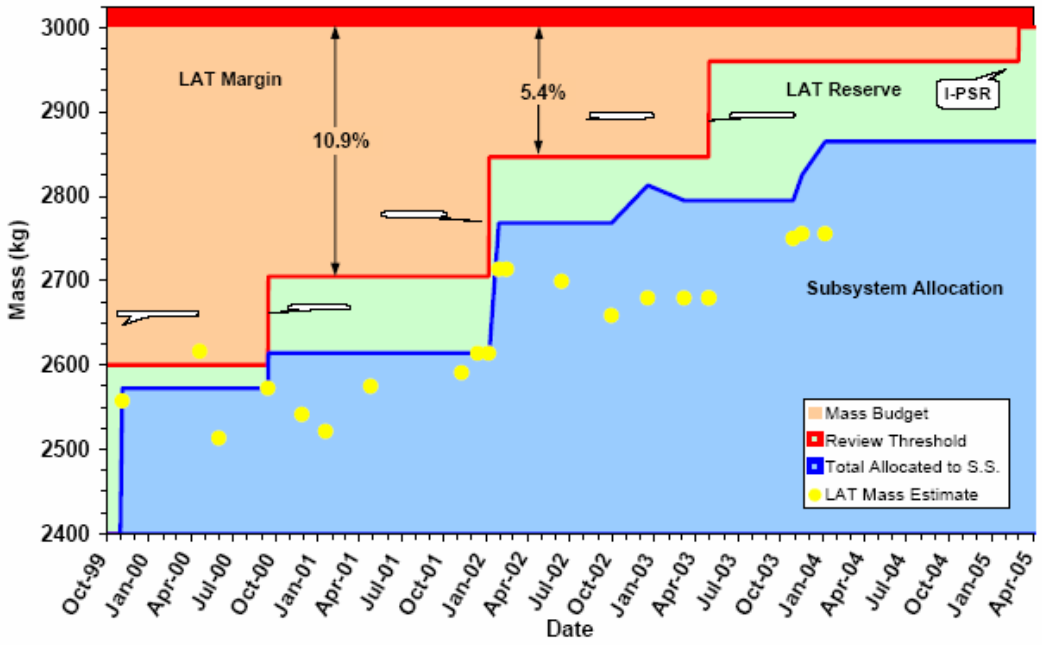
Mass (kg)	Estimate	Alloc.
TKR	508.7	510.0
CAL	1374.3	1440.0
ACD	278.8	280.0
Mech	360.4	386.6
Elec	226.2	240.0
Systems	7.0	8.0
LAT Total	**2755.5**	**2864.6**
Rsrv/Margin	244.5	
Rsrv/Margin*	8.9%	
Allocation		3000.0

* AIAA G-020 recommended min reserve = 6.0%
Current allocations per CCB action on 18 Nov 03

Center of Mass (mm)		
CMx	-0.67	-20 < CMx < 20
CMy	-0.94	-20 < CMy < 20
CMz	-71.45	CMz < -51.2
Ht off LIP	164.75	Ht < 185

Second Moment of Inertia (kg-m^2)		
Ixx	1050.0	1500.0
Iyy	1006.2	1500.0
Izz	1388.9	2000.0

Mass Estimate Breakdown	(kg)	%
Parametric	230.7	8.4%
Calculated	585.5	21.2%
Measured	1939.4	70.4%
Total	**2755.5**	**100%**



November 03 LAT Power Status (TBR)

- **Operational Power**

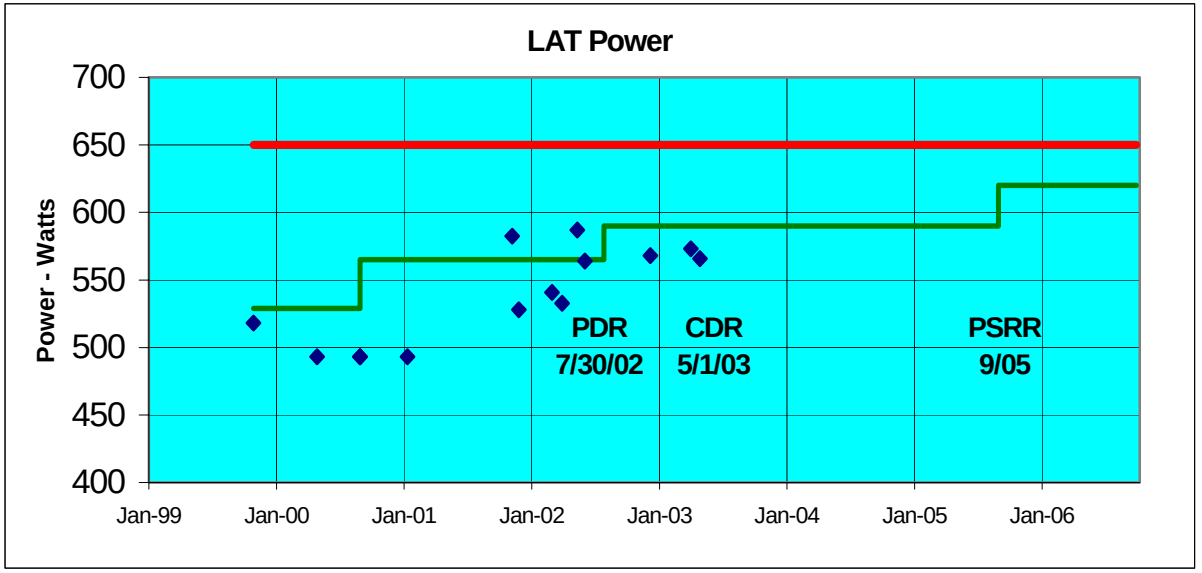
10-Nov-03 Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	9.4	2.3	3.9	3.2	10.5
Tracker	152.4	1.5	0.0	150.9	153.0
Calorimeter	64.9	0.0	0.0	64.9	65.0
Trigger & Data Flow	318.6	44.5	87.3	186.8	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	565.7	68.7	91.1	405.8	591.0
Instrument Allocation	650.0				
% Reserve	14.9%				

PDR Reserve Was 15.2%
CDR Reserve Was 13.4%

Goal for PSRR Reserve > 5%

PARA - Best Estimate based on conceptual design parameters
CALC - Estimate based on Calculated power from detailed design documentation
MEAS - Actual power measurements of components

Goals estimated using guidelines given in ANSI/AIAA G-020-1992 "Estimating and Budgeting Weight and Power Contingencies for Space Craft Systems"



November 03 LAT Power Status (Continued)

- **Survival Power**

Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
On-Orbit Average Power Total1	**278.00**	**0.00**	**230.40**	**0.00**	**230.40**	**20.7%**
Regulated VCHP Power Total	58.00	0.00	48.40	0.00	48.40	19.8%
Unregulated Passive Survival Power	220.00	0.00	182.00	0.00	182.00	20.9%

[1]Power estimates reflect the LAT steady state orbit average. Numbers do not reflect transition into or out of survival mode, i.e. early orbit operations.

FSW Resource Usage Current Estimates

Resource	Total Available	Current Usage	Margin Factor
EPU Boot PROM	256 kB	128 kB	2
SIU Boot PROM	256 kB	128 kB	2
EPU EEPROM	6 MB	1.5 MB	4
SIU EEPROM	6 MB	1.5-2.5 MB	3
EPU CPU cycles	200% in 2 EPUs	30%	> 6
SIU CPU cycles	100% in 1 SIU	25%	4
EPU memory	128 MB	16-32 MB	4-8
SIU memory	128 MB	< 16 MB	8

Instrument Bandwidth Resources

• LAT communication, bandwidth (BW) in Mbyte/sec

Resource	Max Total BW limited by Hardware	Max limited by SC-ground transmission	Ave current BW at 10 KHz max trigger rate*	Ave current BW at 2 KHz nominal trigger rate*	Margin Factor (for 10 KHz rate)
Detector to GASU-EBM	45	N/A	10	2	4.5
GASU-EBM to EPU-CPU	20	N/A	5	1	4
EPU-CPU to GASU-EBM	2.5	0.075	0.04*	0.02*	2
GASU-EBM to SIU-CPU	5	0.15	0.08*	0.015*	2
SIU-CPU to Spacecraft	5	0.15	0.08*	0.015*	2

* Present performance of event filter for EPU-CPU, still being optimized. Eventually the physics filter will be adjusted/loosened to take advantage of the max average bandwidh

EBM: Event-Builder Module

EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit

Key Science Performance Metrics

Parameter	SRD Value	Present Design Value
Peak Effective Area (in range 1-10 GeV)	>8000 cm^2	10,000 cm^2 at 10 GeV
Energy Resolution 100 MeV on-axis	<10%	9%
Energy Resolution 10 GeV on-axis	<10%	8%
Energy Resolution 10-300 GeV on-axis	<20%	<15%
Energy Resolution 10-300 GeV off-axis (>60°)	<6%	<4.5%
PSF 68% 100 MeV on-axis	<3.5°	3.37° (front), 4.64° (total)
PSF 68% 10 GeV on-axis	<0.15°	0.086° (front), 0.115° (total)
PSF 95/68 ratio	<3	2.1 front, 2.6 back (100 MeV)
PSF 55°/normal ratio	<1.7	1.6
Field of View	>2sr	2.4 sr
Background rejection (E>100 MeV)	<10% diffuse	6% diffuse (adjustable)
Point Source Sensitivity(>100MeV)	<6×10^{-9} $cm^{-2}s^{-1}$	3×10^{-9} $cm^{-2}s^{-1}$
Source Location Determination	<0.5 arcmin	<0.4 arcmin (ignoring BACK info)
GRB localization	<10 arcmin	5 arcmin (ignoring BACK info)

Risk Management

Risk Management Activity

- Top Risks identified this month
  - Added risk of logistic/planning error impacting LAT environmental tests at NRL (IT-006)
- Changes in risk assessment
  - Tracker development risk (Proj Mgt – 003) & impact continues to be a challenge
  - Risk now more appropriately identified as LAT schedule issue
- Risks deleted from top list
  - Removed cost of critical skills (Proj Mgt – 006)
    - Although maintaining critical skills continues to be project management focus, team is nearly fully staffed

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 003	Moderate	If completion of Tracker subsystem qualification is delayed due to EM or MCM electronics closure; then start of LAT I & T and schedule will be impacted	• Manufacturing Eng assigned to close MCM issues • Increased team integration with Italian partners • GSFC audit/support to Tracker EM closure	• 50 Unit Pre-production run completed •Restructured SLAC engineering support • Additional INFN support in place • Key schedule issue
Proj Mgt - 002	Moderate	If ASICs fail to meet qualification requirements; then schedule impact will occur	•Focused review & test. Margin for re-runs protected where possible •Individual risks Identified by subsystem •Extensive use of DAQ test bed to drive out system issues	• Tracker GTRC error found, plan in place • Cal/ACD ASIC's continued testing •ACD GARC Mitigation in progress
Proj Mgt - 004	Moderate	If TEM Power supply fails qualification; then final implementation may exceed schedule impacting delivery to I&T	•Key focus item identified for DAQ • Design peer review 9/03 • Basing approach on flight proven designs where possible • TEM/PS extensive EM use as EGSE	• Implementation plan in place and proceeding

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE-007	Moderate	If a critical component fails post LAT integration; then de-integration will result in cost & schedule impact	•Extensive use of EM test bed to support flight H/W & S/W development •Thorough qualification and acceptance tests •Pre planned I&T actions for de-integration	•Qual & acceptance planning in-place •I&T developing re-work contingency plans. •Integration plan baselined
Elec-004	Moderate	If target hardware, requirement development or manpower is delayed; Then Flight-Software development schedule will be impacted	•Detailed incremental development program •Ensure sufficient software test on target hardware during development to drive out any requirement disconnects. • Include adequate peer reviews before each spiral cycle prior to release •Include monthly Demos to verify functionality/measure progress	•Adapting monthly demos •Enhanced software team and processes •Added software management support • EM2 Review 26 Feb

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 005	Moderate	If parts and vendor orders are delayed or bids exceed expectations; then flight production costs & delivery schedule will be impacted	•Manufacturing engineer added to expedite minimum cost closure •Clarification and purchase package review to ensure accurate bids	•Purchase order tracking/monitoring system in place to highlight roadblocks •Design documentation release plan prioritized by vendor selection and component fabrication need dates
IT - 006	Moderate	If logistic or facility integration issues are found during LAT environmental test program; then re-work will delay schedule	•LAT I&T to plan a roadmap of activities from LAT building 33 to completion of environmental testing •LAT I&T to consider and develop opportunities to path find key activities required prior to LAT shipment to NRL	• New risk identified • I & T will provide risk mitigation plan at Environmental kick-off , ECD Aug '04

Summary

- **Systems Engineering is focused on the near term flight hardware build and test planning activities to support a tower in the grid by the end of the year**