TKR Bottom Tray Static Test Plan

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TKR Mechanical Verification Matrix

- **Original TKR-Grid interface design was qualified in the EM Bottom Tray Static Qualification Test, but failed EM Dynamic Testing, thus requiring a re-design**
- **The new design will undergo a very similar qualification program, except as shown below**

EM Bottom Tray Passed Static Qual Test

EM Bottom Tray failed at this point

Hardware				OLD DESIGN Mechanical (Old Design)							NEW DESIGN Mechanical (New Design)							
Assembly Level	Unit Type	Component (ITEM)	Quantity	Static Load	Sine Burst (static equivalent acc.)	Sinusoidal vibration+modal survey	Random Vibe + modal survey	Acoustic	Pressure Profile	Mass Properties	Static Load	Sine Burst (static equivalent acc.)	Sinusoidal vibration+modal survey	Random Vibe + modal survey	Acoustic	Pressure Profile	Mass Properties	Comments
C	E	Tray panels	24				TW							TW				Vibe z-axis only
C	E	EM Joint Coupon	1								TQ							Cones & Stud Assy
C	E	EM Bottom Tray	2	TQ						M	QS						M	
C	E	EM Tracker Std. Trays	18	A			TW				A			TW				Vibe 5; z-axis only
S	E	EM Tracker Tower	1		TQ	TQ	TQ			M	A	TQ	TQ	TQ			M	
C	Q	Tray panels	19				TW							TW				Vibe z-axis only
C	Q	QM Bottom Tray	1	TQ						M	TQ						M	
C	Q	QM Tracker Std. Trays	18	A						M	A						M	
S	Q	QM Tracker Tower	1	A	TQ	TQ	TQ	A		M	A	TQ	TQ	TQ	A		M	
C	F	Tray panels	323			TA	TA						TA	TA				Vibe z-axis only
C	F	Flight Bottom Trays	17	TA							TA							
C	F	Flight Tracker Std. Trays	306															
S	F	Flight Tracker Towers	17		TA	TA	TA			M		TA	TA	TA			M	

Assembly Level
S= Subsystem
C= Component

Unit Type
F= Flight
Q= Protoflight
E= Engineering Model

Verification Method:
T= Test
A= Analysis
M= Measurement
TW=Workmanship Test
QS= Qual by Similarity
TQ= Test, Protoflight Level
TA= Test, Acceptance Level

Load Definitions and Summary

- **Flight Loads:** Loads induced into a structure as the result of launch loads, i.e. quasi-static accelerations, dynamic transients, and acoustic sound pressure. Flight loads are based on heritage and/or predicted from coupled loads and acoustic analyses.
- **Test Loads:** Loads induced into a structure as the result of ground testing. Test loads are typically meant to envelope flight loads, e.g.:
  - Acceptance Test Loads = 1.0 X Flight
  - Protoflight Test Loads = 1.25 X Flight
  - Qualification Test Loads = 1.25 X Flight (duration 2X protoflight)
- **Handling and Transportation Loads:** Loads induced into a structure as a result of ground handling, assembly, and integration or transport. Handling and transport loads are typically enveloped by the Flight Loads, but may have special requirements for proof testing (as in lift cases).
- **Peak Expected Loads:** The highest of Flight, Test, Handling and Transport Loads. Design Loads and margins should be based on peak expected loads (envelope all environments) to ensure structural performance and integrity through manufacturing, verification testing and launch.

- For the TKR Tower, the random vibration test loads define the Peak Expected Loads.
  - The acoustic analysis of the LAT shows TKR response more than 3dB below GEVS minimum workmanship levels.
  - This results in the Random Vibration Acceptance Test Levels, Protoflight Test Levels and Qualification Test Levels all being the SAME.
  - This means the Peak Random Vibration Test Loads for AT, PT, and QT are the SAME.

- **The TKR Bottom Tray static test must proof load every tray to the SAME Peak Expected Loads.**

Eccentric Cones Joint Coupon Static Engineering Development Test to Qualification Levels (Performed at SLAC)

- Objectives
  - Engineering confidence test to verify strength and performance of the TKR-Grid Interface design (i.e. cones and stud) to 1.25 X Flight and Peak Expected Loads
    - Envelope worst case loads and stresses at the TKR-Grid Interface
    - Load interface to qualification design loads
  - Identify Mechanical Characteristics of cones during assembly and disassembly
- Load Cases
  - Load in Z-direction, cycle load in tension and compression
  - While specimen is loaded, apply small shock loads (TBD) to joint to assess cone performance
- Test success criteria
  - Successful test completion is when all load cases have been performed and it is verified that no yielding, buckling, or fractures have been observed
    - A review of all pertinent data during the test, including deflections and strains to verify linearity and return to zero
    - Appropriate inspections (visual with high-magnification, dimensional, etc.) of the grid simulator assembly, cones and stud is to be performed after the test
- Limitations
  - The Grid simulator design for this test will be the old baseline (with press fit bushing and Keensert). There will not be a follow-up test with the flight Grid design because the flight design will be tested at the Protoflight Bottom Tray Static Test.

First Unit: Bottom Tray Static Test to Protoflight Levels (Performed at INFN)

- Objectives
  - The primary objective is to verify strength and performance of the TKR Bottom Tray design to 1.25 X Limit Loads and Peak Expected Loads
    - Envelope worst case loads and stresses at the TKR-Grid Interface
    - Load interface to Peak Expected Loads, i.e. a proof test for the random vibration loads
  - Combined loading conditions are not achieved in the joint coupon testing or acceptance tests. Apply combined loading condition on flexure due to
    - In-plane shear loads
    - Out-of-plane flexural loads
    - Installation and assembly loads
    - Loads or moments induced due to shim
  - Verify/Qualify installation procedure and process
  - Validate FEA Model of TKR Bottom tray assy
- Load Cases
  - Load in X-, Y-, XY- and Z-directions as performed in the original Hytec Static Test
  - While bottom tray is loaded to 100%, hold load for 30 seconds, or as deemed appropriate at the time of the test, to check for internal relaxation
- Test success criteria
  - Successful test completion is when all load cases have been performed and it is verified that no yielding, buckling, relaxation or fractures have been observed
    - A review of all pertinent data during the test, including deflections and strains to verify linearity and return to zero
    - Appropriate inspections (visual with high-magnification, dimensional, etc.) of the grid simulator assembly, cones and stud is to be performed after the test

Follow-on Units (17X): Bottom Tray Static Test to Acceptance Levels (Performed at INFN)

- **Objectives**
  - **The primary objective is to verify workmanship of the TKR Bottom Tray design to 1.00 X Limit Loads and Peak Expected Loads**
    - **Envelope flight loads and stresses at the TKR-Grid Interface**
    - **Load interface to Peak Expected Loads, i.e. a proof test for the random vibration loads**
- **Load Cases**
  - **Load in XY-direction (TBC by analysis), cycle load in tension and compression**
  - **While bottom tray is loaded to 100%, hold load for 30 seconds, or as deemed appropriate at the time of the test, to check for internal relaxation**
- **Test success criteria**
  - **Successful test completion is when all load cases have been performed and it is verified that no yielding, buckling, relaxation or fractures have been observed**
    - **A real-time review of all pertinent data during the test, including deflections and strains to verify linearity and return to zero**