GLAST Large Area Telescope:

LAT Environmental Specification Update

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Background

- **Update to LAT Environmental Specification needed due**
  - **Several approved GLAST customer change request (CCR)**
  - **September 2003 ECLA Results**
  - **Random Vibration Levels (TKR only)**

- **Change request (CR) which incorporated the new specification changes is being circulated for review and comments**

Agenda

Overview of the specification changes in the CR to be discussed

(1) Structural Requirements Update – John Ku

(2) Other LAT Environmental Changes – Leonard Lee

LAT Environmental Specification: Structural Requirements Update

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Contents

- Purpose and scope of update
  - September 2003 ECLA Results (Delta-PDR LAT and PDR SC models)
    - Should not be a surprise to any of the subsystems
    - In general, the new requirements are more benign than before
  - Random Vibration Levels (TKR only)
- Subsystem by subsystem update comparison
  - Static-Equivalent Accelerations
  - Subsystem Interface Forces
  - Sine Vibration Levels
  - Random Vibration Levels
- Timeline of known future updates
  - High Frequency MECO – Less than one month
  - Random Vibration Levels (other SS) – Approx. one month
  - Next CLA Cycle (LATv10.08 and CDR SC Models) – Summer ’04
  - Transportation Loads – TBD

LAT Static-equivalent Accelerations

FROM

LAT	Design		Accept (+)		PFQ (+)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (*)	5.1	0.2	5.1	0.2	6.375	0.25	g
Axial (Z)	+4.1/-1.4	+6.8	+4.1/-1.4	+6.8	+5.13/-1.75	8.5	g
Rot X/Y	0	0	0	0	0	0	rad/sec^2
Rot Z	0	0	0	0	0	0	rad/sec^2
Source	(1)	(3)	(1)	(3)	(1)	(3)	

Comments: (*) Apply load along +/-X and Y axes and each 45 degree vector
(+) Single-axis test levels are to be derived with pre-test analysis

TO

LAT	Design		Accept (+)		PFQ (+)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (X)	+/-1.36	+/-0.2	+/-1.36	+/-0.2	+/-1.7	+/-0.25	g
Lateral (Y)	+/-1.82	+/-0.2	+/-1.82	+/-0.2	+/-2.28	+/-0.25	g
Axial (Z)	+2.9/-0.28	+6.8	+2.9/-0.28	+6.8	+3.63/-0.35	+8.5	g
Rot X	+/-44.26	0	+/-44.26	0	+/-55.33	0	rad/sec^2
Rot Y	+/-11.12	0	+/-11.12	0	+/-13.9	0	rad/sec^2
Rot Z	+/-9.04	0	+/-9.04	0	+/-11.3	0	rad/sec^2
Source	(9)	(3)	(9)	(3)	(9)	(3)	

•Changes effected prior to LAT CDR. Old spec loads possessed overdriven shear to account for rotational acceleration. New spec loads specify rotations.

TKR and CAL Subsystem Static-equivalent Accelerations

FROM

TKR	Design (*)		Accept (+)	Qual (+)	Unit
Launch Event	Lift-Off/ Airloads	MECO			
Lateral (X)	+/-2.30		+/-3.7	+/-4.6	g
Lateral (Y)	+/-2.34		+/-3.7	+/-4.6	g
Lateral (%)		+/-0.2			g
Axial (Z)	+4.43/-1.8	+6.8	+6.8/-1.8	+8.5/-2.25	g
Rot X	+/-19.83	0	0	0	rad/sec^2
Rot Y	+/-20.15	0	0	0	rad/sec^2
Rot Z	+/-20.15	0	0	0	rad/sec^2
Source	(2)	(3)	(4)	(4)	

Comments: (*) For analysis, apply design accel's simultaneously
(+) For test, apply test accel's along one axis at a time
(%) Apply load along +/- X and Y axes and each 45 degree vector

CAL	Design (*)		Accept (+)	Qual (+)	Unit
Launch Event	Lift-Off/ Airloads	MECO			
Lateral (X)	+/-2.14		+/-6.0	+/-7.5	g
Lateral (Y)	+/-2.15		+/-6.0	+/-7.5	g
Lateral (%)		+/-0.2			g
Axial (Z)	+4.43/-1.8	+6.8	+6.8/-1.8	+8.5/-2.25	g
Rot X	+/-19.79	0	0	0	rad/sec^2
Rot Y	+/-19.27	0	0	0	rad/sec^2
Rot Z	+/-20.15	0	0	0	rad/sec^2
Source	(2)	(3)	(5), (8)	(5)	

Comments: (*) For analysis, apply design accel's simultaneously
(+) For test, apply test accel's along one axis at a time
(%) Apply load along +/- X and Y axes and each 45 degree vector

TO

TKR	Design (*)		Accept (+)	Qual (+)	Unit
Launch Event	Lift-Off/ Airloads	MECO			
Lateral (X)	+/-1.71		+/-4.4	+/-5.5	g
Lateral (Y)	+/-2.49		+/-4.4	+/-5.5	g
Lateral (%)		+/-0.2			g
Axial (Z)	+4.74/-1.91	+6.8	+6.8/-1.9	+8.5/-2.4	g
Rot X	+/-54.17	0	0	0	rad/sec^2
Rot Y	+/-15.27	0	0	0	rad/sec^2
Rot Z	+/-9.06	0	0	0	rad/sec^2
Source	(9)	(3)	(9)	(10)	

Comments: (*) For analysis, apply design accel's simultaneously
(+) For test, apply test accel's along one axis at a time
(%) Apply load along +/- X and Y axes and each 45 degree vector

CAL	Design (*)		Accept (+)	Qual (+)	Unit
Launch Event	Lift-Off/ Airloads	MECO			
Lateral (X)	+/-1.46		+/-6.0	+/-7.5	g
Lateral (Y)	+/-2.14		+/-6.0	+/-7.5	g
Lateral (%)		+/-0.2			g
Axial (Z)	+4.74/-1.91	+6.8	+6.8/-1.9	+8.5/-2.4	g
Rot X	+/-47.53	0	0	0	rad/sec^2
Rot Y	+/-13.74	0	0	0	rad/sec^2
Rot Z	+/-9.06	0	0	0	rad/sec^2
Source	(9)	(3)	(9)	(11)	

Comments: (*) For analysis, apply design accel's simultaneously
(+) For test, apply test accel's along one axis at a time
(%) Apply load along +/- X and Y axes and each 45 degree vector

ACD and EBOX Subsystem Static-equivalent Accelerations

FROM

ACD	Design		Accept (+)		PFQ (+)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (*)	5.1	0.2	5.1	0.2	6.375	0.25	g
Axial (Z)	+4.1/-1.4	+6.8	+4.1/-1.4	+6.8	+5.13/-1.75	8.5	g
Rot X/Y	0	0	0	0	0	0	rad/sec^2
Rot Z	0	0	0	0	0	0	rad/sec^2
Source	(1)	(3)	(1)	(3)	(1)	(3)	

Comments: (*) Apply load along +/-X and Y axes and each 45 degree vector
(+) Single-axis test levels are to be derived with pre-test analysis

TO

ACD	Design (*)		Accept (+)		PFQ (+)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral X	+/-1.7	+/-0.2	+/-5.8	+/-0.2	+/-7.25	+/-0.25	g
Lateral Y	+/-3.24	+/-0.2	+/-4.2	+/-0.2	+/-5.25	+/-0.25	g
Axial (Z)	+2.89/-0.2	+6.8	+2.89/-0.2	+6.8	+/-3.61/-0.25	+8.5	g
Rot X	+/-49.12	0	0	0	0	0	rad/sec^2
Rot Y	+/-11.46	0	0	0	0	0	rad/sec^2
Rot Z	+/-9.11	0	0	0	0	0	rad/sec^2
Source	(9)	(3)	(14)	(3)	(14)	(3)	

Elec	Design (*)		Accept (+)	PFQ (+)	Unit
Launch Event	Lift-Off/ Airloads	MECO			
Lateral (X)	+/-2.09		+/-5.9	+/-7.4	g
Lateral (Y)	+/-2.09		+/-5.9	+/-7.4	g
Lateral (%)		+/-0.2			g
Axial (Z)	+4.43/-1.8	+6.8	+6.8/-1.8	+8.5/-2.25	g
Rot X	+/-19.79	0	0	0	rad/sec^2
Rot Y	+/-19.27	0	0	0	rad/sec^2
Rot Z	+/-20.15	0	0	0	rad/sec^2
Source	(2)	(3)	(6), (8)	(6)	

Comments: (*) For analysis, apply design accel's simultaneously
(+) For test, apply test accel's along one axis at a time
(%) Apply load along +/- X and Y axes and each 45 degree vector

Elec	Design (*)		Accept (+)	PFQ (+)	Unit
Launch Event	Lift-Off/ Airloads	MECO			
Lateral (X)	+/-1.41		+/-6.25	+/-7.8	g
Lateral (Y)	+/-2.76		+/-6.25	+/-7.8	g
Lateral (%)		+/-0.2			g
Axial (Z)	+4.76/-1.93	+6.8	+6.8/-1.9	+8.5/-2.4	g
Rot X	+/-48.79	0	0	0	rad/sec^2
Rot Y	+/-13.56	0	0	0	rad/sec^2
Rot Z	+/-9.22	0	0	0	rad/sec^2
Source	(9)	(3)	(9)	(9)	

Comments: (*) For analysis, apply design accel's simultaneously
(+) For test, apply test accel's along one axis at a time
(%) Apply load along +/- X and Y axes and each 45 degree vector

Grid and RAD Subsystem Static-equivalent Accelerations

FROM

Grid Box	Design		Accept (+)		PFQ (+)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (*)	5.1	0.2	5.1	0.2	6.375	0.25	g
Axial (Z)	+4.1/-1.4	+6.8	+4.1/-1.4	+6.8	+5.13/-1.75	8.5	g
Rot X/Y	0	0	0	0	0	0	rad/sec^2
Rot Z	0	0	0	0	0	0	rad/sec^2
Source	(1)	(3)	(1)	(3)	(1)	(3)	

Comments: (*) Apply load along +/-X and Y axes and each 45 degree vector
(+) Single-axis test levels are to be derived with pre-test analysis

TO

Grid Box	Design		Accept (+)		PFQ (+)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (X)	+/-1.36	+/-0.2	+/-1.36	+/-0.2	+/-1.7	+/-0.25	g
Lateral (Y)	+/-1.82	+/-0.2	+/-1.82	+/-0.2	+/-2.28	+/-0.25	g
Axial (Z)	+2.9/-0.28	+6.8	+2.9/-0.28	+6.8	+3.63/-0.35	+8.5	g
Rot X	+/-44.26	0	+/-44.26	0	+/-55.33	0	rad/sec^2
Rot Y	+/-11.12	0	+/-11.12	0	+/-13.9	0	rad/sec^2
Rot Z	+/-9.04	0	+/-9.04	0	+/-11.3	0	rad/sec^2
Source	(9)	(3)	(9)	(3)	(9)	(3)	

Radiator	Design (*)		Accept (%)		PFQ (%)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (X)	+/-2.7		+/-2.7		+/-3.375		g
Normal (Y)	+/-(1.7+AF)		+/-(1.7+AF)		+/-1.25(1.7+AF)		g
Lateral ($)		0.2		0.2		0.25	g
Axial	+4.2/-1.4	+6.8	+4.2/-1.4	+6.8	+5.25/-1.75	+8.50	g
Rot (X)	0	0	0	0	0	0	rad/sec^2
Rot (Y)	0	0	0	0	0	0	rad/sec^2
Rot (Z)	0	0	0	0	0	0	rad/sec^2
Source	(7)	(3)	(7)		(7)		

Comments: (*) For analysis, apply design accel's simultaneously
(%) Single-axis test levels to be derived with pre-test analysis
AF = acoustic factor of 7.8 g (TBR) from SEA acoustic analysis results
($) Apply load along +/-X and Y axes and each 45 degree vector

Radiator	Design (*)		Accept (%)		PFQ (%)		Unit
Launch Event	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	Lift-Off/ Airloads	MECO	
Lateral (X)	+/-1.85		+/-1.85		+/-4.625		g
Normal (Y)	+/- 10.98		+/- 10.98		+/-13.725		g
Lateral ($)		+/-0.2		+/-0.2		+/-0.25	g
Axial	+7.02/-3.85	+6.8	+7.02/-3.85	+6.8	+8.78/-4.81	+8.50	g
Rot (X)	+/- 43.48	0	+/- 43.48	0	+/-54.35	0	rad/sec^2
Rot (Y)	+/- 12.75	0	+/- 12.75	0	+/-15.94	0	rad/sec^2
Rot (Z)	+/- 8.26	0	+/- 8.26	0	+/-10.325	0	rad/sec^2
Source	(9)	(3)	(9)	(3)	(9)	(3)	

Comments: (*) For analysis, apply design accel's simultaneously
(%) Single-axis test levels to be derived with pre-test analysis
($) Apply load along +/-X and Y axes and each 45 degree vector
Normal (Y) load includes an acoustic factor of 7.8g.

LAT to Spacecraft Interface Forces

FROM

LAT-SC Mount	Design		Acceptance		Protoflight Qual		Unit	Comment
Launch Event	Lift-Off/ Transonic	MECO	Lift-Off/ Transonic	MECO	Lift-Off/ Transonic	MECO		
Radial								Along radial line through mount point
Force	29	0	29	0	36	0	N	
Moment	270	0	270	0	338	0	N-m	
Tangential								Parallel to Grid wall
Force	23,778	0	23,778	0	29,723	0	N	
Moment	160	0	160	0	200	0	N-m	
Z-Axis								Parallel to LAT Z-axis
Force	29,625	45,218	29,625	45,218	37,031	56,523	N	
Moment	222	0	222	0	278	0	N-m	
Source	(1)	(4)						

TO

LAT-SC Mount	Design		Acceptance		Protoflight Qual		Unit	Comment
Launch Event	Lift-Off/ Transonic	MECO	Lift-Off/ Transonic	MECO	Lift-Off/ Transonic	MECO		
Radial								Along radial line through mount point
Force	+/-969	0	+/-969	0	+/-1211	0	N	
Moment	+/-303	0	+/-303	0	+/-379	0	N-m	
Tangential								Parallel to Grid wall
Force	+/-25243	0	+/-25243	0	+/-31554	0	N	
Moment	+/-503	0	+/-503	0	+/-629	0	N-m	
Z-Axis					21,991			Parallel to LAT Z-axis
Force	+38774 / -17593	45,218	+38774 / -17593	45,218	+48468 / -21991	56,523	N	
Moment	+/-473	0	+/-473	0	+/-591	0	N-m	
Source	(12)	(4)	(12)	(4)	(12)	(4)		

TKR Subsystem Interface Forces

FROM

TKR-Grid Flexures	Design		Accept	Qual	Unit
Launch Event	Lift-Off/ Transonic	MECO			
Mid-Side Flexures					
Shear	2266	2061	2266	2832.5	N
Tension/Compress.	391	291	391	489	N
Corner Flexures					
Shear	1,003	80	1,003	1,254	N
Tension/Compress.	1,277	1,193	1,277	1,596	N
Source	(2)	(4)			

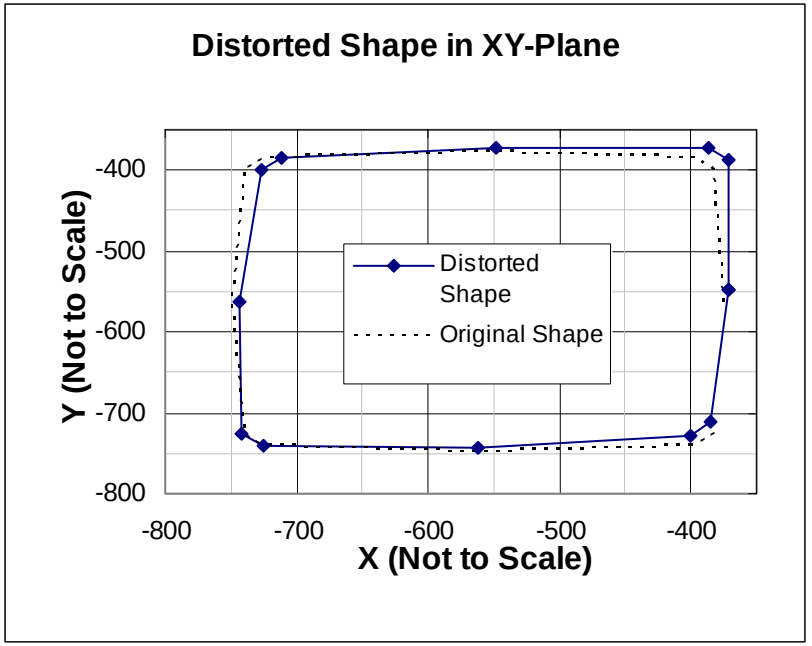
TO

TKR-Grid Flexures	Design		Accept	Qual	Unit
Launch Event	Lift-Off/ Transonic	MECO			
Mid-Side Flexures					
Shear	1454	2061	1454	1818	N
Tension/Compress.	582	291	582	728	N
Corner Flexures					
Shear	691	80	691	864	N
Tension/Compress.	945	1,193	945	1,181	N
Source	(7)	(4)			

TKR Mount Point	Angular Location (deg)	Displacements Radial (micron)	Displacements Vertical (micron)
Left midside	-180	-29	0
Lower left	-135	20	0
Bottom midside	-90	0	0
Lower right	-45	-11	13
Right midside	0	46	93
Upper right	45	81	165
Top midside	90	14	91
Upper left	135	-60	24

Dimensions in microns

Data Source: (5)



CAL Subsystem Interface Forces

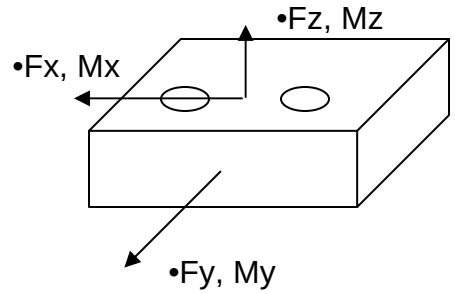
FROM

CAL Tabs	Design Load Cases			Acceptance Test			Qualification Test			Unit	Comments
	LC1	LC2	LC3	LC1	LC2	LC3	LC1	LC2	LC3		
F(x)	4373	1140	-3302	4373	1140	-3302	5467	1424	-4128	N	Across tab in plane of plate
F(y)	206	2994	1414	206	2994	1414	258	3742	1767	N	Along tab
F(z)	-195	-11	654	-195	-11	654	-244	-14	817	N	Out of plane of plate
M(x)	1.39	-0.05	-6.09	1.39	-0.05	-6.09	1.74	-0.06	-7.61	N-m	Around x-axis
M(y)	0.45	-1.28	0.22	0.45	-1.28	0.22	0.56	-1.60	0.27	N-m	Around y-axis
M(z)	20.98	4.58	-14.86	20.98	4.58	-14.86	26.22	5.73	-18.57	N-m	Around z-axis
Source Scale	(6)	(6)	(6)	1	1	1	1.25	1.25	1.25		

TO

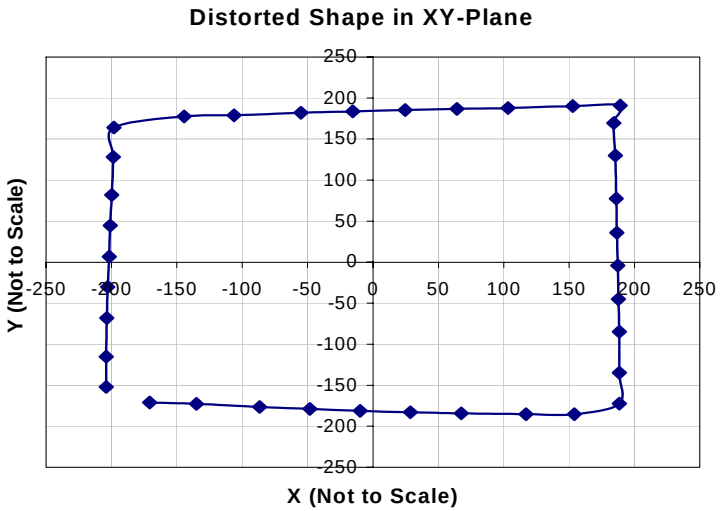
CAL Tabs	Design Load Cases				Acceptance Test				Qualification Test				Unit	Comments
	LC1	LC2	LC3	ECLA	LC1	LC2	LC3	ECLA	LC1	LC2	LC3	ECLA		
F(x)	4373	1140	-3302	1717	4373	1140	-3302	1717	5467	1424	-4128	2146	N	Across tab in plane of plate
F(y)	206	2994	1414	1825	206	2994	1414	1825	258	3742	1767	2281	N	Along tab
F(z)	-195	-11	654	248	-195	-11	654	248	-244	-14	817	310	N	Out of plane of plate
M(x)	1.39	-0.05	-6.09	4.90	1.39	-0.05	-6.09	4.90	1.74	-0.06	-7.61	6.13	N-m	Tab Bending/Prying
M(y)	0.45	-1.28	0.22	2.80	0.45	-1.28	0.22	2.80	0.56	-1.60	0.27	3.50	N-m	Torque/Twist
M(z)	20.98	4.58	-14.86	9.70	20.98	4.58	-14.86	9.70	26.22	5.73	-18.57	12.13	N-m	Yaw
Source Scale	(6)	(6)	(6)	(7)	1	1	1	1	1.25	1.25	1.25	1.25		

Notes: Interface loads are for CAL tab thickness of 7 mm

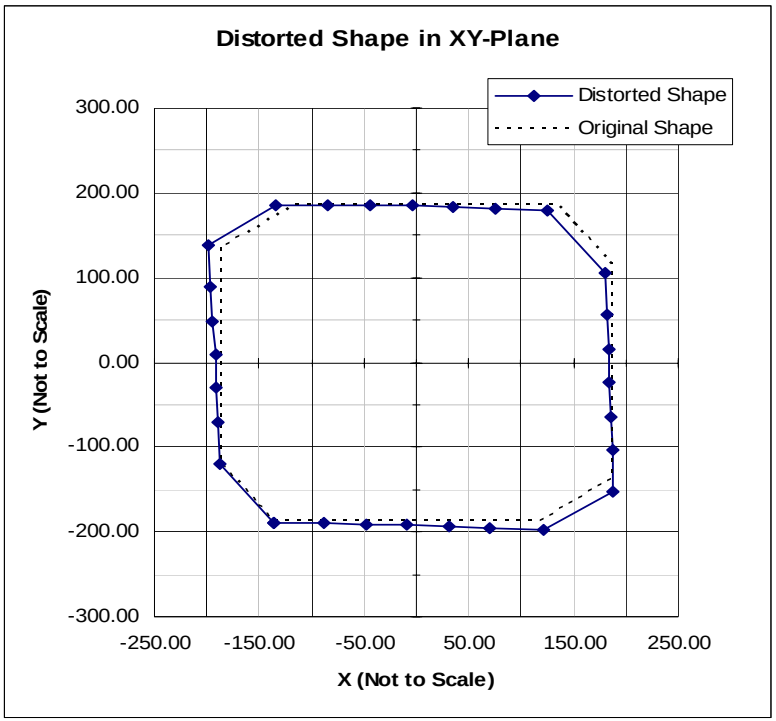


CAL Subsystem Interface Distortion (MECO only)

FROM



TO



ACD Subsystem Interface Forces and Displacements

FROM

ACD-Grid Mount	Design	Accept.	PFQ	Unit	Comment
Corner Mounts					
Shear	0	0	0	N	RSS of X, Y max shear
Tens/Compression	1787	1787	2234	N	Parallel to LAT Z-axis
Mid-Side Mounts					
Shear	4402	4402	5503	N	RSS of X, Z shears in plane of Grid wall
Tens/Compression	2223	2223	2779	N	Normal to Grid wall

TO

ACD-Grid Mount	Design	Accept.	PFQ	Unit	Comment
Corner Mounts					
Shear	0	0	0	N	RSS of X, Y max shear
Tens/Compression	1042	1042	1303	N	Parallel to LAT Z-axis
Mid-Side Mounts					
Shear	4170	4170	5213	N	RSS of X, Z shears in plane of Grid wall
Tens/Compression	4039	4039	5049	N	Normal to Grid wall
Source					

FROM

ACD Mount Point	Displacements	
	Radial	Vertical
Lower Midside	-39	0
Upper Midside	-97	-5
Corner	6	-140

Dimensions in microns

Data Source: (5)

TO

ACD Mount Point	Displacements	
	Radial	Vertical
Lower Midside	-39	0
Upper Midside	-97	-5
Corner	6	-140

Dimensions in microns

Data Source: (5)

EBOX Subsystem Interface Forces

FROM

E-Box Stand-Off	Design	Accept.	Qual	Unit
Tension	3,750	3,750	4,688	N
Compression	2,625	2,625	3,281	N
Shear	1,288	1,288	1,609	N
Bending Moment	19.3	19.3	24.1	N-m

TO

E-Box Stand-Off	Design	Accept.	Qual	Unit
Tension	3,750	3,750	4,688	N
Compression	2,625	2,625	3,281	N
Shear	1,288	1,288	1,609	N
Bending Moment	19.3	19.3	24.1	N-m

Radiator Subsystem Interface Forces

FROM

Rad-Rad Mnt Bkt	Design	Accept	PFQ	Unit
In-Plane Lateral	795	795	994	N
Normal to Plane	266	266	333	N
Z-Axis	1,336	1,336	1,670	N

VCHP-Patch Plate	Design	Accept	PFQ	Unit
In-Plane Lateral	8	8	10	N
Normal to Plane	48	48	60	N
Z-Axis	27	27	34	N

TO

Rad-Rad Mnt Bkt	Design	Accept	PFQ	Unit
In-Plane Lateral	795	795	994	N
Normal to Plane	266	266	333	N
Z-Axis	1,336	1,336	1,670	N
Source	(4)			

VCHP-Patch Plate	Design	Accept	PFQ	Unit
In-Plane Lateral	8	8	10	N
Normal to Plane	48	48	60	N
Z-Axis	27	27	34	N
Source	(4)			

FROM

Radiator-SC Strut	Design	Accept	PFQ	Unit
In-Plane Lateral	0	0	0	N
Normal to Plane	500	500	625	N
Z-Axis	0	0	0	N
Source	(4)			

TO

Radiator-SC Strut	Design	Accept	PFQ	Unit
In-Plane Lateral	0	0	0	N
Normal to Plane	500	500	625	N
Z-Axis	0	0	0	N
Source	(4)			

LAT Sine Vibration Levels

FROM

Acceptance Test Levels			
Axis	**Freq. (Hz)**	**Test levels**	**Sweep Rate**
Thrust	5 to 6.2	1.27 cm (0.5 in.) double amplitude	4 octaves/min
	6.2 to 50	1.0 g (zero to peak)	
Lateral	5 to 50	0.7 g (zero to peak)	4 octaves/min

Proto Flight Qualification Test Levels			
Axis	**Freq. (Hz)**	**Test levels**	**Sweep Rate**
Thrust	5 to 7.4	1.27 cm (0.5 in.) double amplitude	4 octaves/min
	7.4 to 50	1.4 g (zero to peak)	
Lateral	5 to 6.2	1.27 cm (0.5 in.) double amplitude	4 octaves/min
	6.2 to 50	1.0 g (zero to peak)	

Qualification Test Levels			
Axis	**Freq. (Hz)**	**Test levels**	**Sweep Rate**
Thrust	5 to 7.4	1.27 cm (0.5 in.) double amplitude	2 octaves/min
	7.4 to 50	1.4 g (zero to peak)	
Lateral	5 to 6.2	1.27 cm (0.5 in.) double amplitude	2 octaves/min
	6.2 to 50	1.0 g (zero to peak)	

Notes: Values shown are at the spacecraft interface. Pending completion of a flight loads analysis, these values will be updated with LAT-specific design and test levels

TO

LAT Acceptance Test Levels			
Axis	**Freq. (Hz)**	**Test levels [g]**	**Sweep Rate [oct./min]**
Thrust	5 - 15	0.3	4
	15 - 25	0.9	4
	25 - 35	2.2	1.5
	35 - 50	0.5	4
Lateral	5 - 15	1.7	4
	15 - 25	0.4	4
	25 - 35	0.4	1.5
	35 - 50	0.4	4

LAT Protoflight Test Levels			
Axis	**Freq. (Hz)**	**Test levels [g]**	**Sweep Rate [oct./min]**
Thrust	5 - 15	0.4	4
	15 - 25	1.2	4
	25 - 35	2.8	1.5
	35 - 50	0.7	4
Lateral	5 - 15	2.2	4
	15 - 25	0.5	4
	25 - 35	0.5	1.5
	35 - 50	0.5	4

Notes: 1) The test levels represent LAT Net CG responses
2) Input levels may be notched so that the interface forces or response accelerations do not exceed flight loads predictions

TKR and CAL Sine Vibration Levels (New)

LAT TKR Protoflight Test Levels			
Axis	Freq. (Hz)	Test levels	Sweep Rate [Oct/min]
Thrust (Z)	5 - 20	2.4	4
	25 - 35	5.9	1.5
	40 - 50	2.0	4
Lateral (X&Y)	5 - 15	3.2	4
	15 - 25	1.4	4
	25 - 35	1.4	1.5
	35 - 40	1.4	4
	40 - 50	2.3	4

LAT TKR Prototype/Qual Test Levels			
Axis	Freq. (Hz)	Test levels	Sweep Rate [Oct/min]
Thrust (Z)	5 - 20	2.4	2
	25 - 35	5.9	0.75
	40 - 50	2	2
Lateral (X&Y)	5 - 15	3.2	2
	15 - 25	1.4	2
	25 - 35	1.4	0.75
	35 - 40	1.4	2
	40 - 50	2.3	2

Notes: (1) Quarter and Half Level Tests will be performed before testing at full levels
(2) Input levels should be notched to that interface forces or response accelerations do not exceed flight loads predictions
(3) Linear acceleration transition from 2.4g's at 20 Hz to 5.9g's at 25 Hz.
(4) Linear acceleration transition from 5.9g's at 35 Hz to 2.0g's at 40 Hz.

LAT CAL Protoflight Test Levels			
Axis	Freq. (Hz)	Test levels	Sweep Rate [Oct/min]
Thrust (Z)	5 - 20	2.5	4
	25 - 35	5.9	1.5
	40 - 50	2.1	4
Lateral (X&Y)	5 - 15	2.7	4
	15 - 25	1.2	4
	25 - 35	1.2	1.5
	35 - 43	1.5	4
	43 - 50	1.9	4

LAT CAL Prototype/Qual Test Levels			
Axis	Freq. (Hz)	Test levels	Sweep Rate [Oct/min]
Thrust (Z)	5 - 20	2.5	2
	25 - 35	5.9	0.75
	40 - 50	2.1	2
Lateral (X&Y)	5 - 15	2.7	2
	15 - 25	1.2	2
	25 - 35	1.2	0.75
	35 - 43	1.5	2
	43 - 50	1.9	2

Notes: (1) Quarter and Half Level Tests will be performed before testing at full levels
(2) Input levels should be notched to that interface forces or response accelerations do not exceed flight loads predictions
(3) Linear acceleration transition from 2.5g's at 20 Hz to 5.9g's at 25 Hz.
(4) Linear acceleration transition from 5.9g's at 35 Hz to 2.0g's at 40 Hz.

ACD Sine Vibration Levels (New)

LAT ACD Acceptance Test Levels			
Axis	Freq. (Hz)	Test levels	Sweep Rate [Oct/min]
Thrust (Z)	5 - 15	0.3	4
	15 - 25	0.9	4
	25 - 35	2.1	1.5
	35 - 50	0.5	4
Lateral (X&Y)	5 - 15	2	4
	15 - 25	0.65	4
	25 - 35	0.65	1.5
	35 - 40	0.65	4
	40 - 50	1.5	4

LAT ACD Protoflight Test Levels			
Axis	Freq. (Hz)	Test levels	Sweep Rate [Oct/min]
Thrust (Z)	5 - 15	0.4	4
	15 - 25	1.2	4
	25 - 35	2.7	1.5
	35 - 50	0.7	4
Lateral (X&Y)	5 - 15	2.5	4
	15 - 25	0.9	4
	25 - 35	0.9	1.5
	35 - 40	0.9	4
	40 - 50	1.9	4

Notes: (1) The Test levels represent ACD Net CG Responses
(2) Input levels should be notched to that interface forces or response accelerations do not exceed flight loads predictions

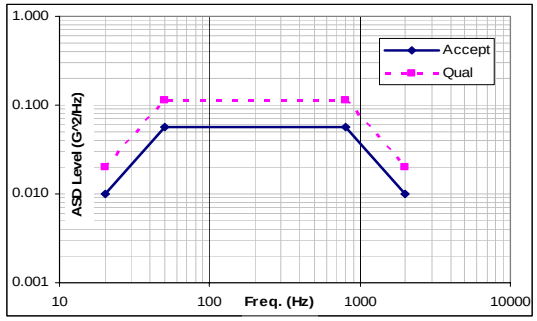
TKR Random Vibration Levels

FROM

TKR Module
Random Vibration Spectra

Freq (Hz)	ASD Level (G^2/Hz)	
	Accept	Qual
20	0.010	0.020
50	0.057	0.115
800	0.057	0.115
2000	0.010	0.020
Overall	8.7 Grms	12.3 Grms

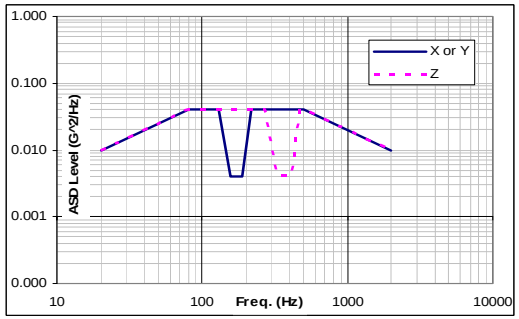
Mass: 31.6 kg
Scale: 0.72



TO

TKR Module
Random Vibration Spectra

Freq (Hz)	Accept and Qual ASD	
	X or Y	Z
20	0.010	0.010
80	0.040	0.040
130	*0.040*	*0.040*
155	*0.004*	*0.040*
190	*0.004*	*0.040*
220	*0.040*	*0.040*
270	*0.040*	*0.040*
330	*0.040*	*0.004*
410	*0.040*	*0.004*
465	*0.040*	*0.040*
500	0.040	0.040
2000	0.010	0.010
Overall	6.59 Grms	6.35 Grms



NOTE: These levels are based upon fundamental frequencies of 175 Hz in X or Y, 370 Hz in Z, and Q=10. The notch portion (italics) will require adjustment if freqeuncy or Q varies by more than 10%.

Conclusions

- September 2003 ECLA Results (Delta-PDR LAT and PDR SC models) incorporated into Environmental Spec, but more updates are planned for
- Should not be a surprise to any of the subsystems
  - Advance copies of loads were provided to ACD and CAL subsystems
  - In general, the new requirements are more benign than before
- Timeline of known future updates
  - High Frequency MECO – Less than one month
  - Random Vibration Levels (other SS) – Approx. one month
  - Next CLA Cycle (LATv10.08 and CDR SC Models) – Summer '04
  - Transportation Loads – TBD

LAT Environmental Specification: Other Environmental Requirement Changes

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Contents

- LAT Equipment EMI Requirements
  - Radiated Emissions and Susceptibility
    - Charts was covered in greater detail at March 2 Engineering Meeting
- Future Environmental Changes
  - Atomic Oxygen
  - LAT Equipment EMI Requirements

  Conducted Emissions and Susceptibility

RE 102

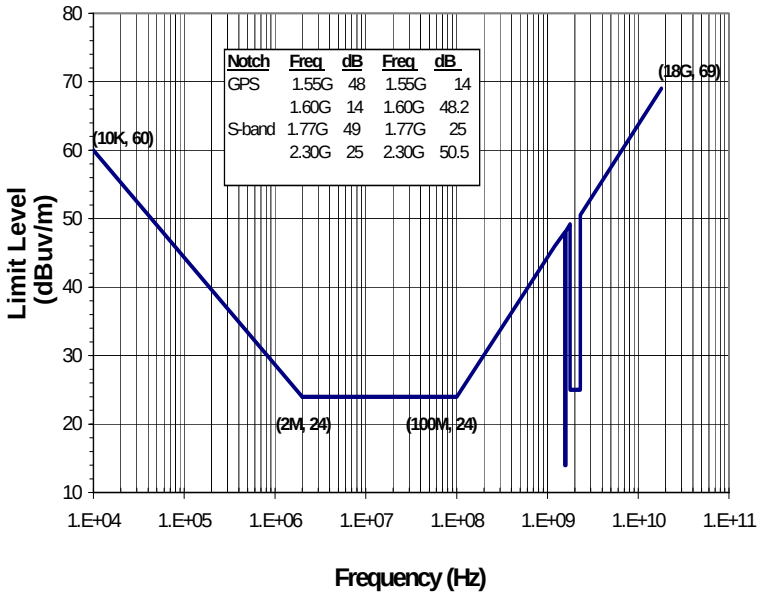

Figure 10(WAS)

The shape of the curve for all LAT Equipment is identical to the LAT instrument level limit and the limit level is 16 db below the LAT instrument level limit.

Figure 10(IS)

RE 101

There was no RE 101 curve for all LAT equipment

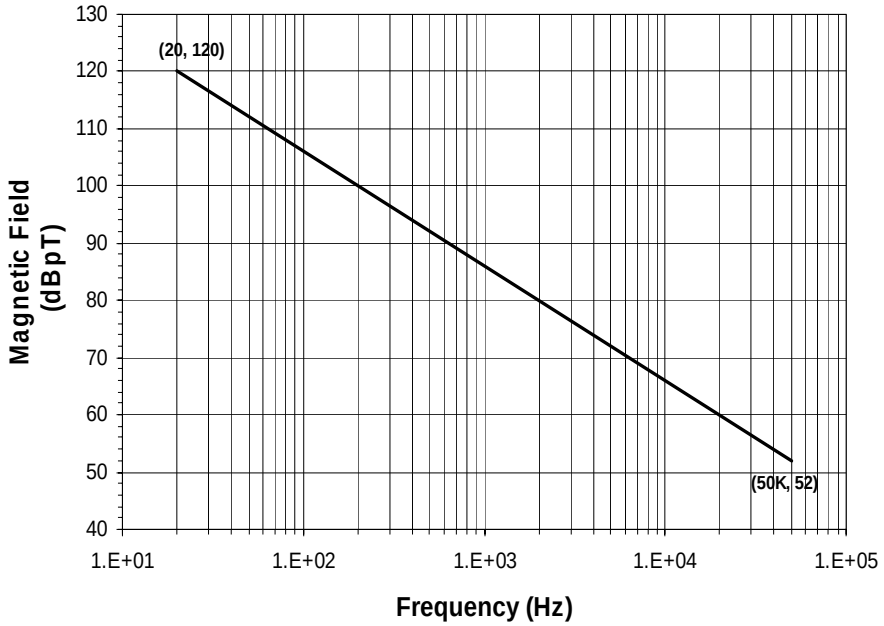

Figure 11(WAS)

Figure 11(IS)

Upcoming Change No. 1

- **Paragraph 12.4 Atomic Oxygen**
  WAS: 12.4 Atomic Oxygen; Figure 9 shows the atomic oxygen environment for the GLAST mission over the range of 475 to 575km orbit altitudes. Since the GLAST system must meet all its requirements over the full altitude range, the worst case environment of 450km should be used for atomic oxygen related design considerations.

  Figure 9: GLAST Atomic Oxygen Environment

  IS: 12.4 Atomic Oxygen; The atomic oxygen environment, which shall be used for analysis, 3.67 E+21 atoms/cm2 for all components except the solar arrays. The atomic oxygen environment, which shall be used for analysis of the solar arrays, is 1.17E+21 atoms/cm2

Upcoming Change No. 2

- **Incorporation of New Conducted Emissions and Susceptibility Levels for the LAT Equipment EMI Requirements**

Conclusions

- The LAT Equipment EMI Requirements For Radiated Emissions and Susceptibility will be incorporated in the LAT Environmental Specification once the CR is approved.

- Future Environmental Changes which include Atomic Oxygen and LAT Equipment EMI Requirements For Conducted Emissions and Susceptibility will be the subject of another CR.