



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

**Presented by: Kim D. Otten
NASA Glenn Research Center
Kim.D.Otten@nasa.gov**

**Co-authors: Kim D. Otten,
Vicente J. Suarez, Dzu K. Le
NASA Glenn Research Center**



May 3rd – 6th 2010



Test Facility Overview

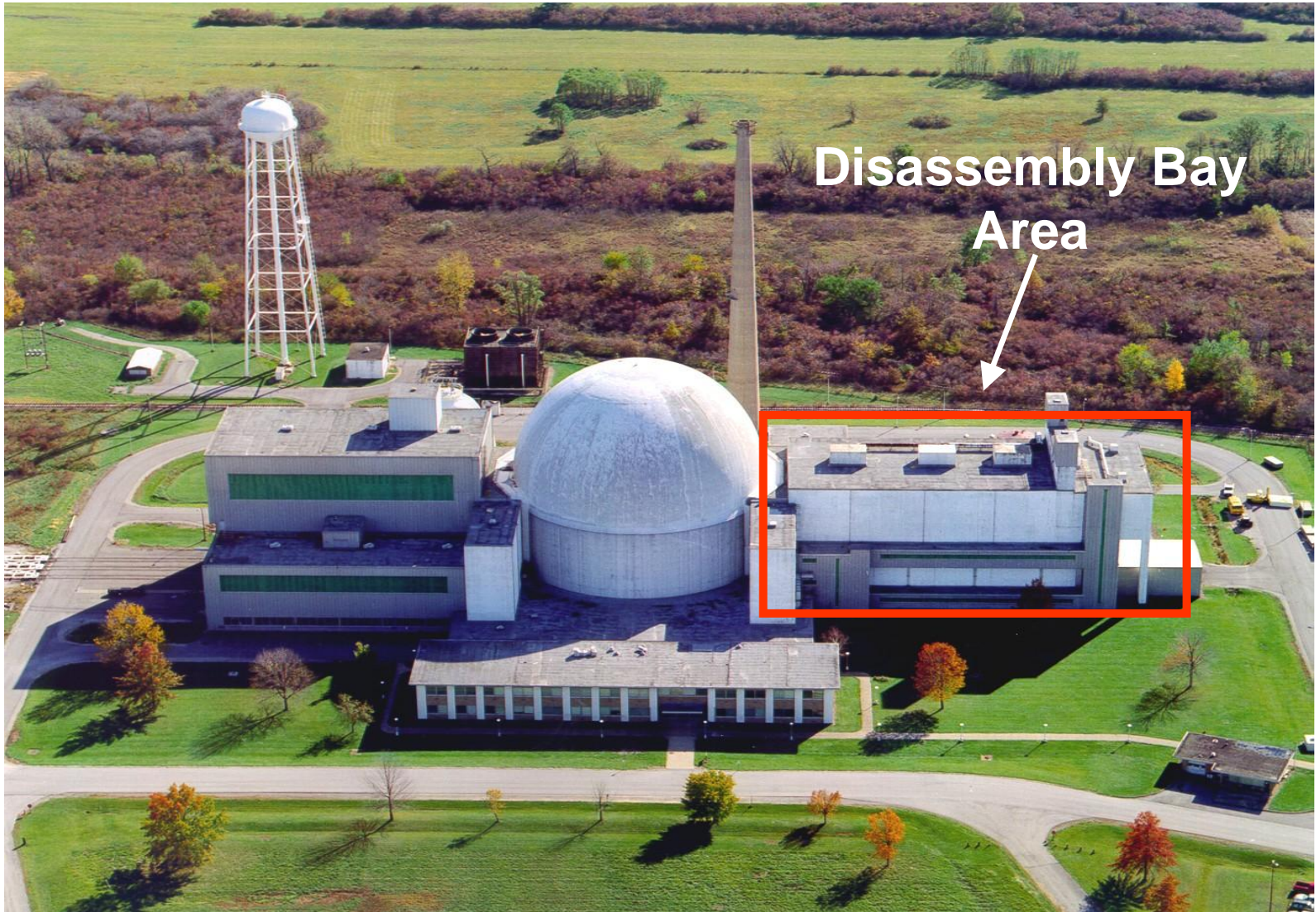
- Environmental test capability for NASA's future space programs is being developed at the Space Power Facility (SPF) at the NASA Glenn Plum Brook Station in Sandusky, OH.
- SPF will provide *one-stop shopping* for a wide variety of space environmental testing.

Environmental Facility Capability:

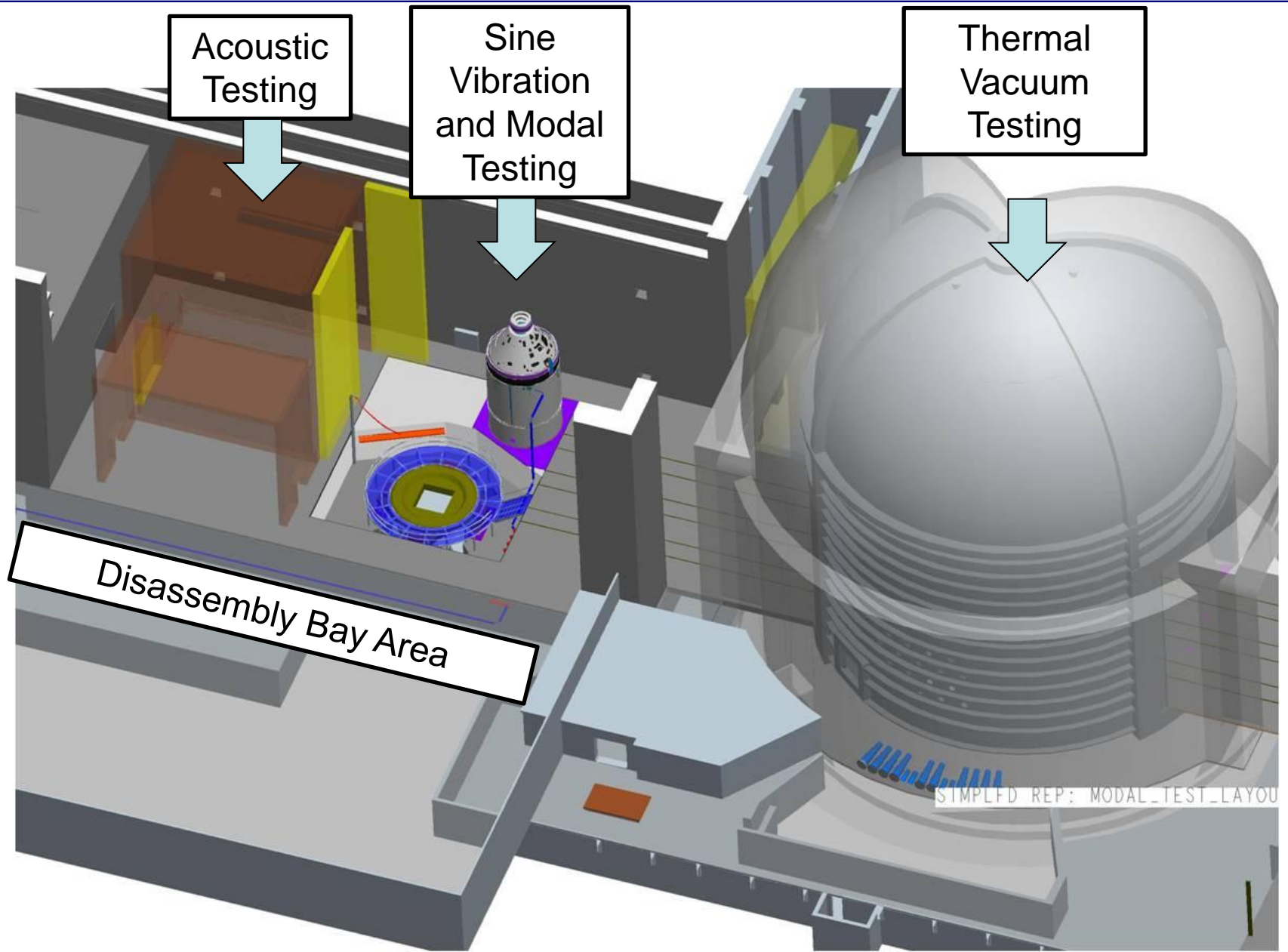
- Mechanical Vibration
 - Acoustic
 - Modal Floor
 - Thermal-Vacuum
-
- The focus of this presentation is the status and design of the Mechanical Vibration Facility (MVF).



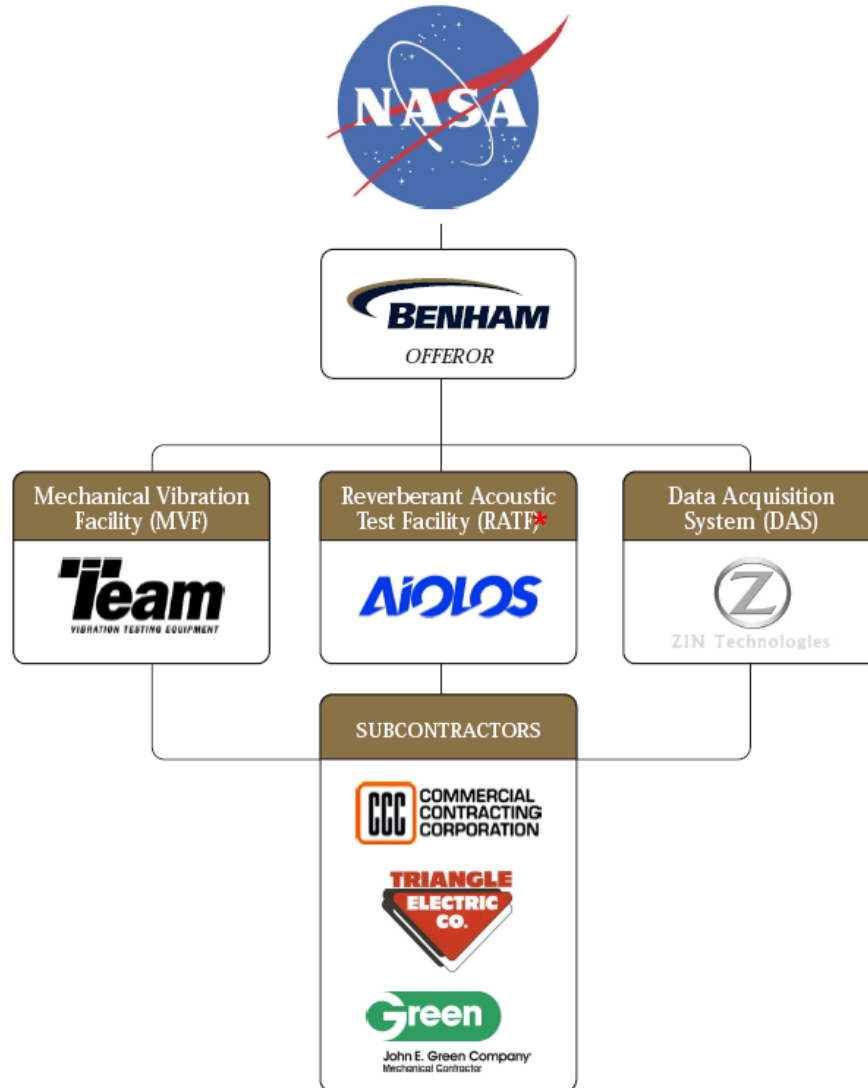
Space Power Facility – Sandusky OH



Provide and Support Future NASA Testing



Benham Corporation is Prime Contractor



* MVF Suppliers:

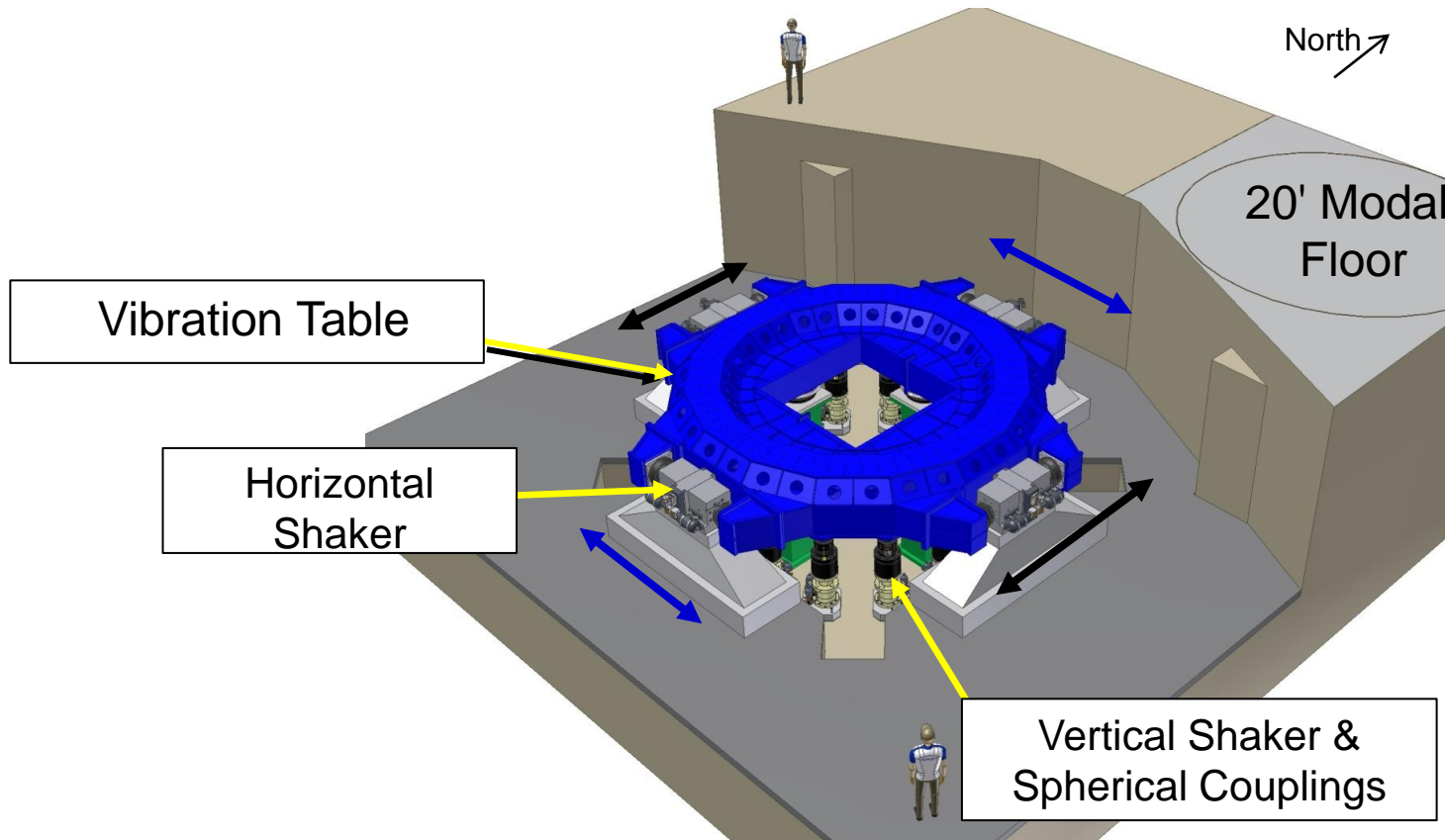
TEAM: Actuators & Spherical Couplings, Pad Bearings, etc.

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)

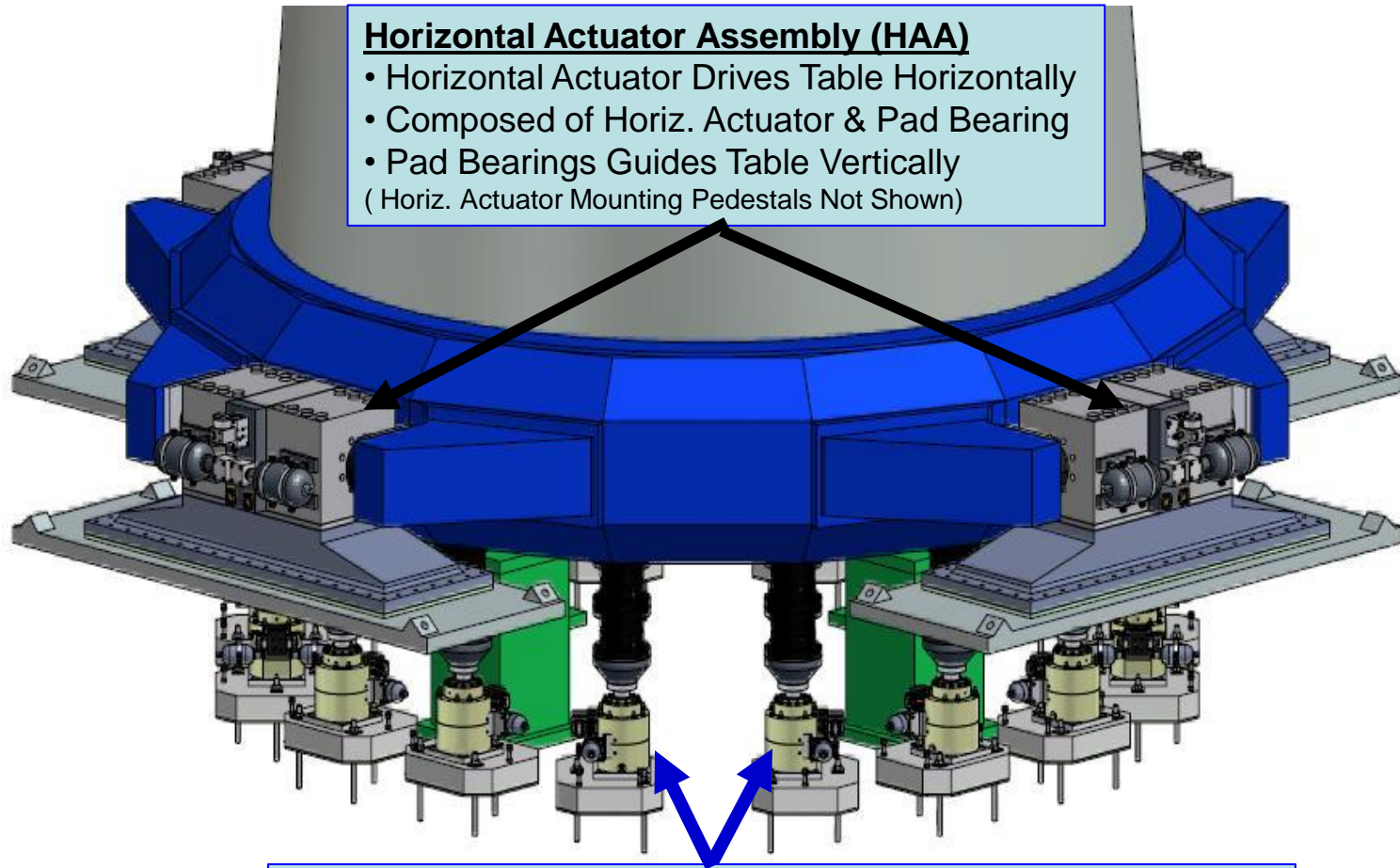
Mechanical Vibration Facility (MVF)



“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



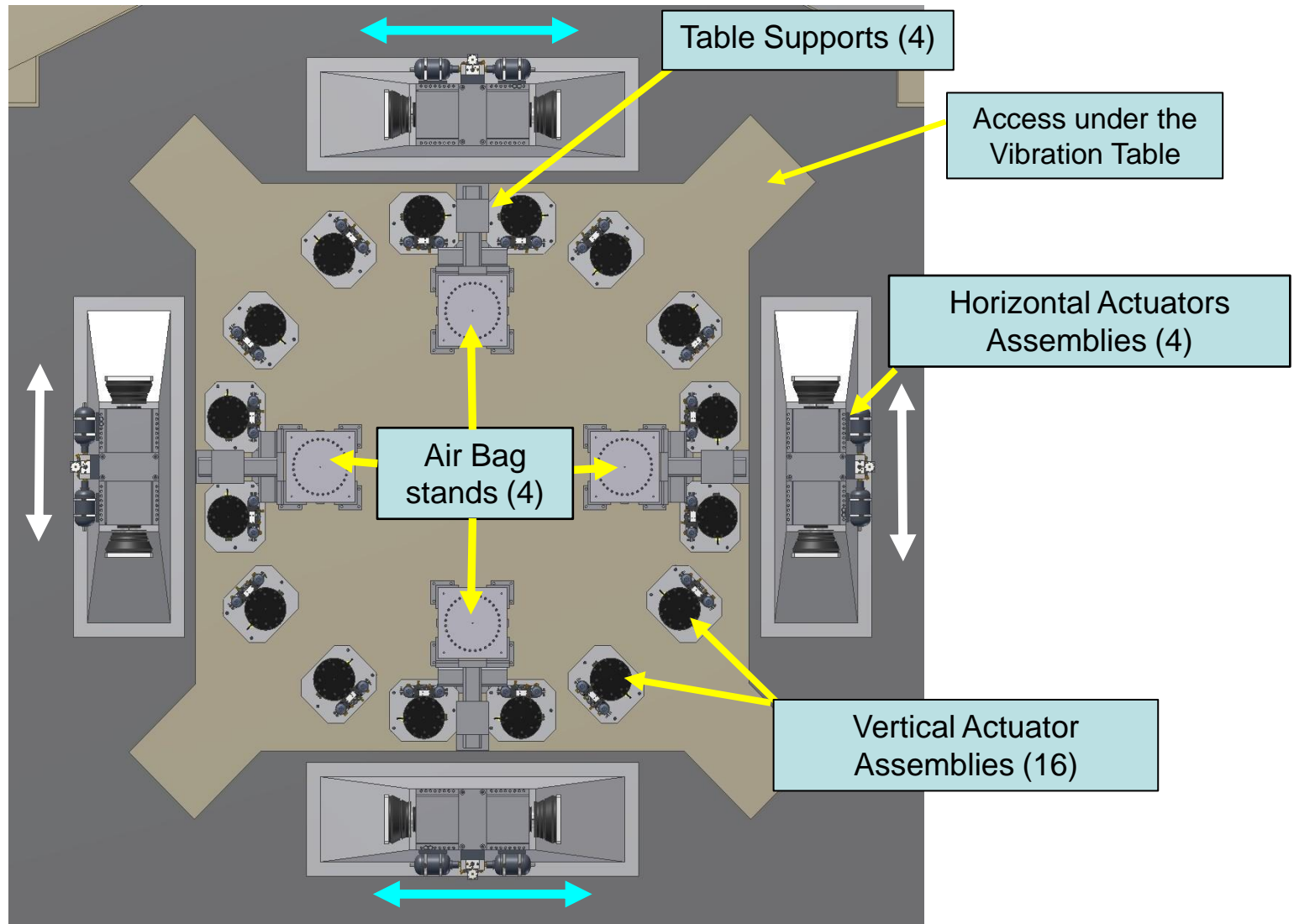
Horizontal Actuator Assembly (HAA)

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

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

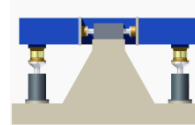


MVF Operation – Overview

Movies

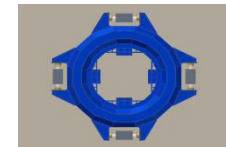
- Vertical Shake

Vertical Motion Movie.wmv



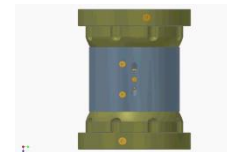
- Horizontal Shake

BIAXIAL PLAN VIEW Y MOTION.wmv



- Spherical Coupling

Spherical 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

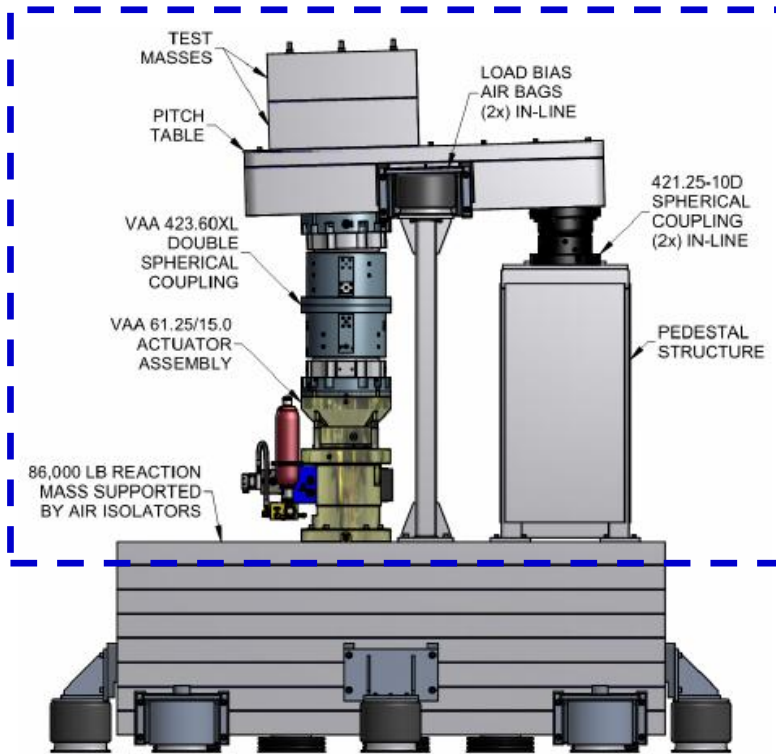
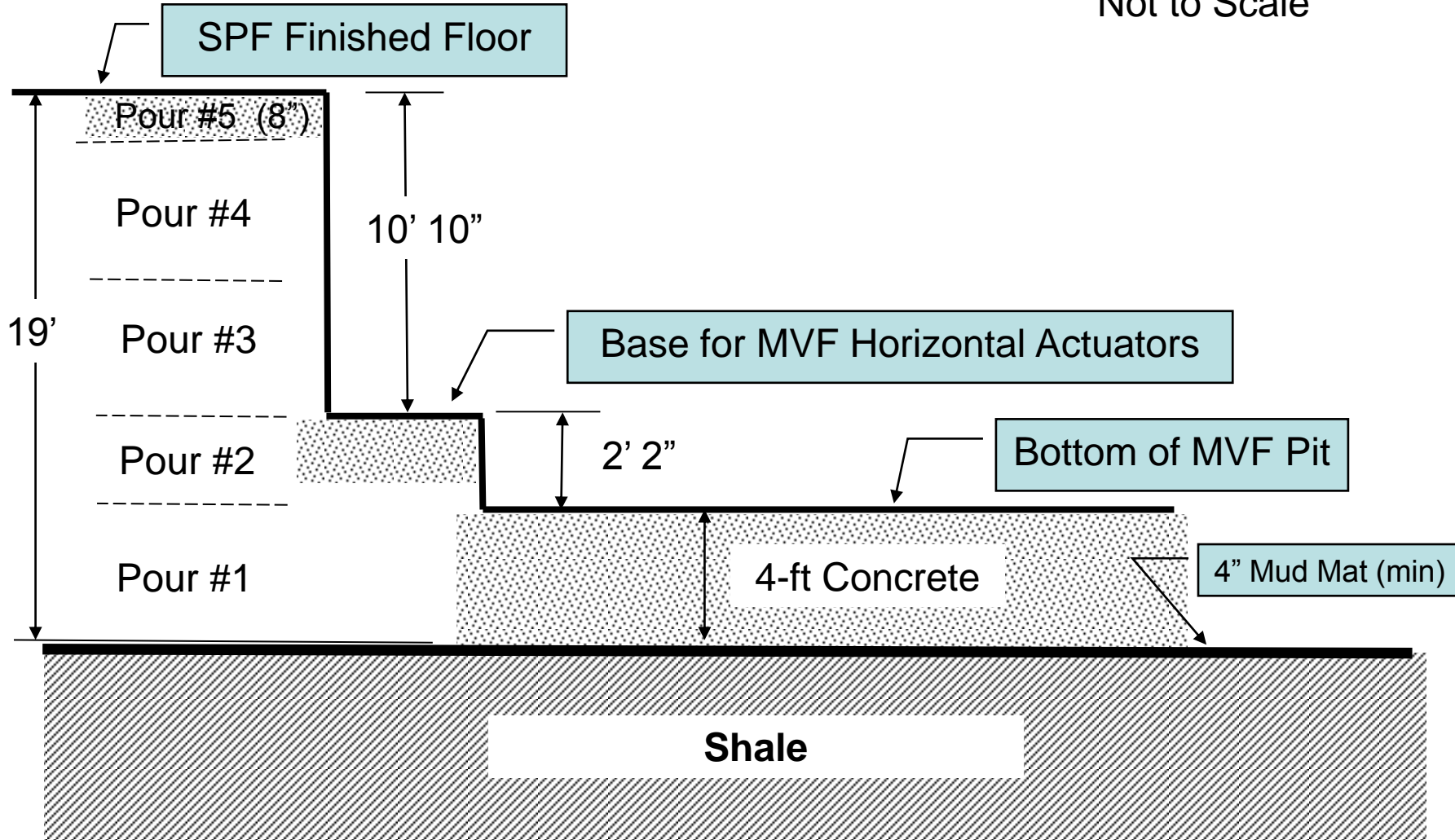


Figure 2: VAA Factory Verification Test Rig



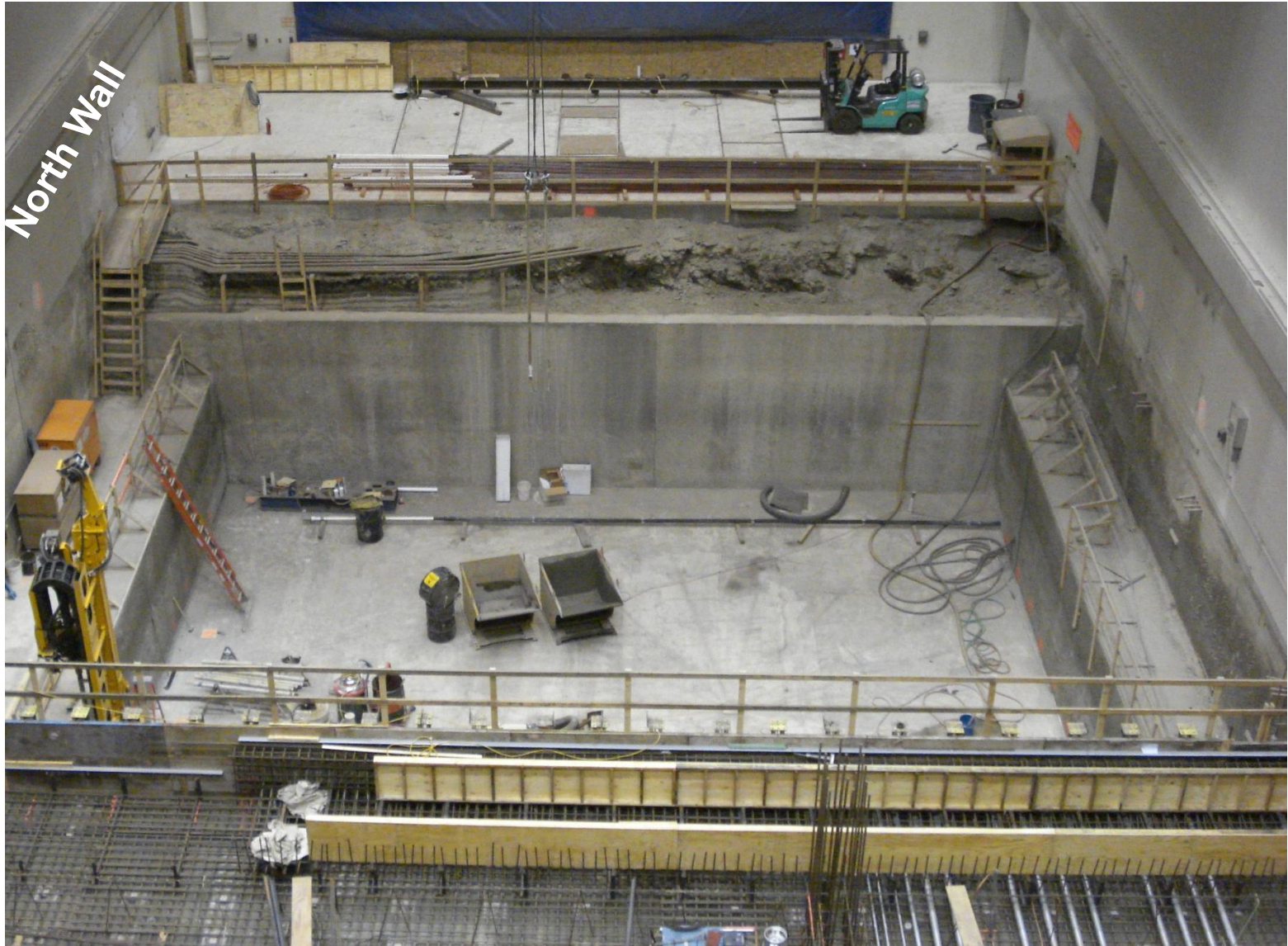
MVF Lifts (Concrete Pours)

Not to Scale



December 2008 - Construction Baseline

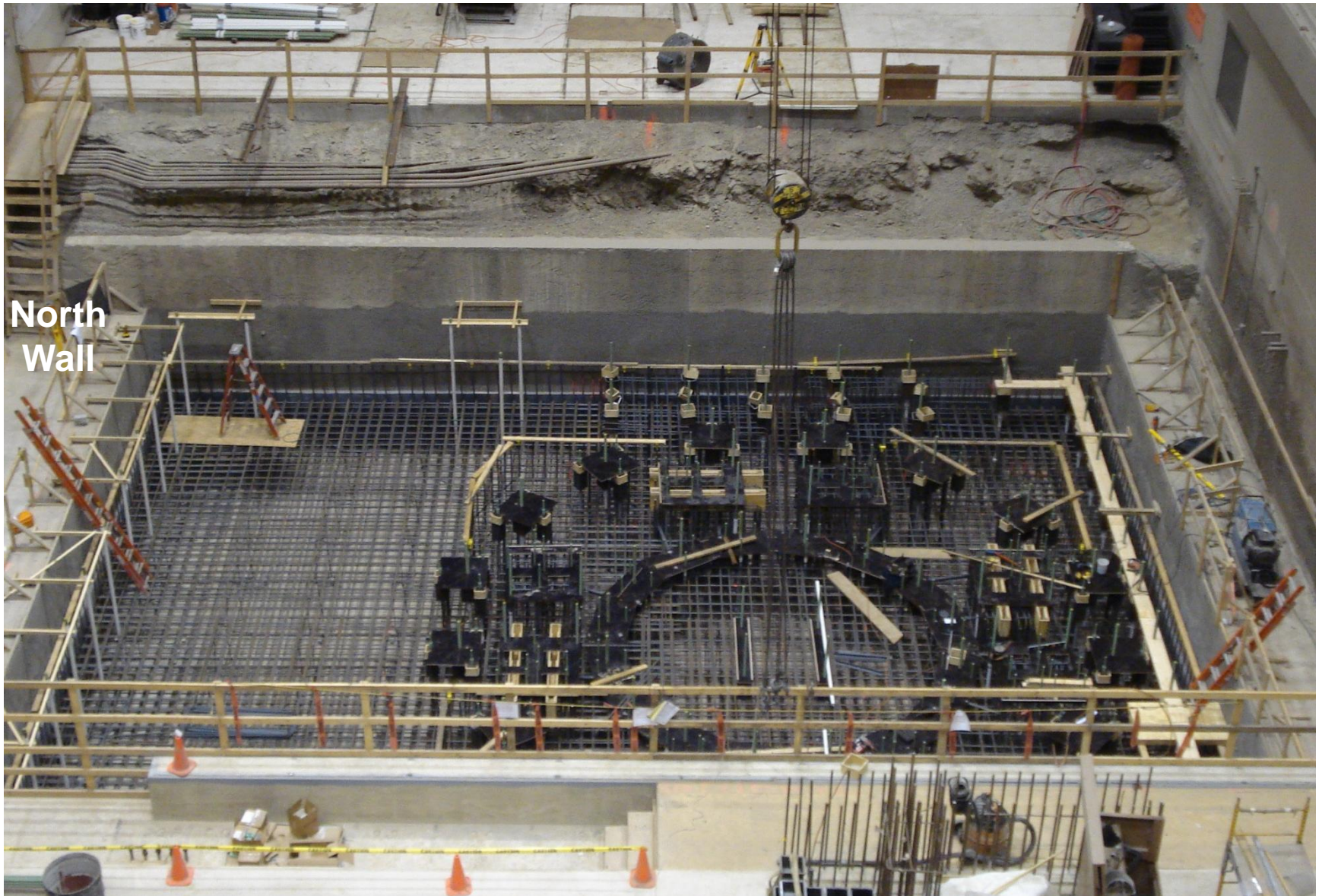
Starting Point: 4" Mud Mat on Floor of 19-ft deep pit, and Shotcrete/Anchored Vertical Walls



December 2008 – Rock Bolt Driller



April 2009 – Rebar for Pour #1

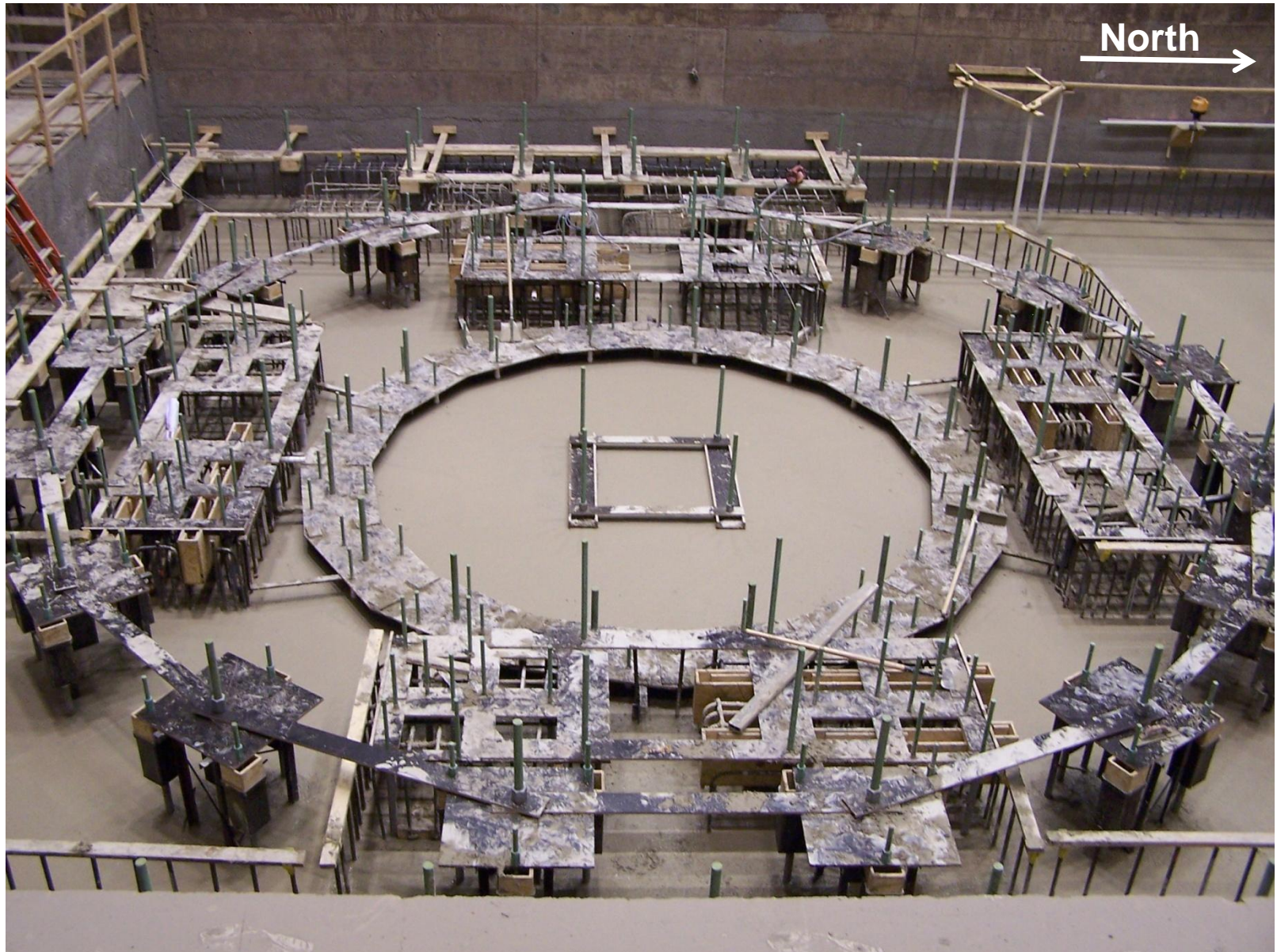


June 2009 – Pour #1



North
Wall

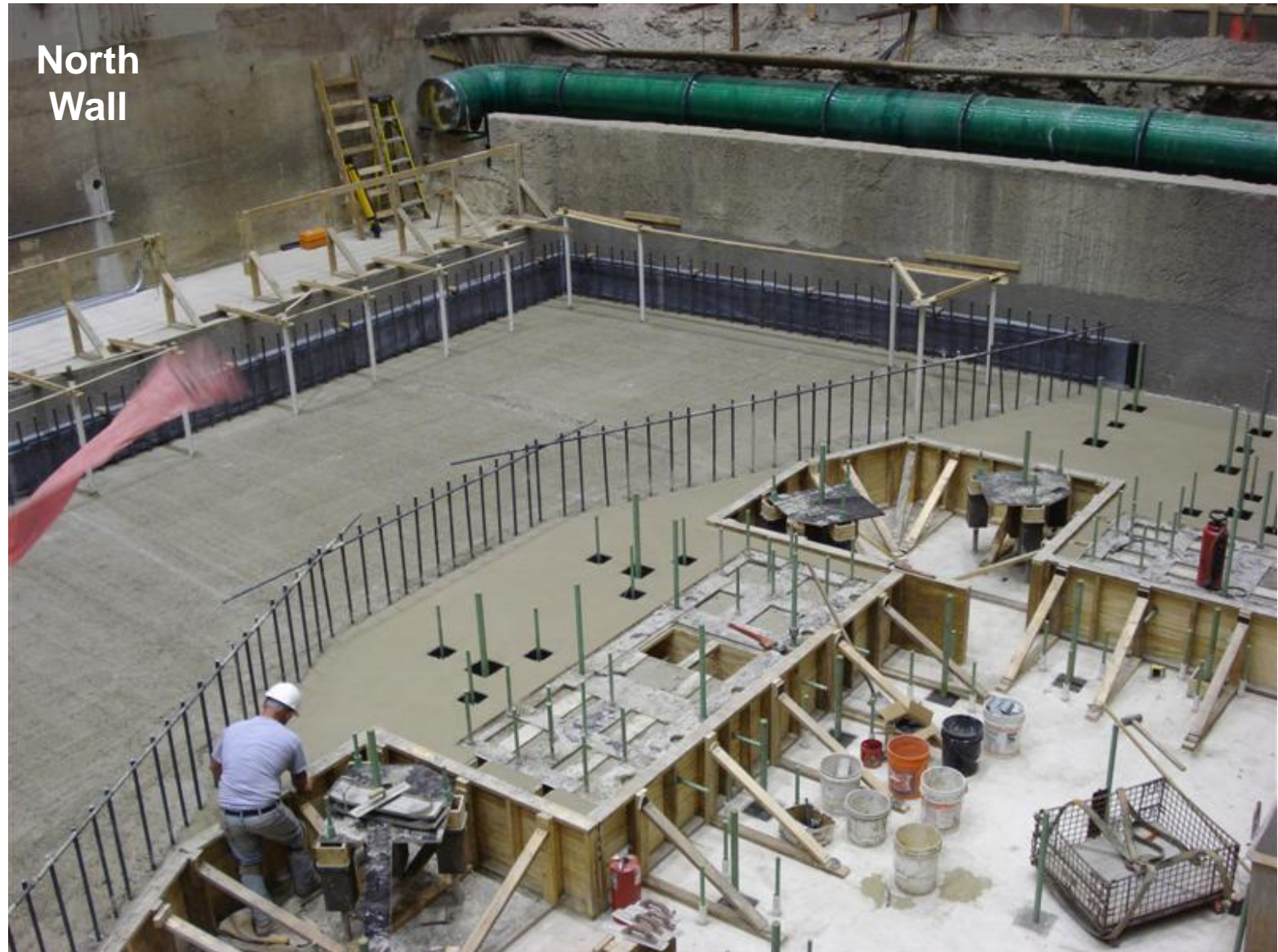
June 2009 - Pour #1 – Complete



June 2009 - Pour #2 – Rebar & Formwork

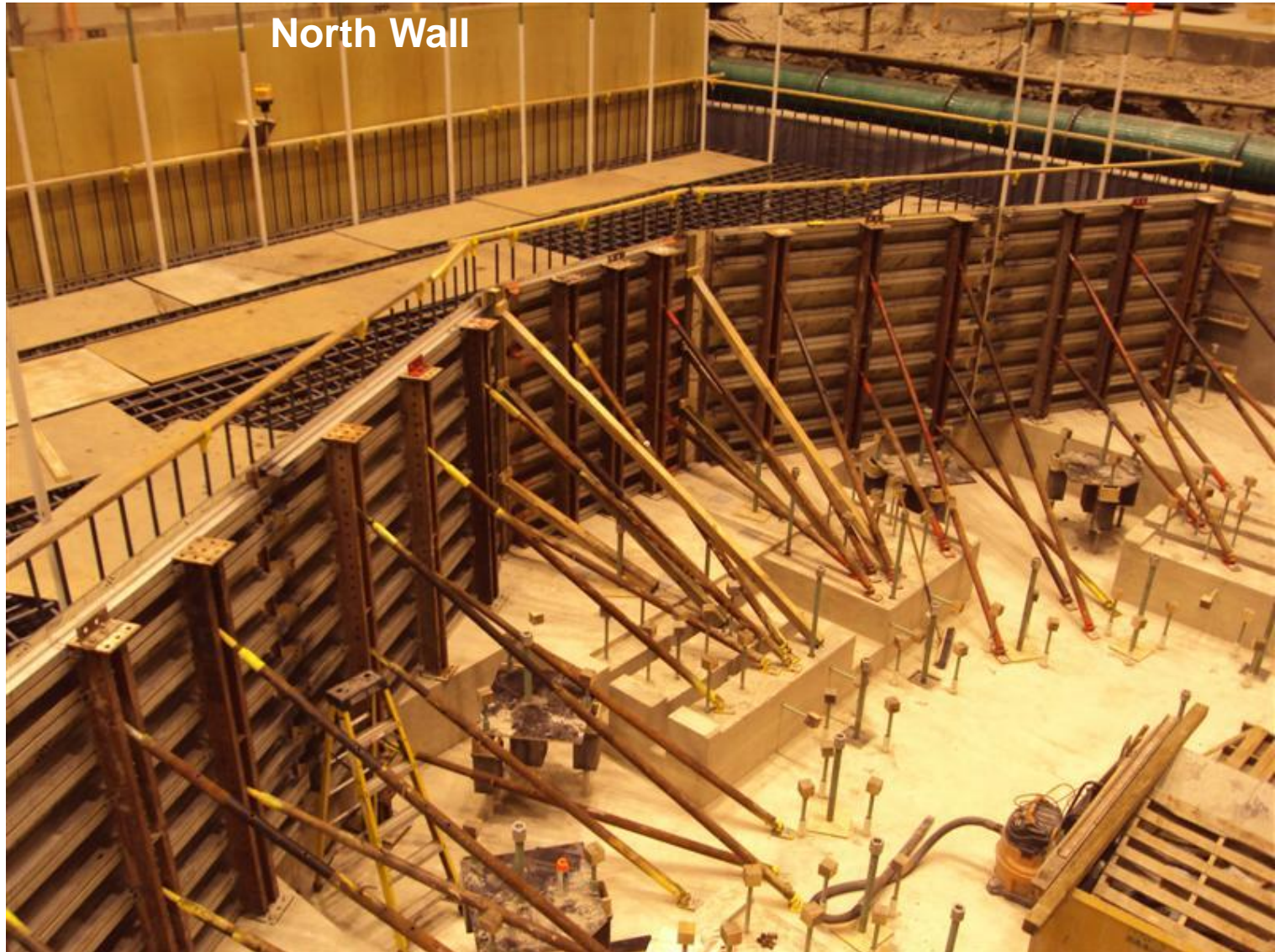


June 2009 - Pour #2 – Complete



North
Wall

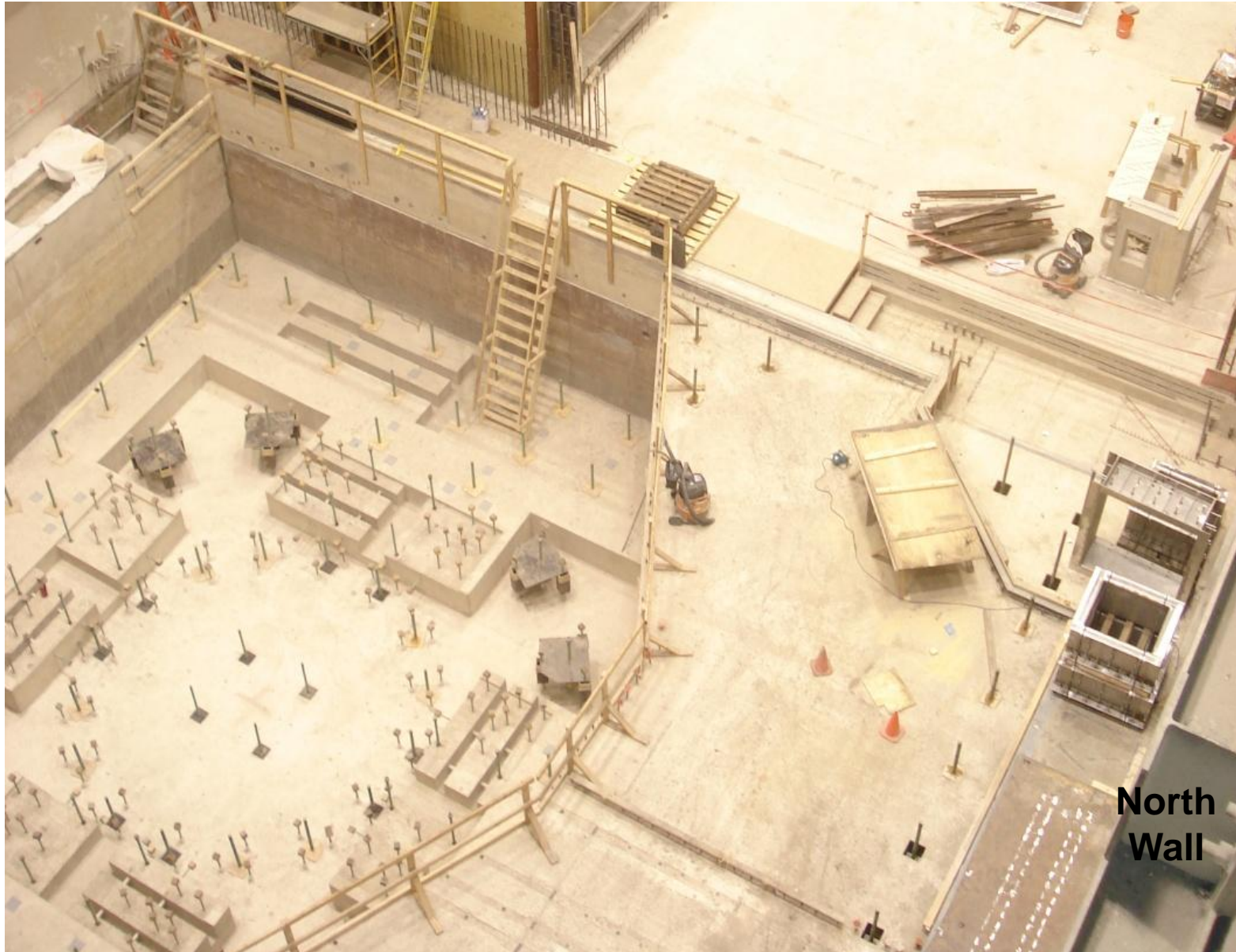
July 2009 - Pour #3 – Formwork



August 2009 - Pour #4 – Rebar



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



Summary: Started w/ Empty 19-ft pit in December 2008



December 2009

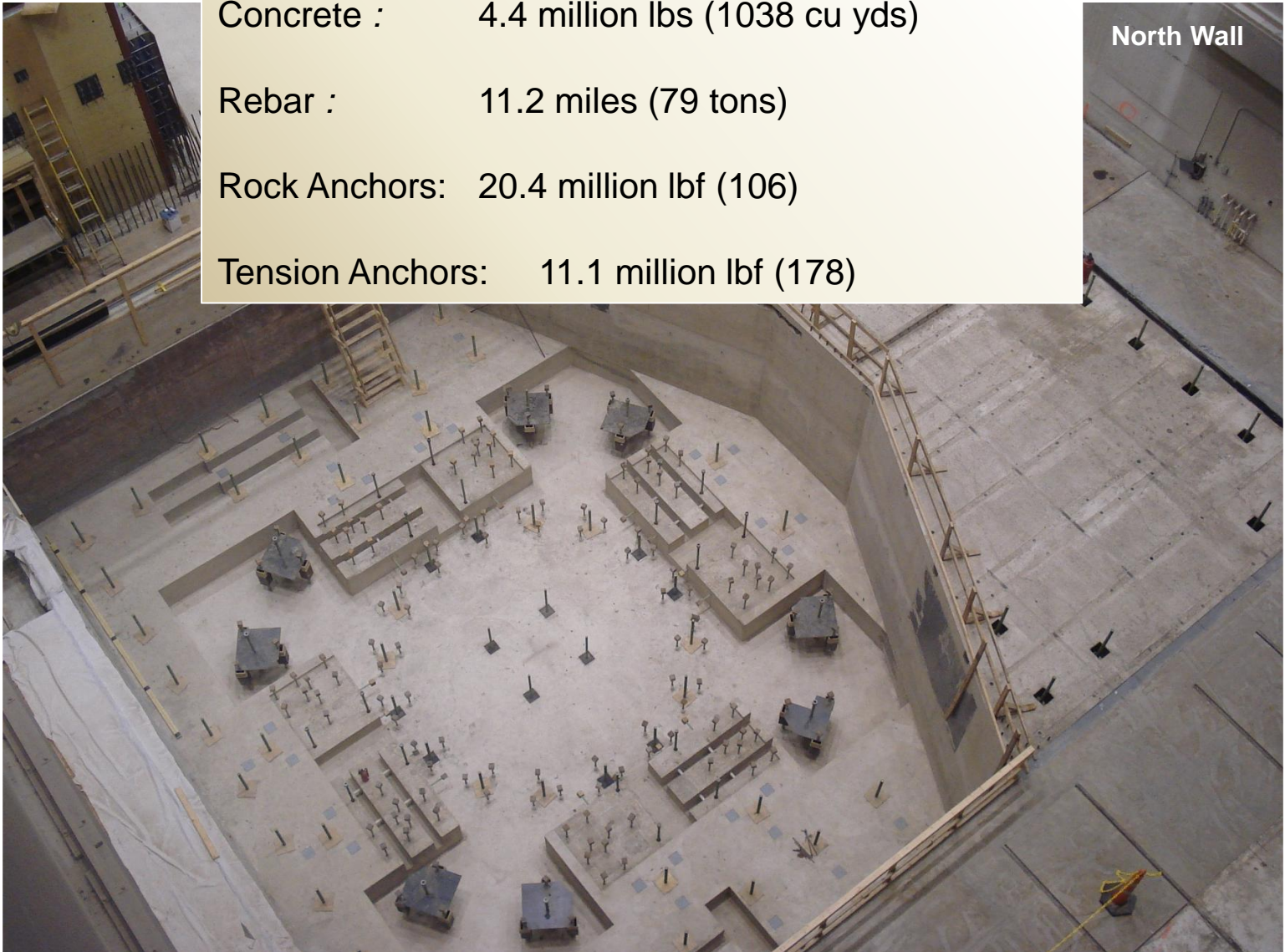
Concrete : 4.4 million lbs (1038 cu yds)

Rebar : 11.2 miles (79 tons)

Rock Anchors: 20.4 million lbf (106)

Tension Anchors: 11.1 million lbf (178)

North Wall



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.

**32-ft Diam
Footprint**

**Modal Plate
Area**

**18-ft Diam.
Footprint**

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

For MVF Testing, Contact
Mr. Jerry Carek,
Phone: (419)-621-3219, Gerald.A.Carek@nasa.gov



Contact Information:
Kim Otten
NASA Glenn Research Center
Kim.D.Otten@nasa.gov

