

# GLAST Large Area Telescope: LAT System Engineering

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# Topics

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- **Action Item Status**
- **Technical Baseline Management**
- **Issues**
- **Interface Control Documentation**
- **RFA Closure**
- **Key Metrics**
- **Risk Management**



# Monthly Action Item Status

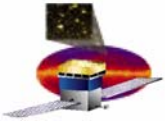
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Action Item ID	Actionee	Description	Status



# Issues

No	Description	Status	Due Date	Actionee
22	ASIC radiation testing Status	Radiation testing scheduled for completion. Request to eliminate TID for 3rd and 4th GTFE run accepted, waiver <b>submitted</b>	30 April ->June- >Jan 05 >March 05>Sept 05	Sadrozinski/ Bright
35	Reliability assessments not completed	FMEAs done, reviews with Subsystems started. Held TKR and Mech reviews with SLAC, TPS, GASU and PDU held on 5/13. Updates to FMEA provided on 5/21. Tony distributed complete set, forwarded to local subsystem managers for review. Received and forwarded updates from DAQ team. <b>Worked with Tony and Bernie. Have submitted TKR, DAQ and Cal. Mech and ACD pending (in review)</b>	12/31/04	DiVenti
37	SIB EEPROM DPA Failure	<b>Recent DPA passed, results from life test</b>		Haller
40	LAT-DAQ FPGA development and qualification	SLAC to respond to AIs' from FPGA reviews – AI's in review <b>4 items left, in work</b>		Haller
41	Qualification of ERNI connectors	Still in work		Haller
42	<b>Power interface impedance requirements not finalized</b>	<b>PRU roadshow demonstrated compatibility, but the requirements were not finalized in the IRD/ICD. Thus LAT does not have firm requirements to verify. Discussed with Bernie and he started working the issue.</b>		<b>NASA</b>



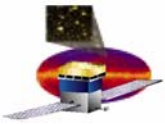
# Interface Management



## Interface Document Status

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- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - ICN-095 Grid Hole Position
    - ICN-097 MLI Interface
    - ICN-98 LAT Heater Isolation
  - **Currently under signature review**
    - None
  - **Currently in draft or revision**
    - ICN-087 LAT Deliveries Table
    - ICN-099 LAT Integration Appendix
    - LAT-SC ICD Rev D
- **Internal LAT ICD's**
  - **Signed off this month**
    - None
  - **Currently in signature review**
    - None
  - **Currently in update**
    - Electronics-LAT ICD (Comments being incorporated as they are received)



# Deliverables/Receivables

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- **LAT Deliverables**
  - **Oct: Return SC Interface Tool to SASS**
  - **Nov: None Scheduled**
  - **Dec: None Scheduled**
  - **Jan: ISIS SIU**
- **LAT Receivables**
  - **Oct: ISIS SIU**
  - **Nov: None Scheduled**
  - **Dec: None Scheduled**
  - **Jan: None Scheduled**

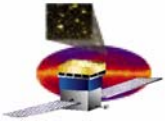


# LAT Level Verification Status

Category	Verification Method					Requirements		
	Test	Demonstration	Analysis	Inspection	Children	# Comp	Total	% Comp
	# Complete	# Complete	# Complete	# Complete	# Complete			
Requirement Identified	-	-	-	-	-	416	416	100.0%
Flow Down Complete	-	-	-	-	-	413	416	99.3%
Draft Verification Plan	128	93	122	38	32	413	416	99.3%
Final Verification Plan	0	0	20	0	32	52	416	12.5%
Verification Plan Executed	0	0	2	0	32	34	416	8.2%
Requirement Sold	0	0	2	0	32	34	416	8.2%

- **Progress this month**
  - Internal review of all 416 Draft VPs, many VPs updated
    - 325 Level 2a/2b VPs and 91 Level 3 VPs
    - 305 requirements sold by LAT Level Test
  - Updated reqt allocations to LAT Level Test Cases due to VP review,
  - Req't issues continue to be worked, will cause req't count to change
- **Status**
  - 6 requirements deleted from the VCRM
    - 6 Subsystem requirements reallocated for sell off at the Subsystem level
  - Verification method counts changed due to the update of the VPs
- **Plans**
  - Performance and Operations Test Plan out for signature by Nov 10





# Key Design Metrics



# Mass and Power Status Summary

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- **Mass**
  - No change
- **Power**
  - **LAT Power Consumption Estimate has increased by 2.1 W**
    - A margin of 10.0% exists to LAT Power Allocation with 80% of the Estimated Power measured.
- **FSW estimates updated**
  - No change



# LAT Mass Status

LAT Mass Status Report		LAT-TD-00564-11
<b>LAT Mass Status</b>		Effective Date: 2-Jun-05
Martin Nordby		Print Date: 29-Jun-05

Jun-05

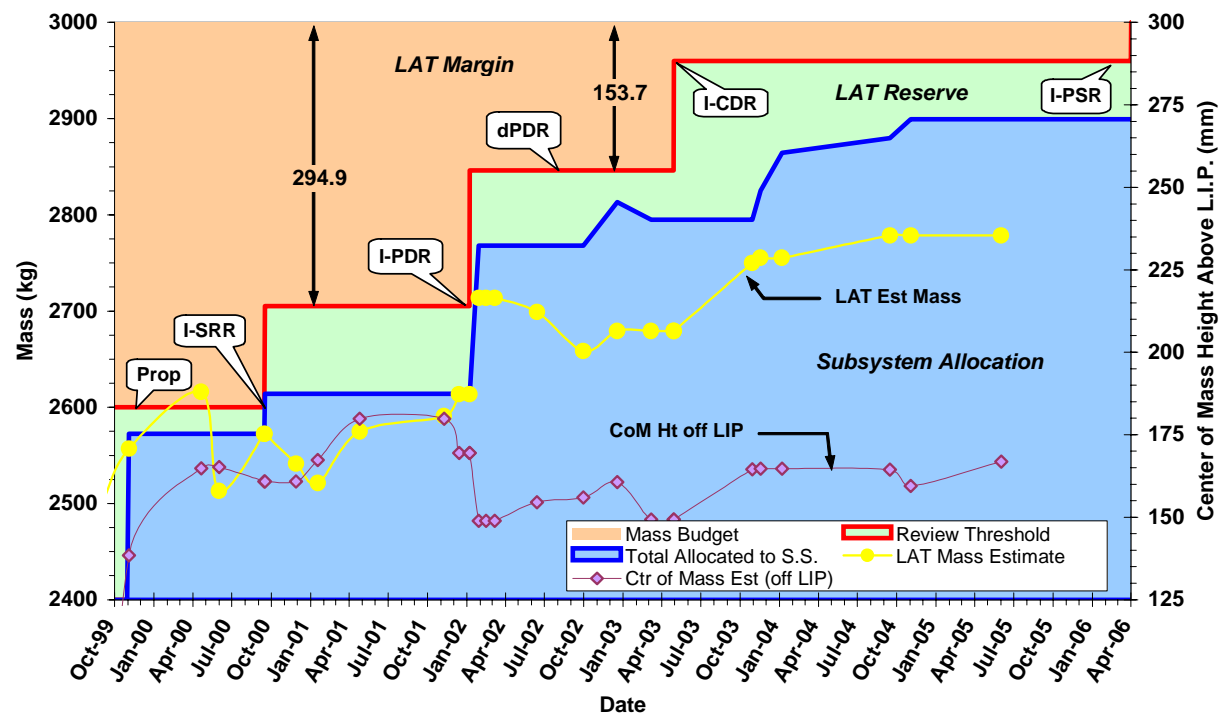
Mass (kg)	Estimate	Alloc.
TKR	523.6	530.0
CAL	1382.3	1440.0
ACD	277.6	295.0
Mech	355.7	386.6
Elec	232.0	240.0
Systems	7.5	8.0
<b>LAT Total</b>	<b>2778.7</b>	<b>2899.6</b>
Rsrv/Margin	221.3	
Rsrv/Margin*	8.0%	
Allocation		3000.0

\* AIAA G-020 recommended min reserve = 4.7%  
 Allocations per latest mass CCB on 3 Nov 2004

Mass Estimate Breakdown		
	(kg)	%
Parametric	56.3	2.0%
Calculated	121.8	4.4%
Measured	2600.5	93.6%
<b>Total</b>	<b>2778.7</b>	<b>100%</b>

Center of Mass (mm)		
CMx	-1.06	-20 < CMx < 20
CMy	-0.87	-20 < CMx < 20
CMz	-69.32	CMz < -51.2
Ht off LIP	166.88	Ht < 185

Second Moment of Inertia (kg-m <sup>2</sup> )		
Ixx	1061.3	1400.0
Iyy	1013.6	1350.0
Izz	1398.4	1580.0





# LAT Power Status

LAT Power Consumption Estimate has increased by 2.1W.

- ACD Estimate decrease by 0.2 W based on measured data.
- TKR Estimate increase by 1.5 W based on average of measured modules.
- CAL Estimate no change.
- T&DF Estimate increase by 0.9 W due to TPS inefficiency with TKR increase.

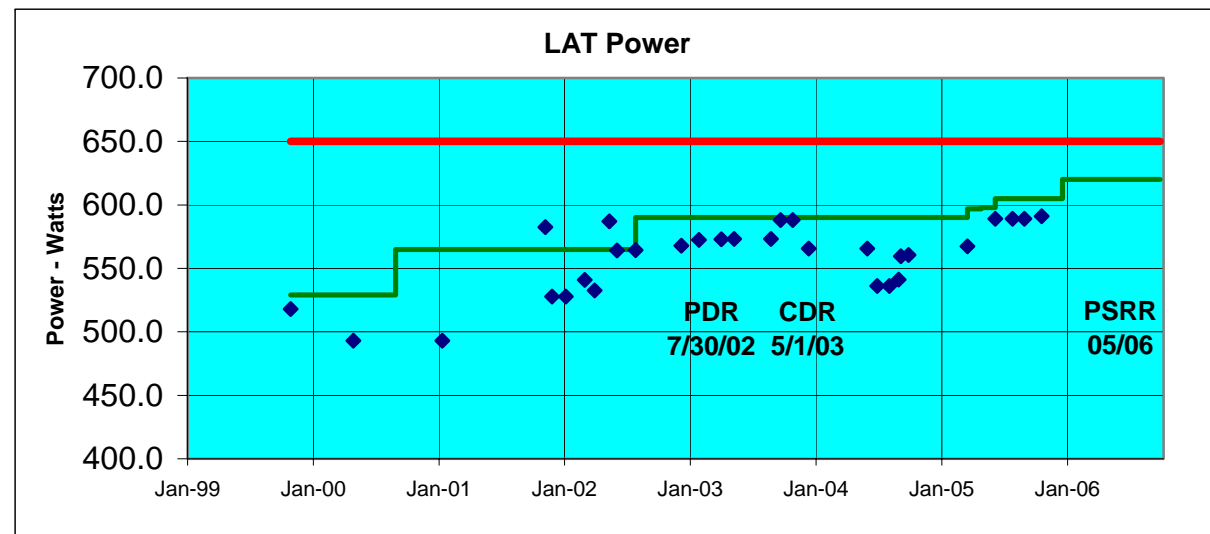
Item	21-Oct-05 Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	SPEC (Watts)
ACD	11.3	0.0	0.0	11.3	11.5
Tracker	159.2	0.0	0.0	159.2	160.0
Calorimeter	67.8	0.0	0.0	67.8	71.0
Trigger & Data Flow	332.4	43.2	57.6	231.7	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	591.1	63.6	57.6	470.0	605.0
Instrument Allocation	650.0				
% Reserve	10.0%				

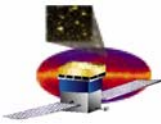
**PDR Reserve Was 15.2%**  
**CDR Reserve Was 13.4%**

**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"





# Measured LAT Power

- Tower measurements for all 16 bays are consistent and supported by predicts

LAT Tower Power	Unit Current (A)	Unit Power (W)
TWR 0	0.964	27.00
TWR 1	0.952	26.67
TWR 2	0.965	27.03
TWR 3	0.964	27.00
TWR 4	0.977	27.37
TWR 5	0.977	27.37
TWR 6	0.977	27.37
TWR 7	0.977	27.37
TWR 8	0.990	27.73
TWR 9	0.989	27.70
TWR 10	0.990	27.73
TWR 11	1.002	28.07
TWR 12	1.002	28.07
TWR 13	1.014	28.40
TWR 14	1.015	28.43
TWR 15	1.027	28.77
TWR Total	15.788	442.06
TWR Avg	0.987	27.63
Tower Variance	0.075	2.10

LAT 16 Tower Measured Estimate	442.06
Unit 16 Tower Estimate	435.34
LAT 16 Tower Increase vs. Unit	6.72

TEM/TPS Pwr Consumption	
Estimate	13.04
Serial #	Ambient
GLAT1754[1]	11.39
GLAT1752	10.73
GLAT1753	11.16
GLAT1831	10.77
GLAT1832	10.10
GLAT1833	11.39
GLAT1834	11.33
GLAT1835	9.98
GLAT1836	10.14
GLAT1837	11.36
GLAT1838	10.30
GLAT1839	12.56
GLAT1840	10.96
GLAT1841	11.36
GLAT1842	10.47
GLAT1843	13.99
GLAT1844	10.29
GLAT1845	11.99
GLAT1846	13.30
GLAT1847	13.00
GLAT1848	13.54
GLAT1849	12.29
Average	11.48
LAT Estimate	183.65

[1] Qualification Unit

CAL Pwr Consumption	
Estimate	4.21
Serial #	25
FM101 [1]	4.12
FM102	4.22
FM103	4.24
FM104	4.25
FM105	4.22
FM106	4.21
FM107	4.25
FM108	4.23
FM109	4.23
FM110	4.26
FM111	4.26
FM112	4.25
FM113	4.25
FM114	4.22
FM115	4.27
FM116	4.26
FM117	4.29
FM118	4.23
Average	4.24
LAT Estimate	67.80

[1] Protoflight Unit

TKR Pwr Consumption	
Estimate	9.18
Serial #	Ambient
A [1]	9.70
B	9.80
1	9.87
2	9.80
3	9.90
4	9.86
5	10.15
6	9.79
7	9.87
8	10.30
9	10.37
10	9.80
11	10.30
12	9.90
13	10.10
14	9.80
15	9.80
Average	9.95
LAT Estimate	159.16

[1] Protoflight Unit



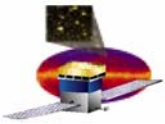
# LAT Power Status (Continued)

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- Survival Power

Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
On-Orbit Average Power Total <sup>1</sup>	278.00	0.00	203.00	0.00	203.00	36.90%
Regulated VCHP Power Total	58.00	0.00	43.00	0.00	43.00	34.90%
Unregulated Passive Survival Power	220.00	0.00	160.00	0.00	160.00	37.50%

<sup>1</sup>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 EEPROM (SUROM)	256 kB	<64 kB*	4*
SIU Boot EEPROM (SUROM)	256 kB	<64 kB*	4*
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	40%	> 5
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

\* Storing multiple copies (4 currently to use available memory) for risk mitigation



# 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 bandwidth

EBM: Event-Builder Module

EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit



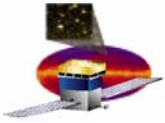


## Key Science Performance Metrics

Parameter	SRD Value	Present Design Value
Peak Effective Area (in range 1-10 GeV)	>8000 cm <sup>2</sup>	10,000 cm <sup>2</sup> 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)	<6x10 <sup>-9</sup> cm <sup>-2</sup> s <sup>-1</sup>	3x10 <sup>-9</sup> cm <sup>-2</sup> s <sup>-1</sup>
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

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- **Added 2 risks**
  - **Availability of environmental facilities at NRL**
  - **Finalization of observatory I&T requirements and procedures**
- **Closed 2 risks**
  - **ASIC qualification (Proj Mgt-002)**
  - **TPS qualification (Proj Mgt-004)**



# 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	<ul style="list-style-type: none"><li>•Manufacturing engineer added to expedite minimum cost closure</li><li>•Clarification and purchase package review to ensure accurate bids</li><li>•Increase production management staff</li><li>•I&amp;T tracks parts needs</li></ul>	<ul style="list-style-type: none"><li>•Parts needs (including long term needs) are addressed weekly during I&amp;T 2 week lookahead meeting.</li><li>•MCM delivery complete</li><li>•Pioneer tracker cables complete in September</li><li>•DAQ complete in December</li></ul>



# 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	<ul style="list-style-type: none"> <li>•Extensive use of EM test bed to support flight H/W &amp; S/W development</li> <li>•Thorough qualification and acceptance tests</li> <li>•Pre planned I&amp;T actions for de-integration</li> </ul>	<ul style="list-style-type: none"> <li>•Qual &amp; acceptance planning in-place</li> <li>•I&amp;T developing re-work contingency plans.</li> <li>•Integration plan baselined</li> </ul>
Elec-004	Moderate	If target hardware, requirement development or manpower is delayed; Then Flight-Software development schedule will be impacted	<ul style="list-style-type: none"> <li>•Detailed incremental development program</li> <li>•Ensure sufficient software test on target hardware during development to drive out any requirement disconnects.</li> <li>• Bring packages under CCB control</li> <li>•Define incremental release plan to FQT</li> </ul>	<ul style="list-style-type: none"> <li>•Adapting monthly demos</li> <li>•Tracking EGSE resource utilization</li> <li>•Updated detailed test plan released</li> <li>•All packages in CCB</li> <li>•Completed release 4. Release 6 targeted for FQT</li> </ul>



# Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 008	Low	If there are availability conflicts with the environmental facilities at NRL then there will be schedule delays	<ul style="list-style-type: none"><li>•Bill Rayner participates in NRL planning and is a LAT advocate</li></ul>	<ul style="list-style-type: none"><li>•No conflicts with current LAT schedule</li></ul>
IT - 006	Moderate	If logistic or facility integration issues are found during LAT environmental test program; then re-work will delay schedule	<ul style="list-style-type: none"><li>•LAT I&amp;T to plan a roadmap of activities from LAT building 33 to completion of environmental testing</li><li>•LAT I&amp;T to consider and develop opportunities to path find key activities required prior to LAT shipment to NRL</li></ul>	<ul style="list-style-type: none"><li>•Follow up Environmental Planning TIM held on 1 October at SLAC, I&amp;T driving AIs to conclusion</li><li>•Continuing periodic TIMS, next is scheduled for 8 Sept.</li><li>•Pathfinder plan defined</li></ul>



# Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE - 011	Low	If individual tracker towers do not meet performance requirements due to manufacturing issues (e.g. wire bond breaks) then the LAT may not meet science requirements	<p>Understand stability of performance to determine mitigation strategies</p> <p>Limit LAT temperature excursions to minimize possible propagation of some types of tracker issues</p> <p>Optimize placement of towers based on individual tower performance to minimize science effects and to minimize removal and replacement efforts should they become necessary</p>	<p>Temperature range reduced at the LAT level to allow a narrower range during Tracker and LAT tests</p> <p>Alternate plan for placement of Tracker A and B being implemented</p> <p>Trending tracker efficiency throughout integration testing</p>



# Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE - 012	Moderate	If hardware deliveries are delayed (TRK, DAQ) then there will be a delay in finding system integration or performance issues	1-Improve test bed utilization 2-Transition to system test using EM hardware as needed	1-Test bed updated to accommodate calibration requirements 2-Plan in place to support early integration checkout starting in November
SE-013	Moderate	If Observatory I&T requirements and procedures are not finalized then there will be schedule delays	LAT proposed integration plan appendix to ICD	LAT prepared mechanical integration issues





# Cost Report

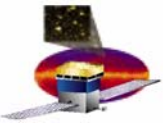
Reporting Category	Cost Incurred/Hours Worked				Estimated Cost/Hours to Complete			Estimated Final Cost/Hours		Unfilled Orders Outstanding
	During Month		Cum. to Date		Detail		Balance of Contract	Contractor Estimate	Contract Value	
	Actual	Planned	Actual	Planned	OCT05					
<b>4.1.2 SYSTEM ENGINEERING</b>										
4.1.2.1 REQ'TS MGMT, DESIGN INTEGRATION & TEST	70	27	3,388	3,253			-135	3,253	3,253	0
4.1.2.3 SYSTEM ANALYSIS	140	176	1,325	1,337			13	1,337	1,337	0
4.1.2.4 QUALIFICATION & TRACKING	83	59	627	689			62	689	689	0
4.1.2.5 RISK & RELIABILITY ANALYSIS	0	0	99	98			-1	98	98	0
4.1.2.6 CONFIG MGMT & DOC / DATA LIBRARY	5	9	311	321			10	321	321	0
4.1.2.7 MANAGEMENT & PLANNING	55	145	2,222	2,372			150	2,372	2,372	0
<b>CAPW[3]Totals:</b>	<b>353</b>	<b>416</b>	<b>7,972</b>	<b>8,070</b>			<b>98</b>	<b>8,070</b>	<b>8,070</b>	<b>0</b>



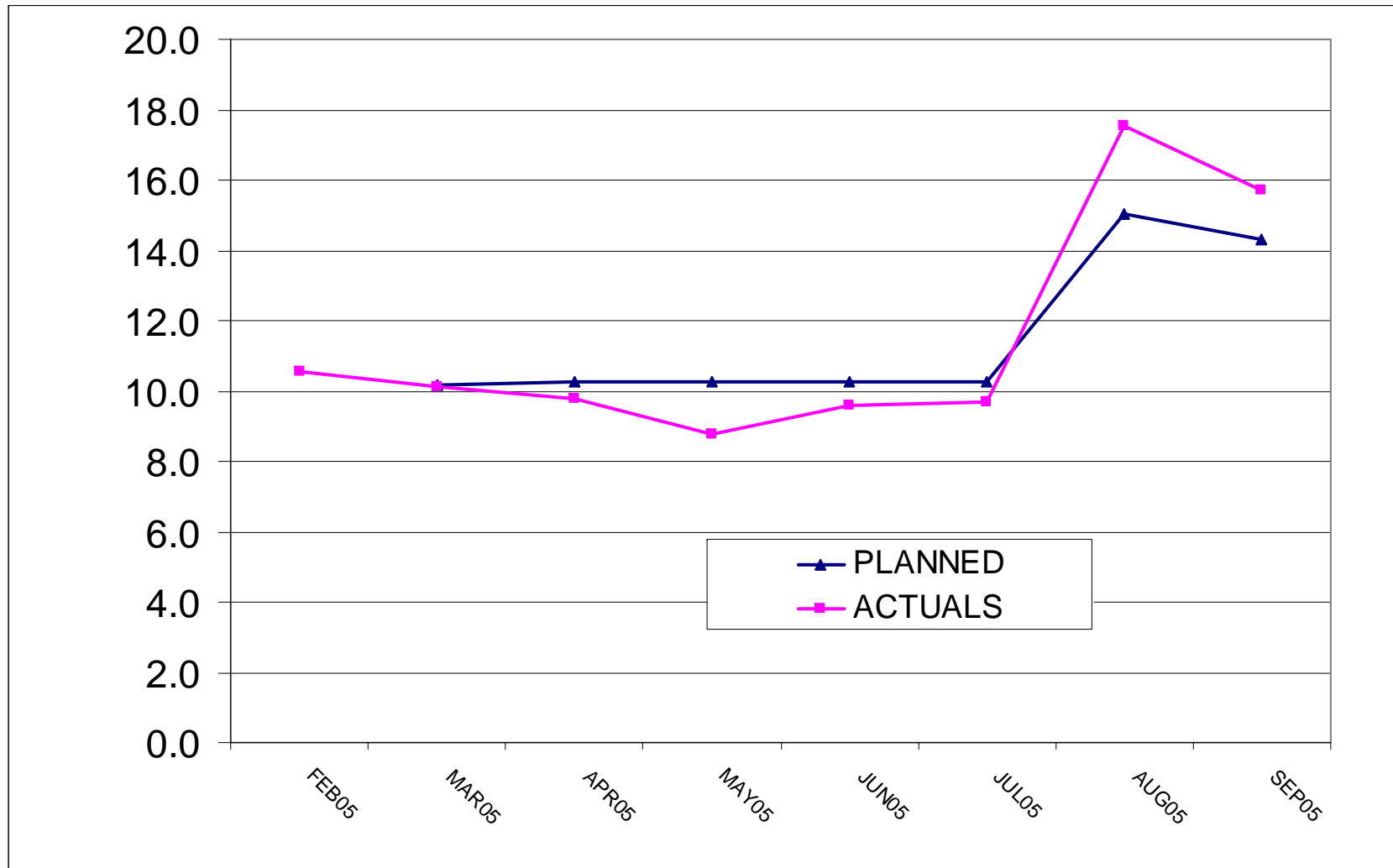
# Cost Variance Explanation

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- Why overrun/underrun?
- What will be done to correct?



# FTE Report





# FTE Variance Explanation

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- **Why overrun/underrun?**
- **What is the impact?**
- **What will be done to correct?**