

Review of EM Tracker Tower Vibration Test Documents

By C. Fransen (w/ comments from S. Seipel, F. Tahmasebi, and T. Venator)

3 November 2003

Document: HTN-102090-0006 Draft, GLAST Tower Vibration Test Analysis and Predictions

<u>Page/Section</u>	<u>Comment</u>
16 / Fig 6.3	Labeling of input curve should be X (typo)
17 / Fig 6.4	Labeling of input curve and plot title should be Z (typo)
15 / Tab 6.1	Given these results it appears a center Grms of ~12 can be tolerated before margins reach zero (based on min MS). It is recommended that a not to exceed Grms level be identified, whereby if measured levels from -6dB run suggest exceedances will occur at full-level (due to higher than expected Q) an informed decision can be made with regard to limiting response. CF

Document: LAT-TD-1841, Engineering Model Tower-Vibration Test Plan

<u>Page/Section</u>	<u>Comment</u>
5 / 6.1	This section should be re-titled "Low Level Signature Sweep" to better describe what is being accomplished (ie a modal survey identifies mode shapes, something which is not explicitly being performed here) CF, FT
6 / Table 2	Suggest limiting the frequency range to 1000 Hz, which will capture all significant modes while limiting unnecessary shaker aborts due to fixture resonances, and other high-Q modes. CF, TV
6 / 6.2	Change the -6dB and -3dB durations to 30 seconds to be consistent with Sections 7.3.1-3, and to minimize excessive test time on the hardware. CF
6 / 6.3	Add quarter (-12 dB) and half-level (-6 dB) sine sweep runs, which will allow identification of modes that may require notching at full-level. FT
6 / 6.3	Replace Table 4 with that provided in Attachment 1. FT
7 / 6.4	After the third paragraph, add the following: "Each sine burst pulse-profile shall contain no more than: 10 cycles of increasing amplitude, 5-7 cycles at full-level and 10 cycles of decreasing amplitude. CF
8 / 6.4	Delete the two sentences which follow: "3. Full level (qualification)". CF
9 / 7.2	The bare-fixture evaluation described here is of limited value, and only serves to check-out equipment operation. It is suggested a Tracker mass-simulator be installed on the fixture to enable measurement of actual fixture dynamics, which could deleteriously affect Tracker testing. CF
10 / 7.3.1 etc	Suggest to delete the "Modal Survey" after the 6-dB and -3 dB random vibration runs. PSD responses obtained during the random exposures should be adequate to reveal any frequency shifts that occur. CF

Document: LAT-TD-2363, Engineering Model Tower-Vibration Test Procedure

<u>Page/Section</u>	<u>Comment</u>
3 / 2	Add to the scope mention of the 150 Hz MECO sine sweep. SS
3 / 4	See Attachment 2 on Referenced Documents. SS
4 / 4	Add the Tracker pretest document here: HTN-102090-0006 CF
8 / 5.3	Add a section on Test Tolerances, which should match those provided in Section 1.14 of GEVS-SE CF
12 / 7.4.1	Delete the second paragraph (not needed after Tolerances added) CF
19 / 8.1	This section should be re-titled “Low Level Signature Sweep” to better describe what is being accomplished (ie a modal survey identifies mode shapes, something which is not explicitly being performed here) CF, FT
19 / Table 6	Suggest limiting the frequency range to 1000 Hz, which will capture all significant modes while limiting unnecessary shaker aborts due to fixture resonances, and other high-Q modes. CF, TV
19 / 8.2	Replace Table 7 with that provided in Attachment 1 FT
20 / 8.3	Change the –6dB and –3dB durations to 30 seconds to be consistent with Sections 9.5.1-3, and to minimize excessive test time on the hardware. CF
19 / 8.2	Add quarter (-12 dB) and half-level (–6 dB) sine sweep runs, which will allow identification of modes that may require notching at full-level. FT
20 / 8.3	Add a note stating all response data will be plotted and compared against predictions following the –6dB run. If measured response exceeds predictions by more than 2-3 dB, consideration shall be given notching at the fundamental before proceeding. CF
21 / 8.4	After the third paragraph, add the following: “Each sine burst pulse-profile shall contain no more than: 10 cycles of increasing amplitude, 5-7 cycles at full-level and 10 cycles of decreasing amplitude. CF
21 / 8.4	Delete the sentence which follows: “3. Full level (qualification)”. CF
23 / 9.1	Add the following to the list of anomalies to observe “Fastener stacking which appears cracked or otherwise disturbed” CF
24 / 9.4	The bare-fixture evaluation described here is of limited value, and only serves to check-out equipment operation. It is suggested a Tracker mass-simulator be installed on the fixture to enable measurement of actual fixture dynamics, which could deleteriously affect Tracker testing. CF
25 / 9.5.1 etc	Suggest to delete the “Modal Survey” after the 6-dB and –3 dB random vibration runs. PSD responses obtained during the random exposures should be adequate to reveal any frequency shifts that occur. CF
27 / 9.6	Add to Step 70: “Assure all fasteners are torqued and either torque-striped or staked.” CF
29 / 11.2	Add to this section the types of data plots desired, such as PSD for random, amplitude spectra for sine sweeps and time histories for sine bursts. CF

Attachment 1
Farhad Tahmasebi

Farhad Tahmasebi – October 30, 2003

1 - Comments on LAT-TD-2363: Engineering Model Tower - Vibration Test Procedure

General

Replace the term “modal survey” with “low level signature sweep” throughout the document. Mode shapes are not being determined. So, using the term “modal survey” is confusing and misleading.

Section 8.2

Replace Table 7 with the following update, which was submitted to the GPO on 10/17/2003.

TKR Sine Vibration Prototype Test levels			
Axis	Frequency (Hz)	Prototype Level (g)	Prototype Sweep Rate (Oct/Min)
Lateral (X & Y)	5 - 15	4.4	2
	15 - 25	1.9	2
	25 - 35	1.9	0.75
	35 - 45	3.8	2
	45 - 50	4.6	2
Thrust (Z)	5 - 18	2.5	2
	20 - 25	5.0	2
	25 - 35	5.0	0.75
	35 - 40	5.0	2
	42 - 50	2.5	2

Notes:

1. The above specification is obtained using the results of two “study” in-house GLAST CLA cycles performed at the GSFC. Updates to the above specification will be provided using the data from the future CLA cycles.
2. $\frac{1}{4}$ and $\frac{1}{2}$ level sine vibration tests may be performed before testing at the above full levels.
3. **If necessary, the sine vibration test input levels must be notched to limit the CG response of the TKR to the levels outlined in Table 3 of the LAT Environmental Specification.**
4. Linear acceleration transition from 2.5 G's at 18 Hz to 5.0 G's at 20 Hz.
5. Linear acceleration transition from 5.0 G's at 40 Hz to 2.5 G's at 42 Hz.

Sections 9.5.1, 9.5.2, and 9.5.3

- The low level signature sweeps before the sine vibration tests need only go up to 150 Hz.
- The low level signature sweeps after the sine burst tests need only go up to around 100 Hz.
- Before performing the sine vibration test at full level, a $\frac{1}{4}$ level test should be performed to make sure there are no unexpected surprises (e.g., an unexpected mode below or near 50 Hz). If the previous predictions have been wrong and there's an unexpected mode below or near 50 Hz, the sine vibration levels must be notched (see comment 3 under the table above).

2 - Comments on LAT-TD-1841: Engineering Model Tower - Vibration Test Plan

General

Replace the term “modal survey” with “low level signature sweep” throughout the document. Mode shapes are not being determined. So, using the term “modal survey” is confusing and misleading.

Section 6.3

Replace Table 4 with the following update, which was submitted to the GPO on 10/17/2003.

TKR Sine Vibration Prototype Test levels			
Axis	Frequency (Hz)	Prototype Level (g)	Prototype Sweep Rate (Oct/Min)
Lateral (X & Y)	5 - 15	4.4	2
	15 - 25	1.9	2
	25 - 35	1.9	0.75
	35 - 45	3.8	2
	45 - 50	4.6	2
Thrust (Z)	5 - 18	2.5	2
	20 - 25	5.0	2
	25 - 35	5.0	0.75
	35 - 40	5.0	2
	42 - 50	2.5	2

Notes:

1. The above specification is obtained using the results of two “study” in-house GLAST CLA cycles performed at the GSFC. Updates to the above specification will be provided using the data from the future CLA cycles.
2. $\frac{1}{4}$ and $\frac{1}{2}$ level sine vibration tests may be performed before testing at the above full levels.
3. **If necessary, the sine vibration test input levels must be notched to limit the CG response of the TKR to the levels outlined in Table 3 of the LAT Environmental Specification.**
4. Linear acceleration transition from 2.5 G’s at 18 Hz to 5.0 G’s at 20 Hz.
5. Linear acceleration transition from 5.0 G’s at 40 Hz to 2.5 G’s at 42 Hz.

Sections 7.3.1, 7.3.2, and 7.3.3

- The low level signature sweeps before the sine vibration tests need only go up to 150 Hz.

- The low level signature sweeps after the sine burst tests need only go up to around 100 Hz.
- Before performing the sine vibration test at full level, a ¼ level test should be performed to make sure there are no unexpected surprises (e.g., an unexpected mode below or near 50 Hz). If the previous predictions have been wrong and there's an unexpected mode below or near 50 Hz, the sine vibration levels must be notched (see comment 3 under the table above).

Attachment 2 (Sharon Seipel)

4. APPLICABLE DOCUMENTS

[2] GSFC 433-IRD-0001, "GLAST Science Instrument – Spacecraft Interface Requirements Document", Draft July 14, 2000

This is not a draft document. Update to current version which is Rev. B issued 04/24/02, change notice CH-10, issued 09/05/03 via CRR number 433-0181. Make sure you are in compliance with document.

[3] LAT Vibration and Acoustic Testing, 21st May 2001, by M. Nordby

Why is this an applicable Document? The information in this document has likely been overcome by events or updated since May 2001.

[5] HTN-102070-0008, "GLAST Tracker Tower '01 Prototype Random Vibration Test Plan"

Why is this an applicable reference document? Doesn't this document supercede it?

[7] LAT-MD-43.7, "Memorandum of Agreement between SU-SLAC/INFN/ASI"

This document is not released in either CyberDocs or LAT Docs. Is this the correct number?

[8] LAT-MD-00078.1, "Performance and Safety Assurance", F. O'Neill

This document has been superceded by LAT-MD-00078-02. Check that you are in compliance with the new document and update.

[9] LAT-MD-00091.1, "GLAST LAT Quality Manual", D. Marsh

The correct document number is LAT-MD-00091-01. Please update.

[10] LAT-MD-228-D1, "Calorimeter, Tracker and Data Acquisition Contamination Control Plan", N. Virmani

A test to qualify flight hardware should not be performed to a draft spec. The overall governing document for the LAT is LAT-MD-00404-03, which also has 2 DCN's against it (LAT-XR-00622-02 and LAT-XR-00622-03). Please make sure you are in compliance with this document and update reference.

[12] LAT-SS-00134 LAT TKR Detailed Subsystem Specification – Level IV, T. Borden, R. Johnson

The applicable version of this document should be noted. It is: LAT-SS-00134-03. Verify compliance and update the reference.

[13] LAT-SS-173-D0, Tracker Grounding and Shielding, D. Nelson, R. Johnson

The document LAT-SS-00173-00 is not a released document. Qualification of the flight design should not be performed to an unreleased document.

[14] LAT-SS-778-01-D4, LAT Environmental Specifications, M. Nordby, T. Leisgang

This is not a draft document. The correct reference is LAT-SS-00778-01 which has a released DCN against it (LAT-XR-01858-01). Make sure you are in compliance with the document and update the reference.

[15] LAT-DS-681-05, LAT TKR Tower Assembly Shake Test Mounting Plate

The released version of this document is LAT-DS-00681-03. Version -05 is still draft per on-line CM. Qualification testing should not be performed using unreleased documents.

[16] LAT-DS-688-02, LAT TKR Tower Shake Test Slip Table Adapter Plate

LAT-DS-00688-02 is still a draft document. Qualification testing should not be performed using unreleased documents.

[17] LAT-DS-873-01, LAT TKR Tower Module Lifting Fixture Assembly

LAT-DS-00873-01 02 is still a draft document. Qualification testing should not be performed using unreleased documents.

[18] LAT-DS-2358-01, LAT TKR Vibration Test Fixture Assembly Cable Holding Plate

LAT-DS-02358-01 is still a draft document. Qualification testing should not be performed using unreleased documents.

[19] LAT-DS-2359-01, LAT TKR Vibration Test Fixture Assembly 51 PIN Plug Adapter

LAT-DS-02359-01 is still a draft document. Qualification testing should not be performed using unreleased documents.

[20] LAT-TD-1841, Engineering Model Tower, Vibration Test Plan

LAT-TD-01841-01 is superceded by this test plan. This is an unreleased draft. It should be removed.

[22] Standard MIL-STD-...

Define this standard, or remove item 22.