Status and Design Features of the new NASA GRC Mechanical Vibration Facility (MVF)

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Test Facility Overview

• Environmental test capability for NASA’s future space programs is being developed at the Space Power Facility (SPF) at the NASA Glenn Plum Brook Station in Sandusky, OH.

• SPF will provide *one-stop shopping* for a wide variety of space environmental testing.

  **Environmental Facility Capability:**
  • Mechanical Vibration
  • Acoustic
  • Modal Floor
  • Thermal-Vacuum

• The focus of this presentation is the status and design of the Mechanical Vibration Facility (MVF).
Space Power Facility – Sandusky OH
Provide and Support Future NASA Testing

- Acoustic Testing
- Sine Vibration and Modal Testing
- Thermal Vacuum Testing

Disassembly Bay Area
Benham Corporation is Prime Contractor

* MVF Suppliers:

**TEAM**: Actuators & Spherical Couplings, Pad Bearings, etc.

**Data Physics**: Vibration Control System
MVF Primary Objectives

• Benham is tasked to design and deliver a Mechanical Vibration Facility (MVF):

  – Capable of base shaking a 75-ft, 75,000 lb, 23.67-ft CG, 18-ft diameter test article with single-axis sine excitation to 1.25-g vertically and 1.0-g horizontally from 5-to-150-Hz without repositioning the test article.

  – Capable of fixed-base modal testing the same test article (71-ft tall)
“The MVF requirements make it a higher capacity facility than any in existence - 50% greater payload capacity, 25% greater vertical force capacity and 50% higher frequency range than HYDRA (ESTEC), the current largest capacity (aerospace) vibration system.”

Note: MVF is capable 480,000 lbf vertically, and 170,000 lbf in each lateral direction.
Mechanical Vibration Subsystem – Close-up

**Horizontal Actuator Assembly (HAA)**
- Horizontal Actuator drives Table Horizontally
- Composed of Horiz. Actuator & Pad Bearing
- Pad Bearings Guides Table Vertically
  (Horiz. Actuator Mounting Pedestals Not Shown)

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**Vertical Actuator Assembly (VAA)**
- Vertical Actuators Drives Vertical Vibration
- Composed of Vertical Actuator & Spherical Coupling
- Spherical Couplings Permits Horizontal Motion
- Spherical Coupling Restrains overturning Moments
  (With Vertical Actuators Locked Down)
MVF with Vibration Table Removed

- Table Supports (4)
- Access under the Vibration Table
- Horizontal Actuators Assemblies (4)
- Vertical Actuator Assemblies (16)
- Air Bag stands (4)
MVF Operation – Overview

Movies

• Vertical Shake
  Vertical Motion Movie.wmv

• Horizontal Shake
  BIAXIAL PLAN VIEW Y MOTION.wmv

• Spherical Coupling
  Sherical Coupling-Double Animation WMF.wmv

Note: MVF is capable of 6-DOF, but the MVF Controller would require modification
Testing has been performed for Vertical Actuators
MVF Lifts (Concrete Pours)

SPF Finished Floor

Pour #5 (8")

Pour #4

Pour #3

Pour #2

Pour #1

19'

10' 10"

2' 2"

4-ft Concrete

4" Mud Mat (min)

Shale

Base for MVF Horizontal Actuators

Bottom of MVF Pit

Not to Scale
December 2008 - Construction Baseline
Starting Point: 4” Mud Mat on Floor of 19-ft deep pit, and Shotcrete/Anchored Vertical Walls
December 2008 – Rock Bolt Driller
April 2009 – Rebar for Pour #1
June 2009 – Pour #1

North Wall
June 2009 - Pour #1 – Complete

North
June 2009 - Pour #2 – Rebar & Formwork
June 2009 - Pour #2 – Complete

North Wall
July 2009 - Pour #3 – Formwork

North Wall
August 2009 - Pour #4 – Rebar

North Wall
September 2009 – Pour #4 Forms Removed
October 2009 - Tensioning Rock Bolts

90 of 106 Rock Anchors Tensioned to 208,000 lbs
Remaining 16 will be Tensioned when Horizontal Pedestals Installed
November 2009 – Pour #5 Complete

North Wall
Summary: Started w/ Empty 19-ft pit in December 2008
**December 2009**

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>4.4 million lbs (1038 cu yds)</td>
</tr>
<tr>
<td>Rebar</td>
<td>11.2 miles (79 tons)</td>
</tr>
<tr>
<td>Rock Anchors</td>
<td>20.4 million lbf (106)</td>
</tr>
<tr>
<td>Tension Anchors</td>
<td>11.1 million lbf (178)</td>
</tr>
</tbody>
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Mechanical Vibration Facility

- Will be able to accommodate single-axis sine excitation for 75,000 lb test article with 23.67-ft CG and 18-ft diameter to 1.25-g vertically and 1.0-g lateral from 5 to 150 Hz without rotating test article.

- Space and the MVF reaction mass is designed to accommodate even larger diameter test articles.
Looking Forward

- Vertical Actuators – Completed
- Spherical Couplings – Completed
- Horizontal Actuators Complete – June 2010
- MVF Table Complete – June 2010
- MVF Assembly Complete – August 2010
- Benham Verification of MVF Complete – April 2011
- NASA Integrated System Testing – Summer 2011
- Available for Testing – Fall 2011

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