

 GLAST TKR	Document # XXXXXXX	Date Effective xx xx 01
	Author(s) XXXXXXX	Supersedes
	Subsystem/Office INFN Bari	
Document Title TKR tray test plan		

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes

CONTENTS

1. Purpose
2. Definitions
3. References
4. Description
5. Test plan
 - 5.1. Test requirements
 - 5.1.1. Sine sweep
 - 5.1.2. Random Vibration
 - 5.1.3. Thermal cycling
 - 5.2. Test procedures
 - 5.2.1. Qualification test
 - 5.2.1.1. Dynamic loads
 - 5.2.1.2. Thermal cycling
 - 5.2.2. Acceptance test
 - 5.2.2.1. Dynamic loads
 - 5.2.2.2. Thermal cycling

1. PURPOSE

This plan describes the requirements by which the tray need to be analyzed and the procedures of the tests.

Requirements in this plan are derived from the documents reported in the reference section.

2. DEFINITIONS

Acronyms

GLAST	Gamma-ray Large Area Space Telescope
LAT	Large Area Telescope
TKR	Tracker
SA	Same as
TBD	To be determined
TBR	To be reviewed
FEM	Finite Element Model

3. REFERENCES

GEVS- General Environmental Verification Specification for STS & ELV, NASA GSFC
433- IRD-0001

LAT-SS-00047-1, by Martin Nordby

4. DESCRIPTION

Items in this document are divided into two main sections.

The first focuses on the kind of tests to be performed to qualify and accept the TKR trays and points out the general performance requirements.

The second part of the document describes the procedures that should be followed during the tests in a more detailed way.

In the definition of the procedures we have taken into account that the tray cannot be considered neither a primary nor a secondary structure, but it is a part of a TKR tower, which is a primary structure itself. As a consequence, the final decision was to find a *ad hoc* procedure to perform the tray acceptance tests.

The trays qualification tests will be done following the specifications reported in the GEVS and LAT documents. They shall be performed at SLAC; anyway also INFN is planning to perform tests on mock-ups at qualification levels.

The INFN qualification test will be performed at:

- Centrotecnica s.a.s. (Milan) for vibration tests;
- Material Engineer Department, in Terni (Perugia University) for thermal cycling.

The thermal and dynamic acceptance tests shall be done in the ladders' assembly factories (TBD) avoiding any handling or transport problems.

5. TEST PLAN

We are planning the procedures of both qualification and acceptance tests to be performed on TKR trays.

For the qualification, dummy silicon detectors will be used to study the behaviour of the trays under dynamic loads and thermal stresses and to validate the FEM.

The structural load environment includes sine sweep and vibration loading.

The qualification tests will be performed by locating accelerometers and strain gauges on the dummy silicon surfaces. First of all, the unloaded fixture (without the trays mounted on) should be tested, then the tests will be performed on the three axis of the tray (vertical z axis, horizontal x-y axis).

The acceptance tests will be done on live trays to verify the workmanship. The SSD should be kept free, without any accelerometer fixed on. As a consequence the tests could be performed either by simply verifying the trays' survival (current measure) or by means of a laser interferometer. Moreover, the fixture for the vibration tests should be verified daily before beginning the tests (TBD).

5.1 Test requirements

5.1.1 Sine sweep

The trays shall be subjected to low level sine sweep tests to determine the normal modes on the three axis (x, y and z) during the qualification by means of 5^g (TBR) accelerometers. The accelerometers should be as light as possible (0.6 grams, TBD).

5.1.2 Random Vibration

The prototype trays shall be qualified for the acceleration spectral density (ASD) levels shown in Table 5.1.2.-1, notched at the normal modes frequencies.

The flight trays shall be acceptance-tested for the acceleration spectral density (ASD) levels shown in Table 5.1.2.-1, notched at the normal modes frequencies.

Frequency(Hz)	ASD Level (g ² /Hz)	
	Qualification	Acceptance
20	0.026	0.013
20-50	+6 dB/oct	+6 dB/oct
50-800	0.16	0.08
800-2000	-6 dB/oct	-6 dB/oct
2000	0.026	0.013
Overall	14.1 g rms	10.0 g rms

Table 5.1.2-1: GEVS Table 2.4-4

5.1.3 Thermal cycling

The quality of workmanship and materials of the hardware shall pass a thermal cycle test screening at ambient pressure.

The TKR tray shall be capable of operating over the temperature ranges defined in table 5.1.3-1:

	Qualification test	Acceptance test
Low limit (°C)	-30 °C	-20°C
High limit (°C)	+50 °C	+40°C

Table 5.1.3-1: TKR tray temperature ranges

5.2 Test procedures

This section reports the procedures to be followed in the performance of qualification and acceptance tests.

5.2.1 Qualification test

5.2.1.1 Dynamic loads

This kind of test should be performed on dummy trays using accelerometers whose position on the tray/ladder/wafer is TBD.

The sequence of the qualification tests for each axis (z, x and y) will be as follows:

- Fixture verification;
- Sine sweep vibration (0.25÷0.5 g, TBR) in a frequency range 10÷2000 Hz, with 5 (TBR) accelerometers;
- Random vibration from 10 g rms (-6dB) to 14.1 g rms (0dB) levels, TBR, in a frequency range (10÷2000 Hz) with 5 (TBR) accelerometers;
- Sine sweep performed as before the random test in order to check the normal mode frequencies.

5.2.1.2 Thermal cycling

The thermal cycling qualification requires to verify the survival of the TKR tray to a -30°C÷+50°C temperature range.

The tray shall be subjected to 4 thermal cycles to be performed following GEVS requirements as reported below:

- Temperature range: $-30^{\circ}\text{C} \div +50^{\circ}\text{C}$;
- number of cycles = 4;
- 12 hr @ -30°C
- $dT/dt_{\text{max}} = 5^{\circ}\text{C/hr}$;
- 12 hr @ $+50^{\circ}\text{C}$
- **Time expected: 56 hr / cycle / tray**

5.2.2 Acceptance test

5.2.2.1 Dynamic loads

This kind of test should be performed on live trays in clean room in order to verify any structure damage by measuring the power supply current @ 100 V using a picoamperometer.

Every day, before the beginning of the tests, the fixture should be verified as in the qualification test procedure.

The sequence of the tests on each axis should be as follows:

- Measure of the current @ 100 V;
- Random vibration 10 g rms (TBR) in a frequency range $10 \div 2000$ Hz;
- Measure of the current @ 100 V .

5.2.2.2 Thermal cycling

The thermal cycling acceptance requires the verification of the TKR tray survival of the TKR tray to a $-20^{\circ}\text{C} \div +40^{\circ}\text{C}$ temperature range.

The tray shall be subjected to 4 thermal cycles to be performed as follows:

- Temperature Range: $-20^{\circ}\text{C} \div +40^{\circ}\text{C}$
- $\frac{1}{2}$ h @ -20°C
- $dT/dt_{\text{max}} = 0.5^{\circ}\text{C/min}$
- $\frac{1}{2}$ h @ $+40^{\circ}\text{C}$
- number of cycles: 4
- **Time expected: 5 hr / cycle / tray**