

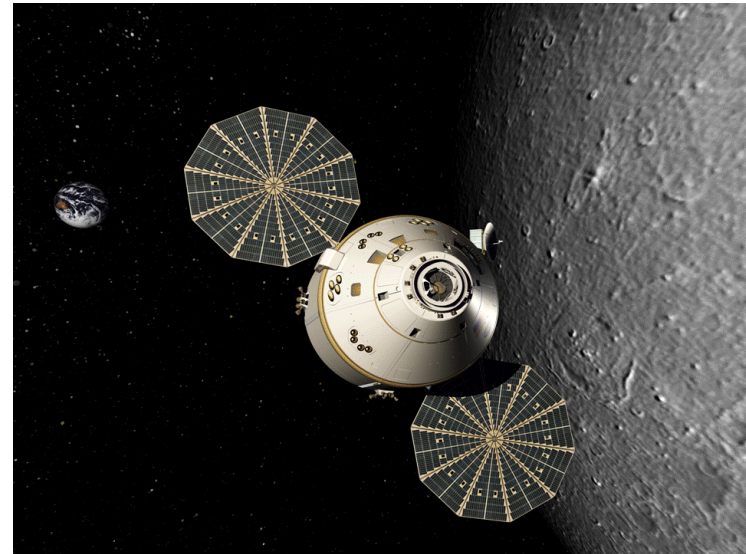
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# Overview of the Orion Vibroacoustic Test Capability at NASA Glenn Research Center

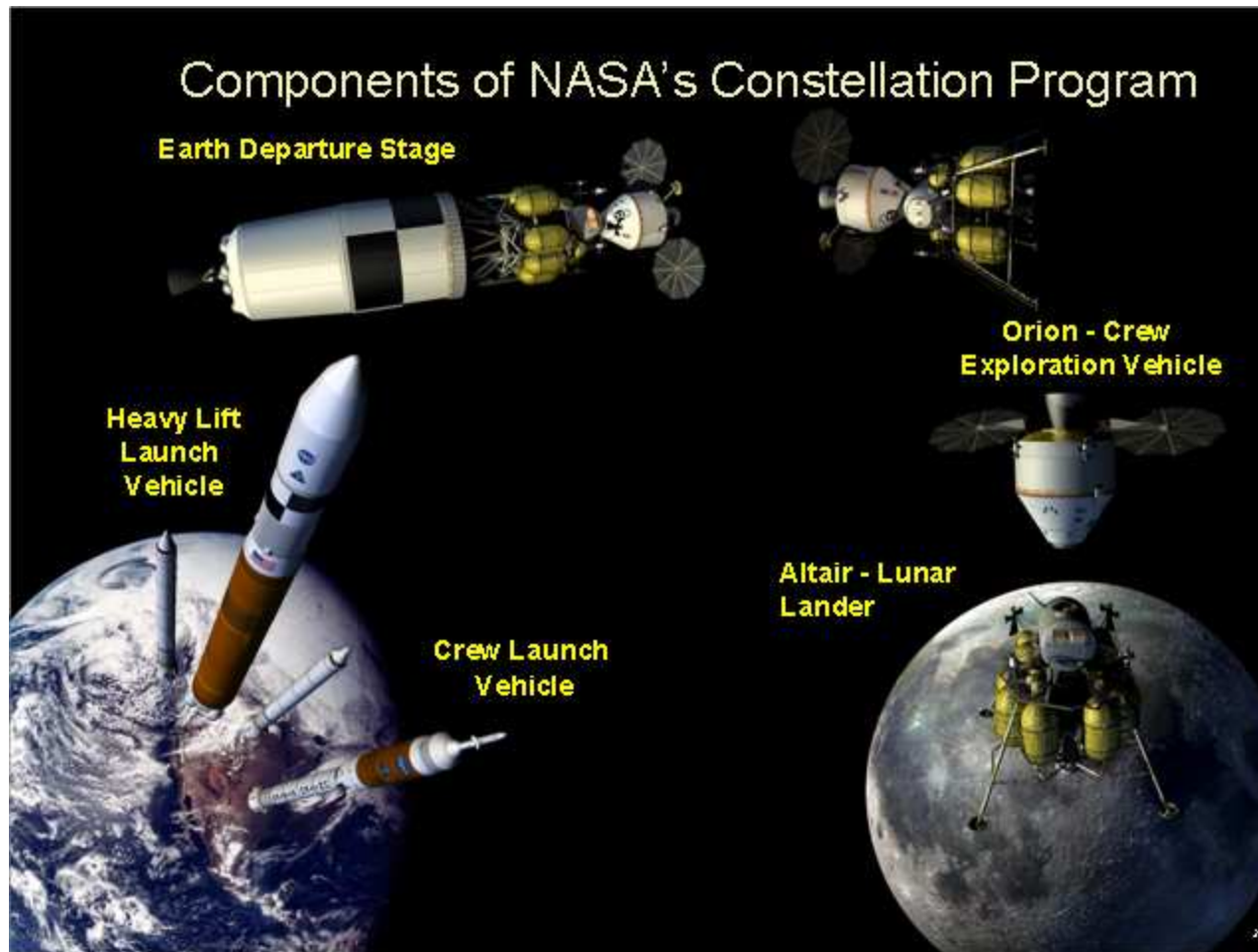
William Hughes  
Aron Hozman  
Mark McNelis  
Kim Otten

NASA Glenn Research Center  
Cleveland, OH

June 10-12, 2008

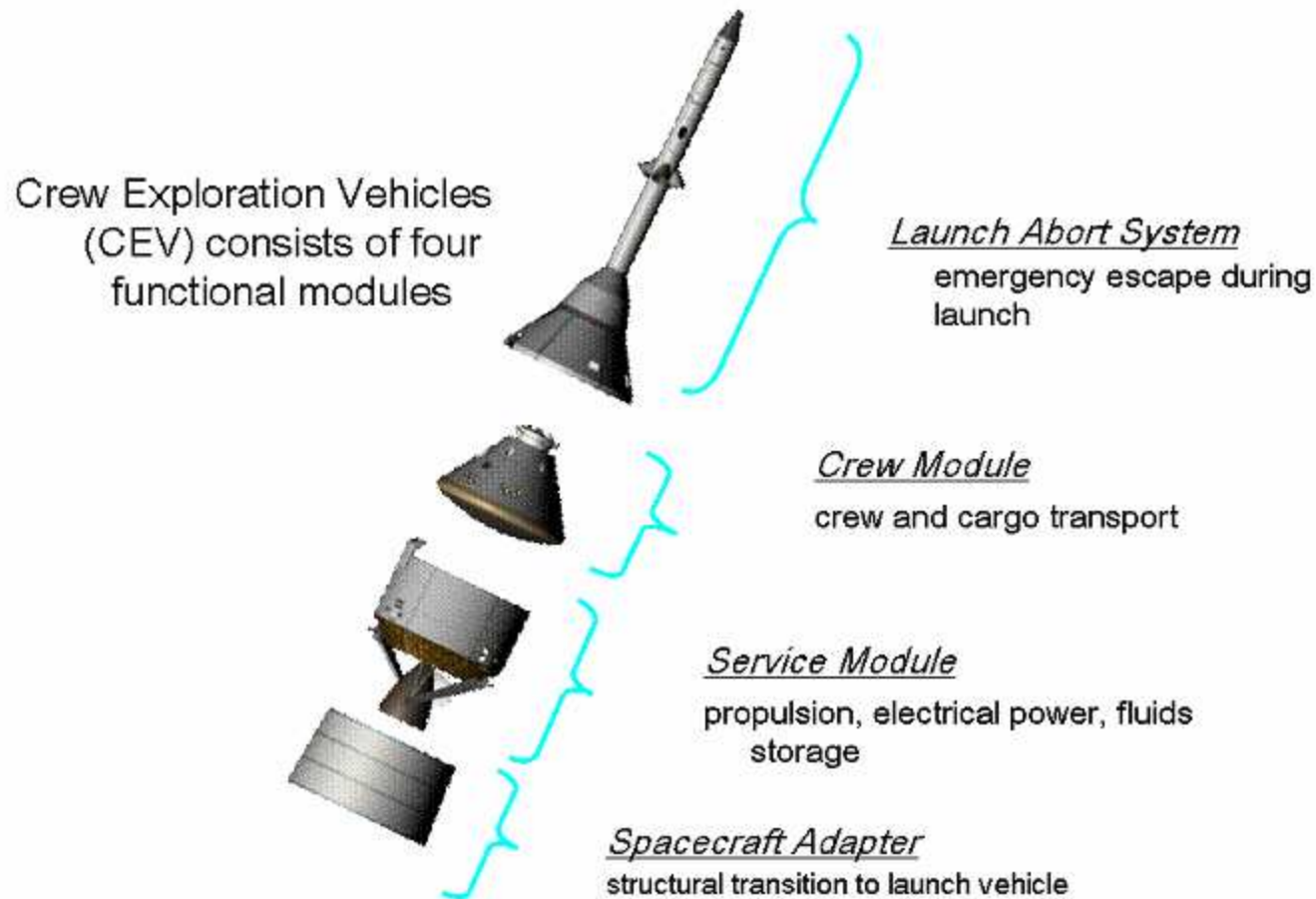


# Components of NASA's Constellation Program



# Orion System Elements

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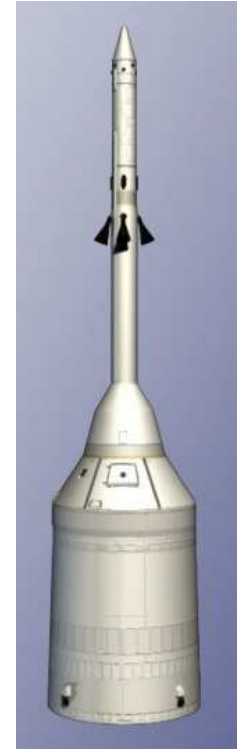
# Test Facility Overview

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- The Space Power Facility at the NASA Glenn Plum Brook Station in Sandusky, OH is developing an environmental test capability for the NASA Constellation Program, and the Orion Crew Exploration Vehicle (CEV).
- The CEV is part of the next generation of manned space flight vehicles being developed for return to the Moon and for Mars.
- Testing will be conducted on the Ground Test Article (GTA) and Qualification Test Article in a “test as you fly” configuration.

## Environmental Facility Capability:

- Acoustic Vibration
- Mechanical Vibration
- Modal
- Thermal-Vacuum
- EMI/EMC



**Crew  
Exploration  
Vehicle**



# Plum Brook Station



# Space Power Facility (SPF)

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# Space Environmental Testing Under One Roof

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- Maintain thermal vacuum test capability of SPF.
- Incorporate EMI/EMC testing within vacuum test chamber.
- Design and build two new vibroacoustic test capabilities within disassembly (west) area of SPF Facility
  - Mechanical Vibration Facility (MVF) (sine and modal)
  - Reverberant Acoustic Test Facility (RATF)
- Vibroacoustic facilities required to be commissioned (verification testing successfully completed) by July 2009.





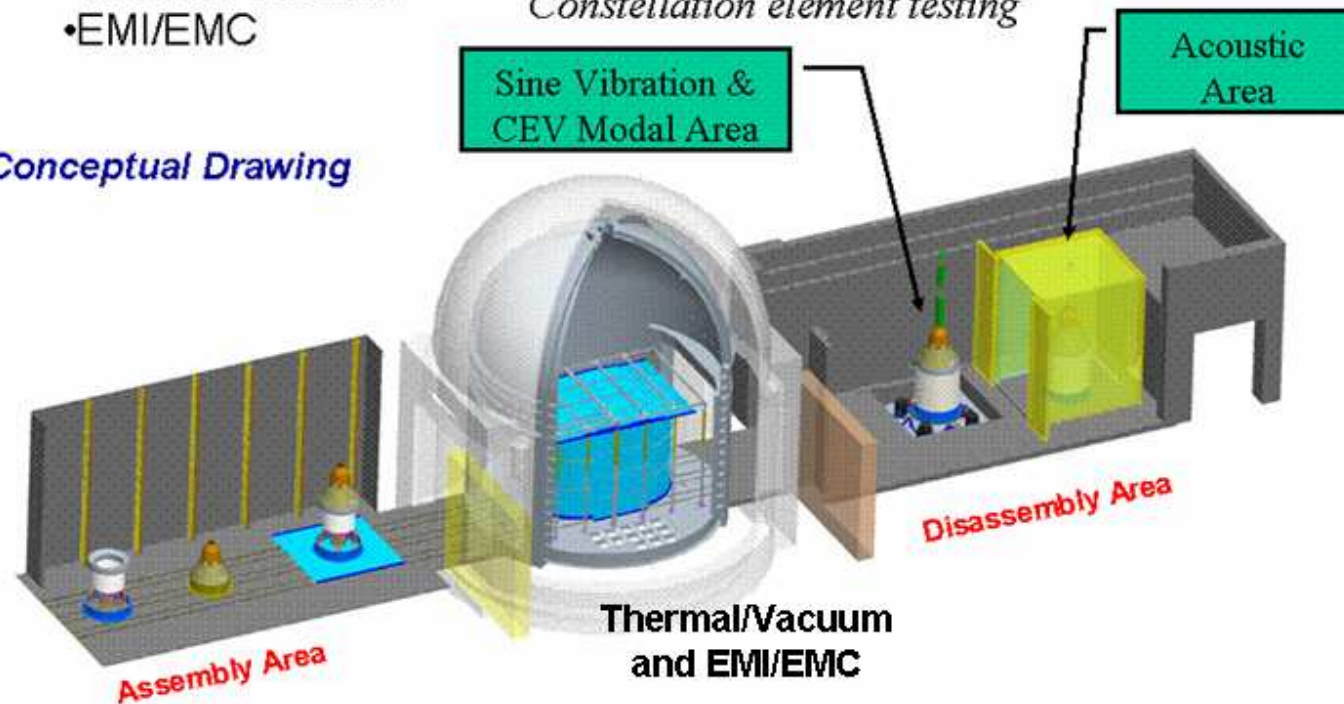
# Provide Orion Critical Path Testing and Support Future Constellation Testing

Perform modifications to the Space Power Facility for:

- Acoustic Vibration
- Mechanical Vibration
- Modal
- Thermal-Vacuum
- EMI/EMC

*Ensure Mechanical and Acoustic Vibration Facilities capabilities meet CEV Testing requirements and do not preclude future Constellation element testing*

*Conceptual Drawing*

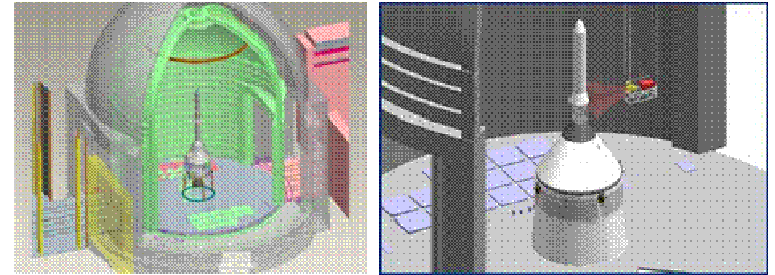




# Thermal Vacuum & EMI/EMC

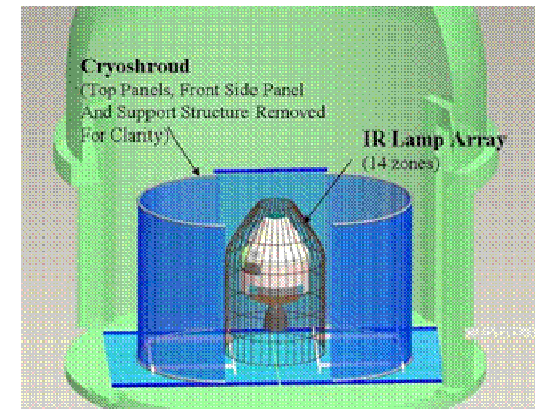
## Thermal Vacuum

- Vacuum to 10<sup>-6</sup> torr; 100 ft Diameter, 122 ft Height
- Thermal simulation: -200 F to 175 F
  - GN2-cooled Cryoshroud
    - 2 new ceiling cryogenic panels (1700 ft<sup>2</sup> total)
    - Modify cryoshroud suspension structure and refurbish existing cryoshroud panels.
  - Thermal heat flux simulation (14 zones, 480 V)
    - 1 sun thermal heat flux
    - Phase angle power supply controllers
    - 14 zones, 400 kW/zone



## EMI/EMC

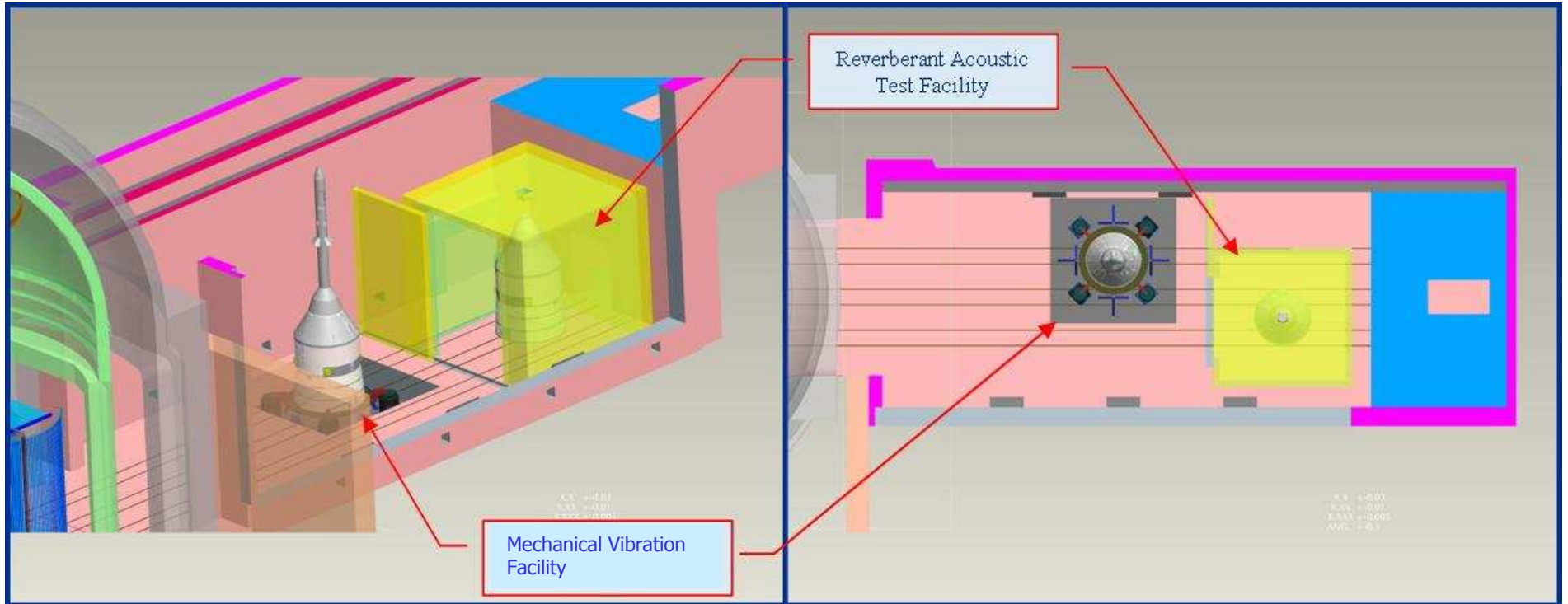
- All tests are performed inside the aluminum vacuum chamber using the chamber as an RF shield
  - Unwanted, external signals stay outside test chamber
  - Signals generated for tests remain inside test chamber
- Suspended, moveable equipment platforms provide direct, localized RF illumination of the vehicle
- Radiated susceptibility and shielding effectiveness testing at frequencies up to 35 GHz



# Major Area for Facility Upgrades

## Vibration Test Area

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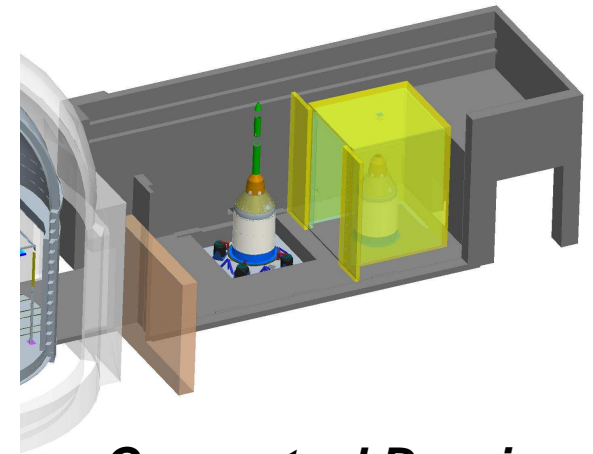


*Conceptual Drawing*

# Vibro-Acoustic Test Capability (VTC)

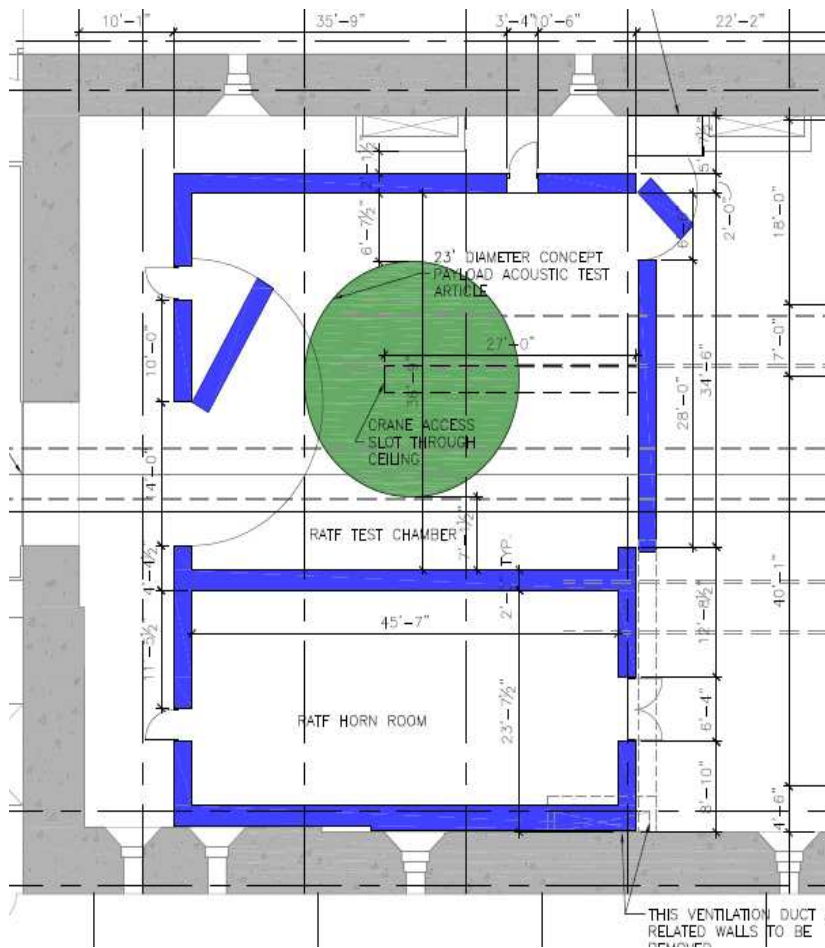
## Technical Requirements Highlights

- Mechanical Vibration Facility (MVF)
  - Single axis sine vibration (vertical, lateral)
  - CEV test article: 75,000 lb, 75 ft height, 18 ft diameter
  - Design for Overturning Moment of CEV
  - Change axis of input motion without removing the test article
  - Seismic mass to accommodate 120,000 lbm test article for modal
- Reverberant Acoustic Test Facility (RATF)
  - 163 dB OASPL (empty chamber)
  - 20 minute continuous run times
  - Designed for 47 ft tall x 20 ft diameter (CEV elements with margin)
  - Accommodates Altair - Lunar Lander (32.8 ft diameter)
- High-Speed Data Acquisition System (HSDAS)
  - 1024 channels dynamic data
  - Acceleration, pressure, strain, temperature
  - Support both MVF and RATF needs



**Conceptual Drawing**

# Reverberant Acoustic Test Facility (RATF)



	Chamber Properties
Chamber Size	47.5 ft L x 37.5 ft W x 57 ft H
Chamber Volume	101,189 ft <sup>3</sup>
Horns/Modulators	23 High Power Modulators and 23 Horns *
Nominal acoustic power installed	4,000 kW *
Nominal GN <sub>2</sub> flow rate	84,000 scfm *
Main Door Opening	34.5 ft wide
Number of Main Doors	2
Door Type	Sliding and hinged
OASPL, empty	163 dB OASPL

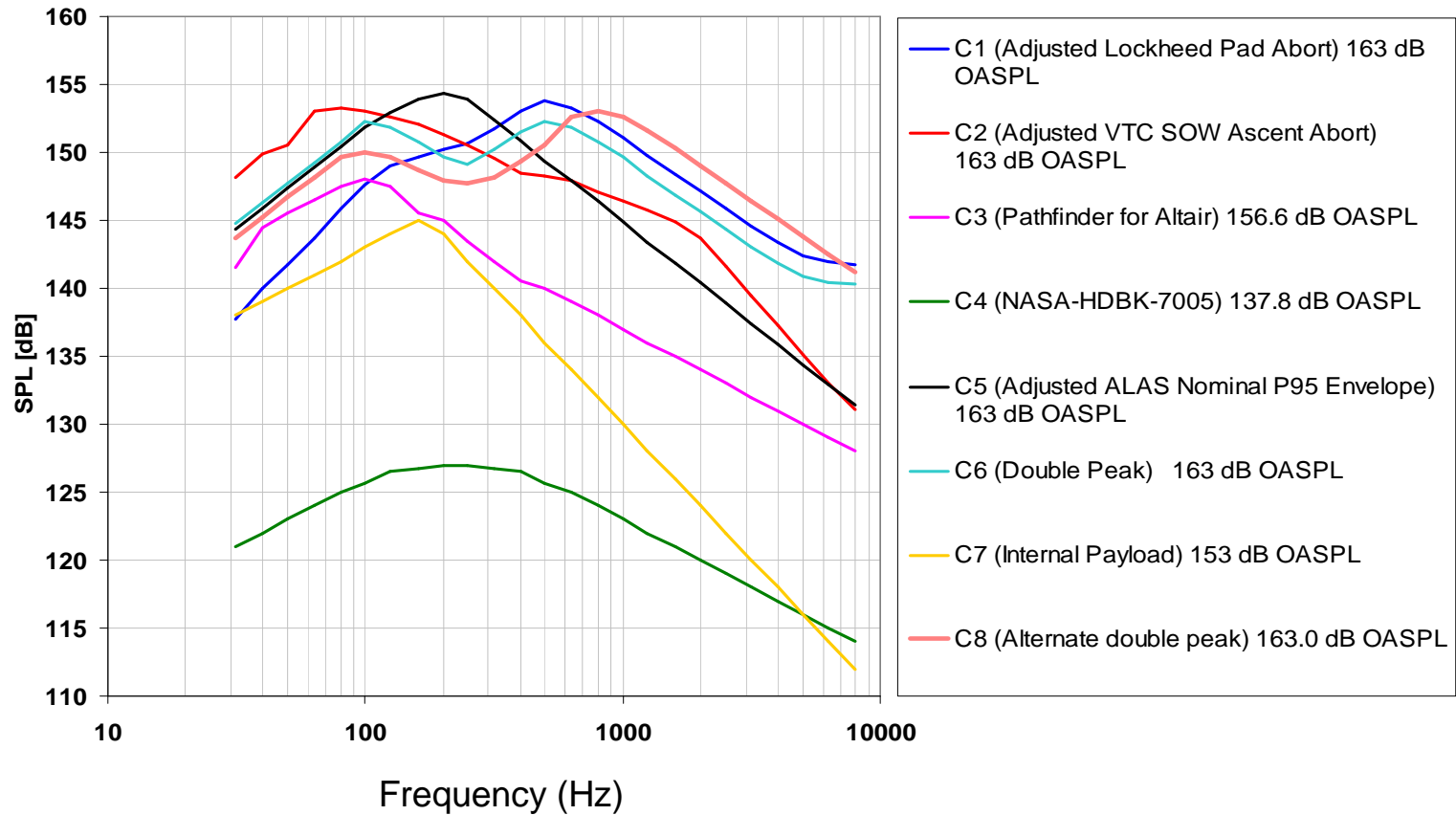
\* Subject to design changes



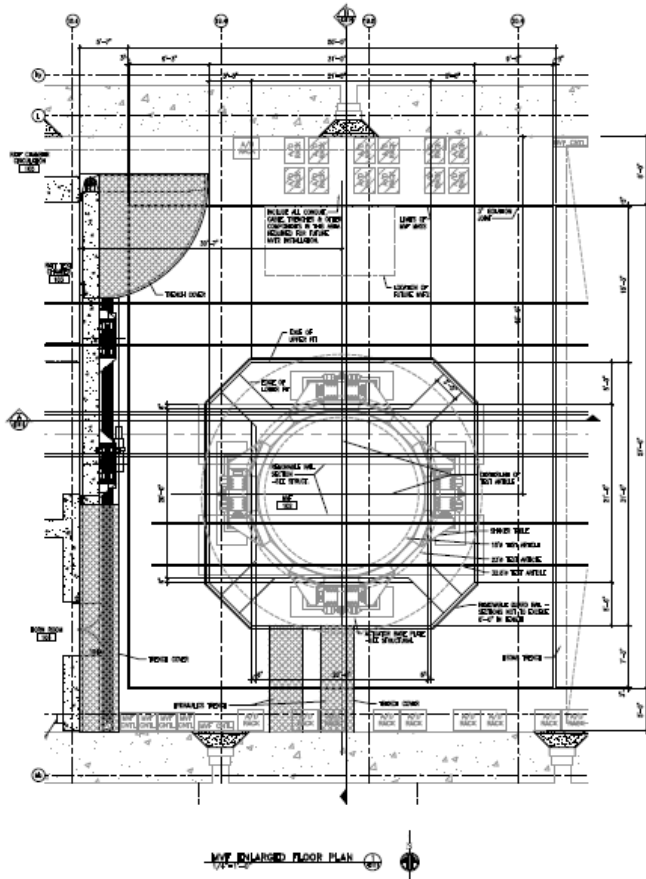


# Reverberant Acoustic Test Facility (RATF)

RATF Proposed SOW Updates - Rev 6



# Mechanical Vibration Facility (MVF)

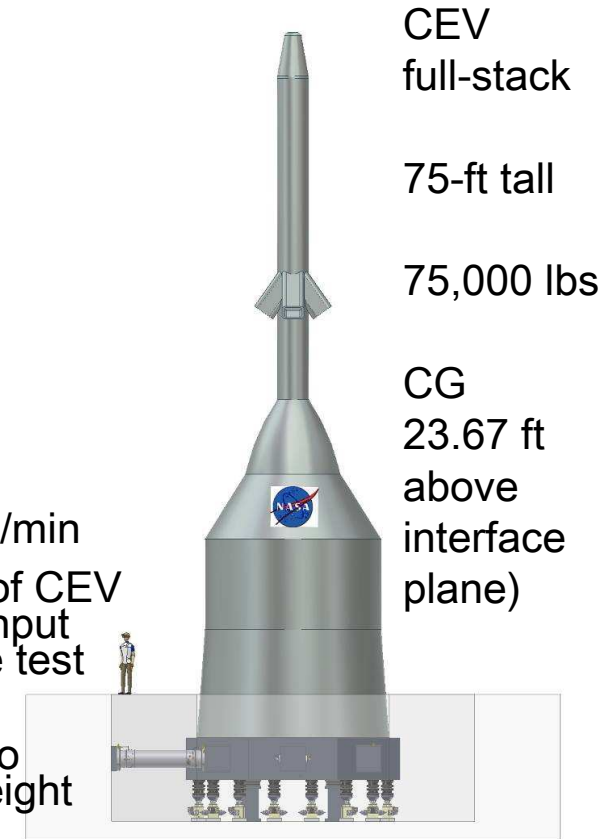


- Low-frequency (servo-hydraulic) sinusoidal vibration system

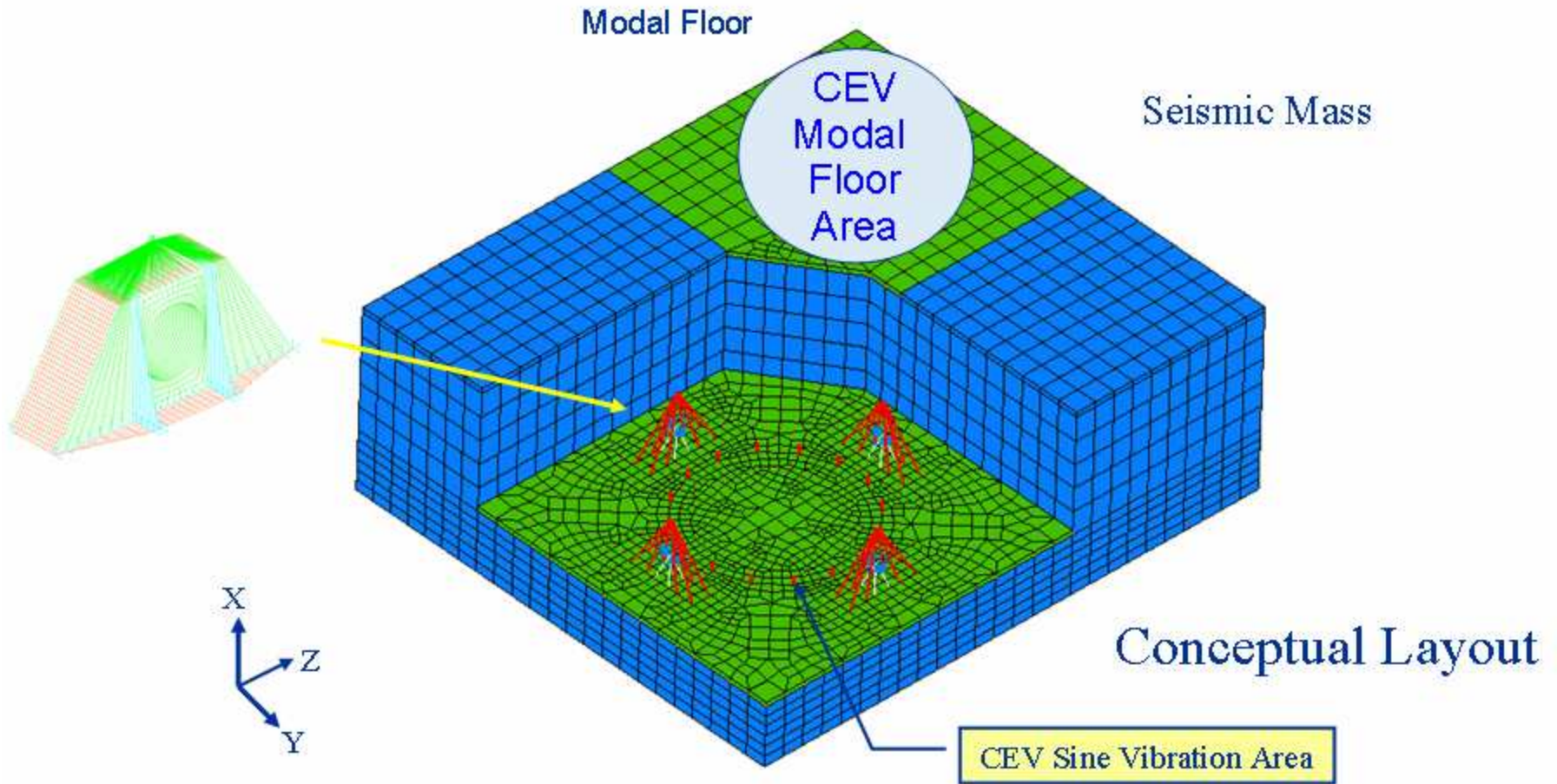
Vertical: 0 to 1.25-g's;  
5 to 150-Hz;  
Sine sweep up  
to 4 octaves/min

Horizontal: 0 to 1.0-g's;  
5 to 150-Hz;  
Sine sweep  
up to 4 octaves/min

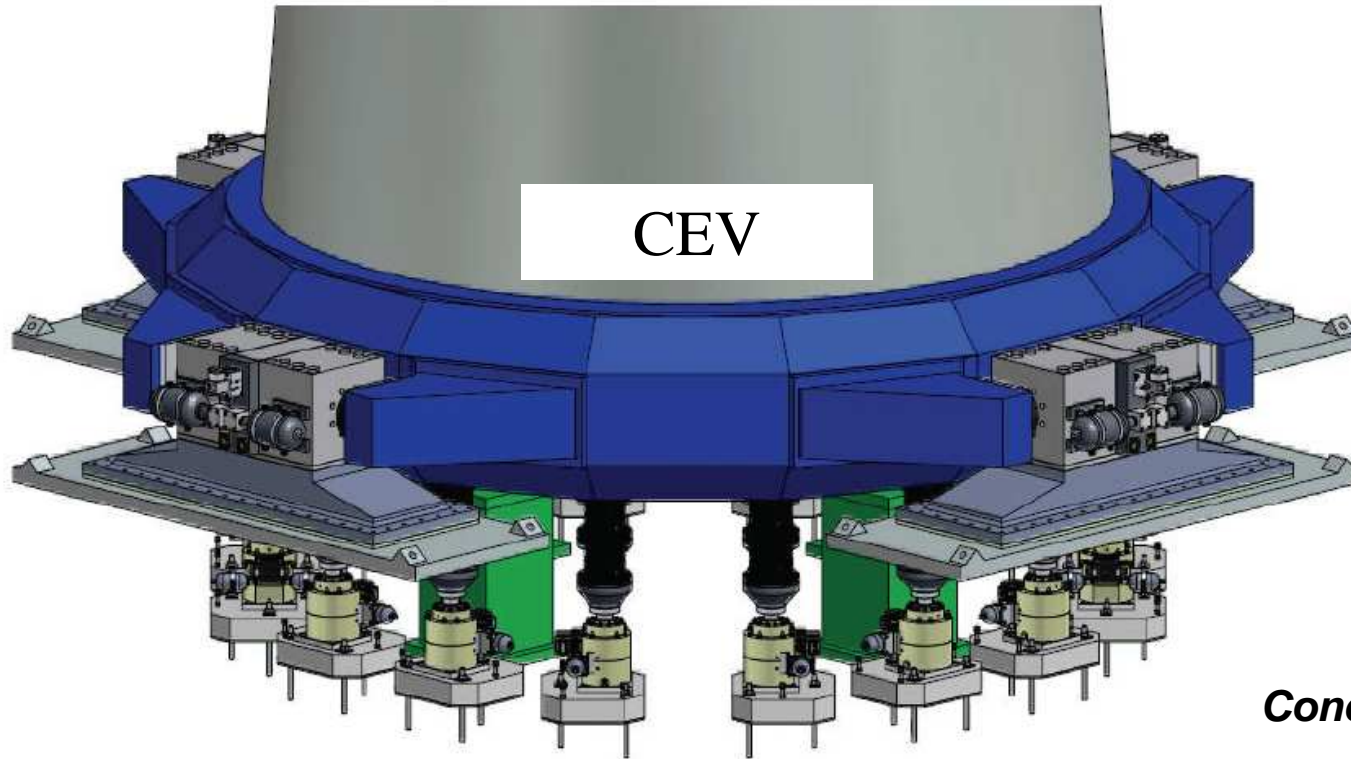
- 3 single axis test capability of CEV Full Stack; Change axis of input motion without removing the test article
- Table surface below grade to accommodate test article height



# MVF Facility Layout



# Vibration System



*Conceptual Layout*

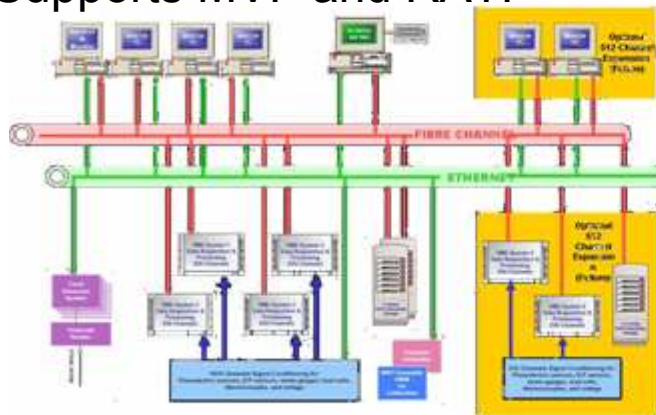
16 Vertical, 4 Horizontal exciters give full 6 DOF Vibration Table



# High Speed Data Acquisition System (HSDAS)

## COTS Data Acquisition proposed

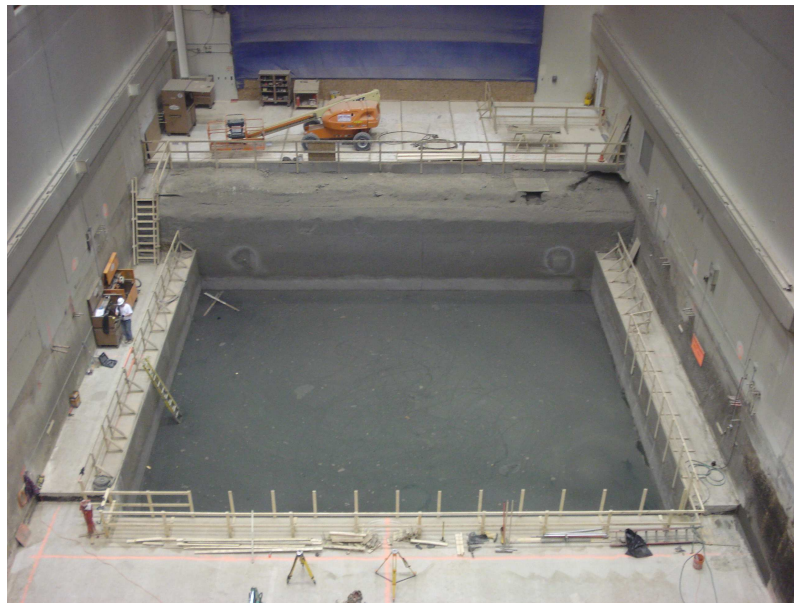
- Open hardware and software architecture
- Real-time displays
- Simultaneous data acquisition and access
- Scalable/Reconfigurable
  - 1024 Channels
  - Expansion to provide 1536 channels
- Supports MVF and RATF



# Construction Status

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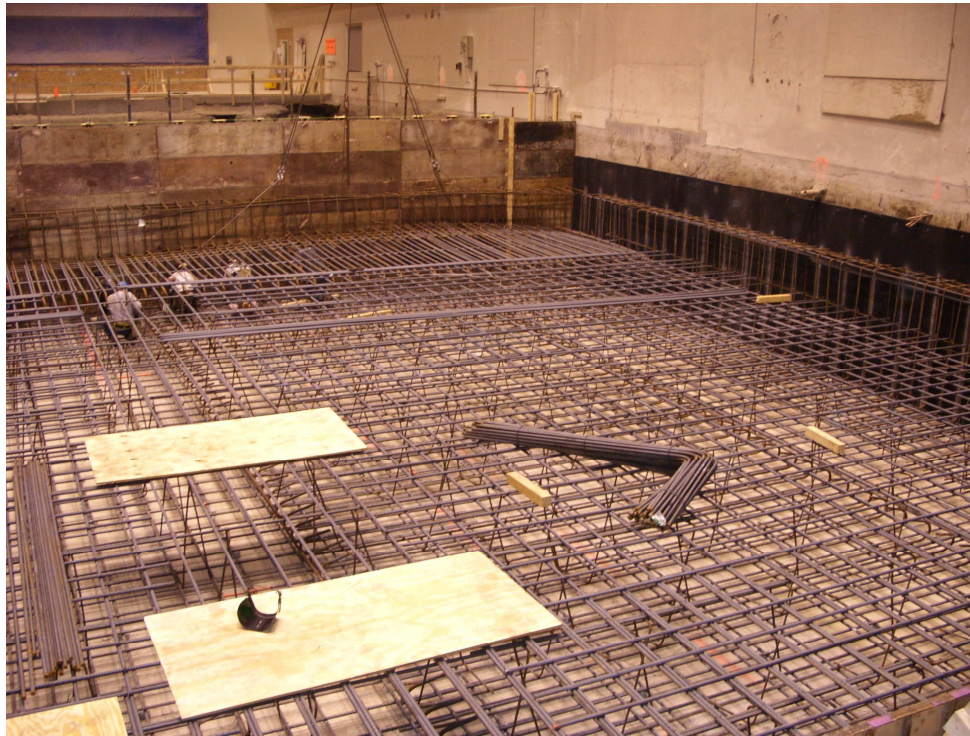
- Construction mobilization continues in parallel with demolition
- Installed Thermal/Vacuum Chamber barrier
- Completed geo-probe samples and analyses - received approval to remove soil
- Floor demolition complete
- Hot cell demolition completed by end of December 2007
- MVF excavation started January 2008 (19 ft deep; 56.6 ft by 49.5 ft)



# Construction Status

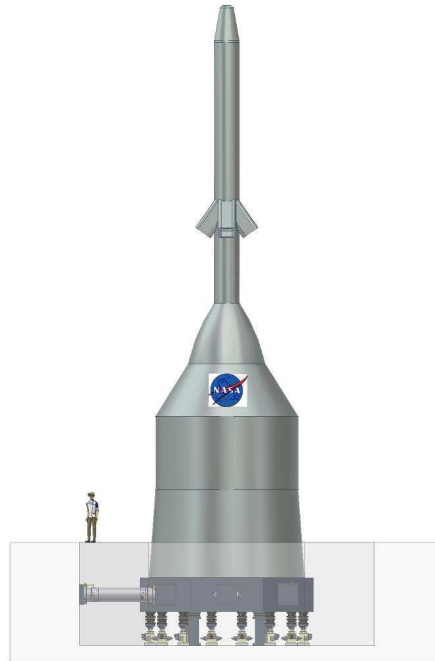
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- Current RATF Foundation Status:
  - RATF foundation excavation has been completed.
  - RATF foundation construction started April 2008.



# CEV Test Schedule

Test Article	Test Begins	Test Completion
Ground Test Article (GTA)	September 2009	April 2010
Qualification	May 2011	June 2012

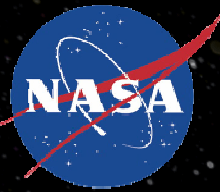




# Summary

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- Orion Integrated Environmental Testing Project provides one-stop testing under one roof at the NASA Glenn Plum Brook Station.
- NASA will have World Class Facilities available to support Constellation Architectural elements environmental testing needs:
  - Acoustic Vibration
  - Mechanical Vibration
  - Modal
  - Thermal Vacuum
  - EMI/EMC
- Facilities will support the spaceflight testing required for the development (GTA) and qualification of the Orion CEV hardware.



## Contact Information:

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