



Status and Design Features of the new NASA GRC Reverberant Acoustic Test Facility (RATF)

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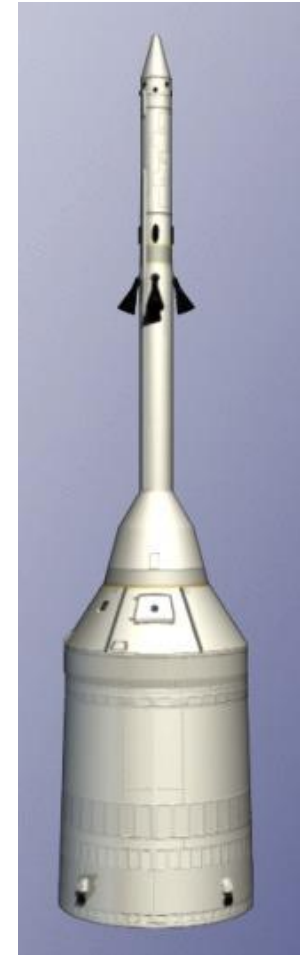
Test Facility Overview



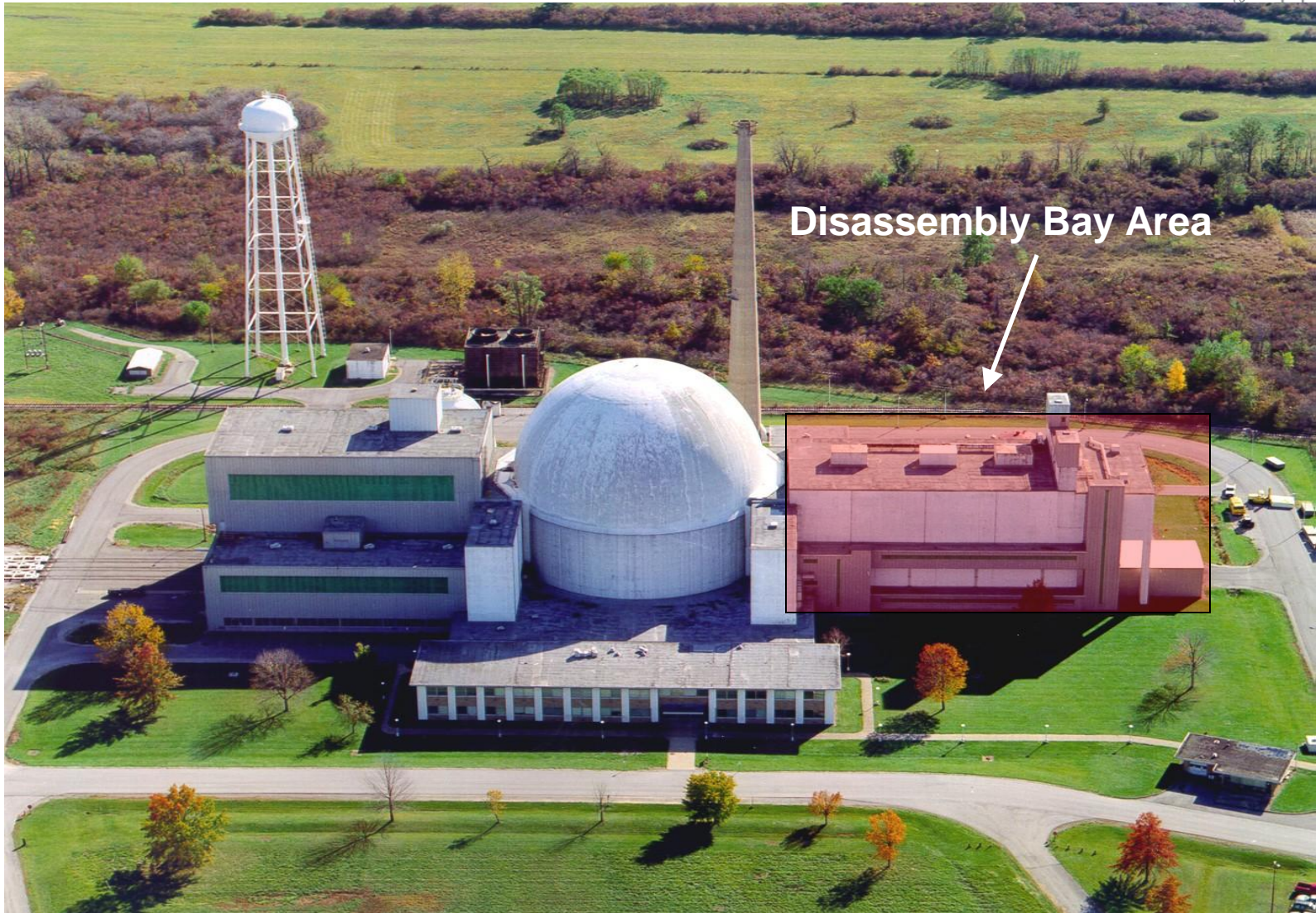
- The Space Power Facility (SPF) at the NASA Glenn Plum Brook Station in Sandusky, OH is developing an environmental test capability for NASA's future space programs.
- SPF will provide *one-stop shopping* for a wide variety of space environmental testing.

Environmental Facility Capability:

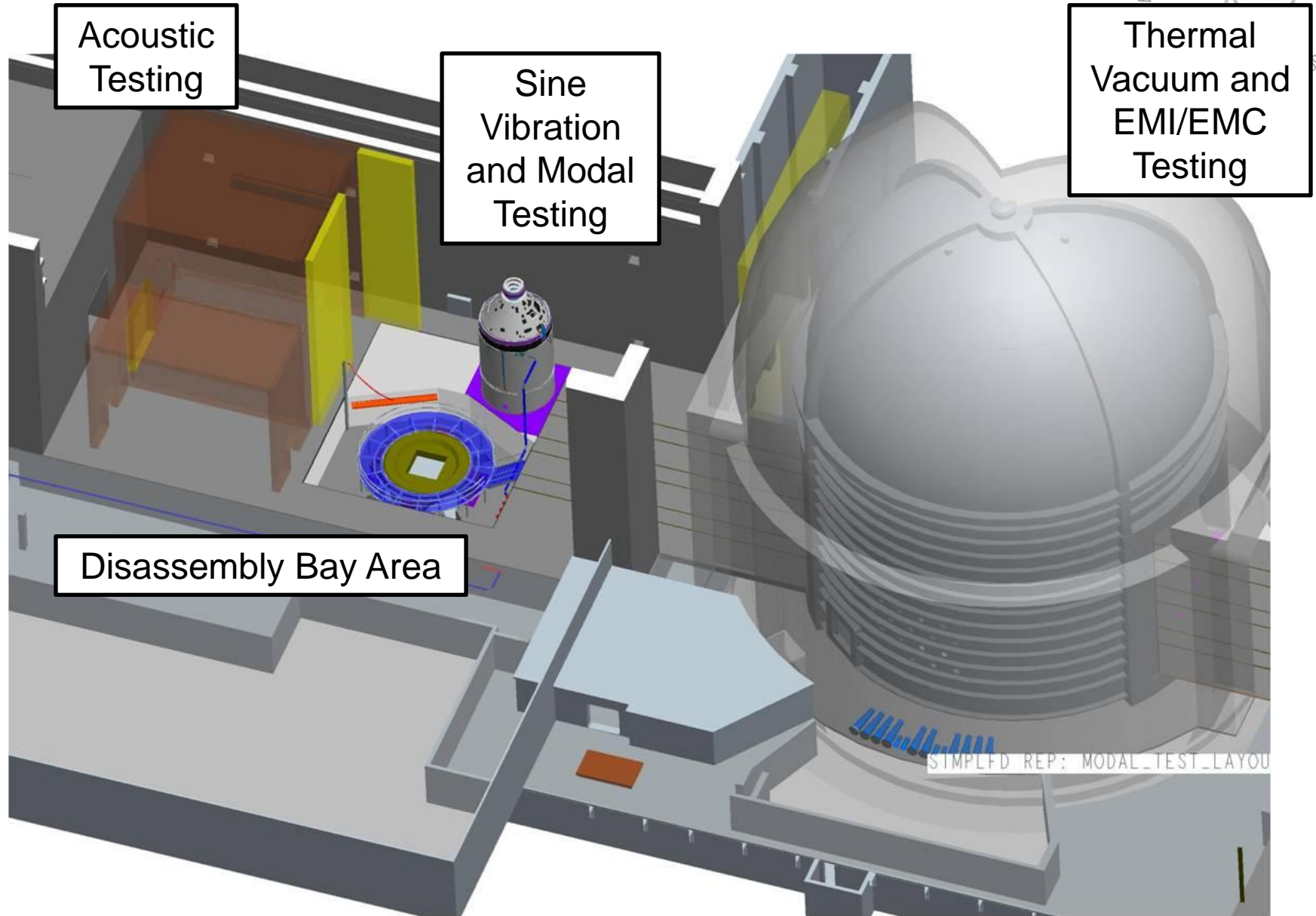
- Acoustic
 - Mechanical Vibration
 - Modal
 - Thermal-Vacuum
 - EMI/EMC
- The focus of this presentation is the status and design of the **Reverberant Acoustic Test Facility (RATF)**.



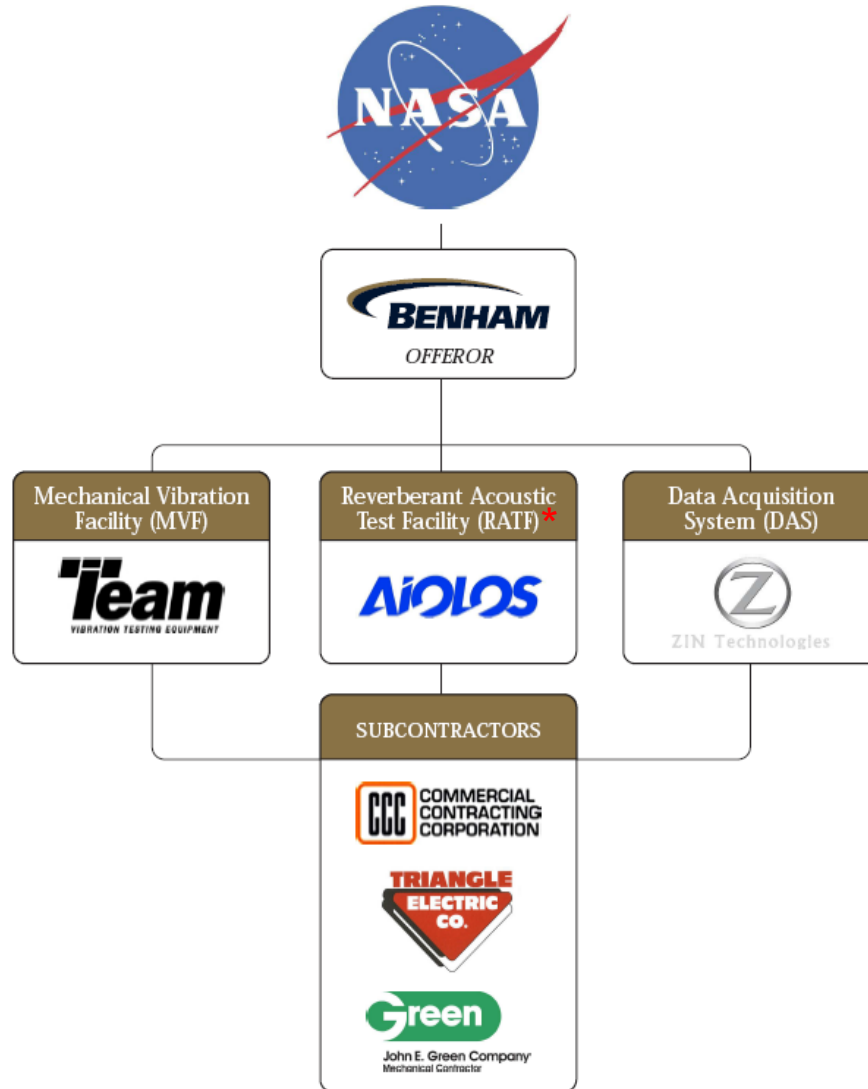
Space Power Facility (SPF)



Provide and Support Future NASA Testing



Benham Corporation is Prime Contractor



* RATF Suppliers:

TEAM: MK VI and MK VII Modulators

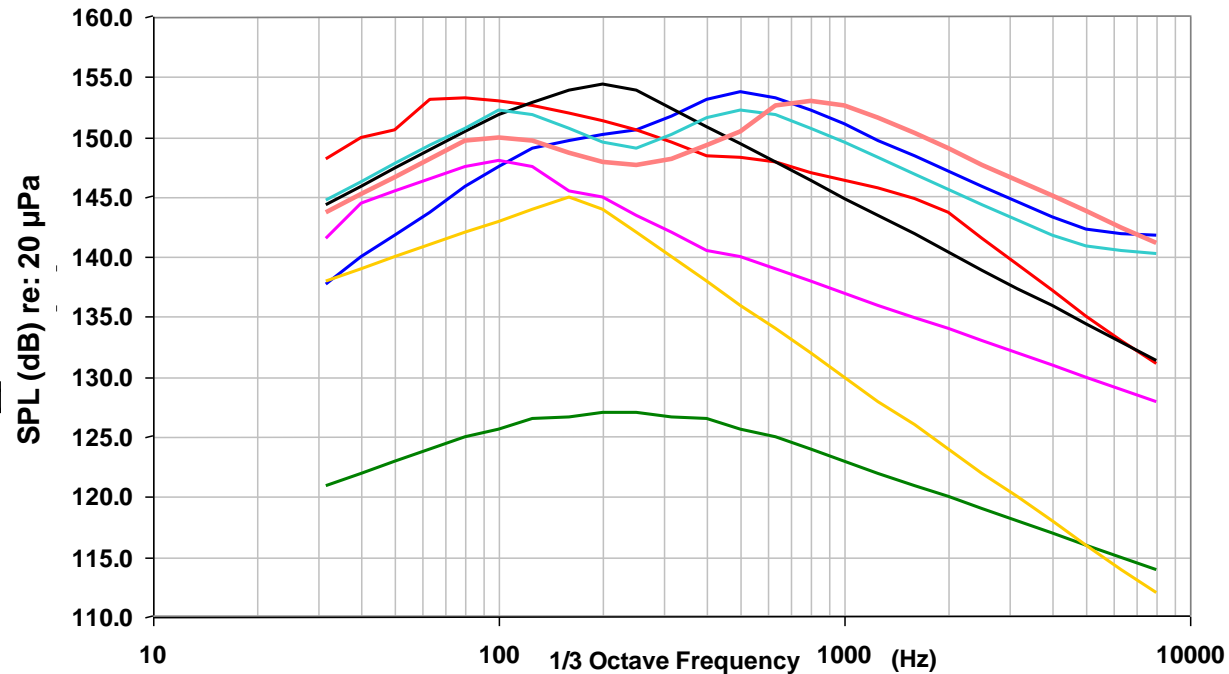
Wyle: WAS 5000 Modulators

m+p International: Acoustic Control System

RATF Acoustic Requirements



- Wide range of OASPL
- Diverse spectral energy requirements
 - Low frequency dominant spectra
 - High frequency dominant spectra
 - Twin peaked spectra



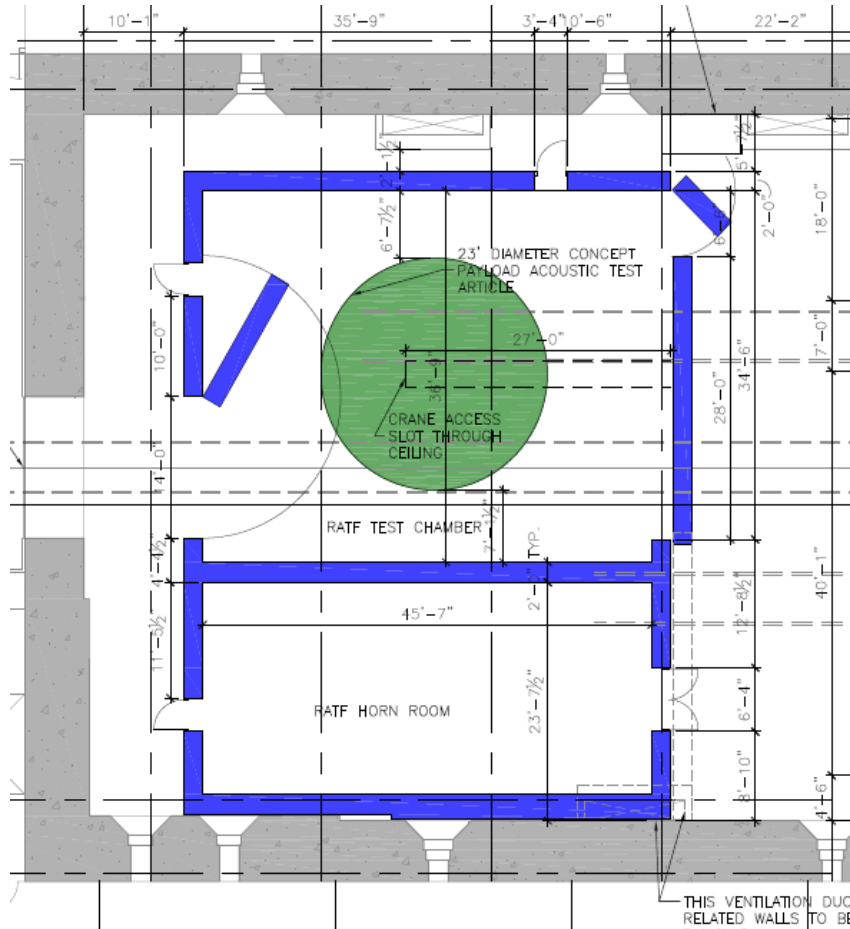
— C1 (Adjusted Lockheed Pad Abort) 163 dB OASPL
— C2 (Adjusted VTC SOW Ascent Abort) 163 dB OASPL
— C3 (Pathfinder for Altair) 156.6 dB OASPL
— C4 (NASA-HDBK-7005) 137.8 dB OASPL
— C5 (Adjusted ALAS Nominal P95 Envelope) 163 dB OASPL
— C6 (Double Peak) 163 dB OASPL
— C7 (Internal Payload) 153 dB OASPL
— C8 (Alternate double peak) 163.0 dB OASPL

Acoustic Test Series



Test	Date	Location	Test Objective
NRC I and II	December 2007 - January 2008, April 2008	NRC, Ottawa, Ontario, Canada	Acoustic response characterization of the TEAM modulators and initial horn evaluation. (Benham/Aiolos)
Redstone	May 2008	Redstone Arsenal, Huntsville, AL	NASA independent acoustic characterization of TEAM modulator and horns, including high frequency horn. Comparison of results with WAS 3000 modulator. (NASA)
Phase 1	March - April 2009	NRC, Ottawa, Ontario, Canada	Jet testing. Additional TEAM modulator acoustic characterization: <ul style="list-style-type: none"> a. Modulator redesign acoustic response b. Single modulator control c. Dynamic range (Benham/Aiolos)
Phase 2	October 2009	NRC, Ottawa, Ontario, Canada	Multiple modulator control. WAS 5000 acoustic characterization. (Benham/Aiolos)
Paint Absorption	February - March 2010	Owens-Corning, Granville, OH	Test characterization of acoustic absorption of RATF wall paint. (Cambridge Collaborative Inc. for NASA)

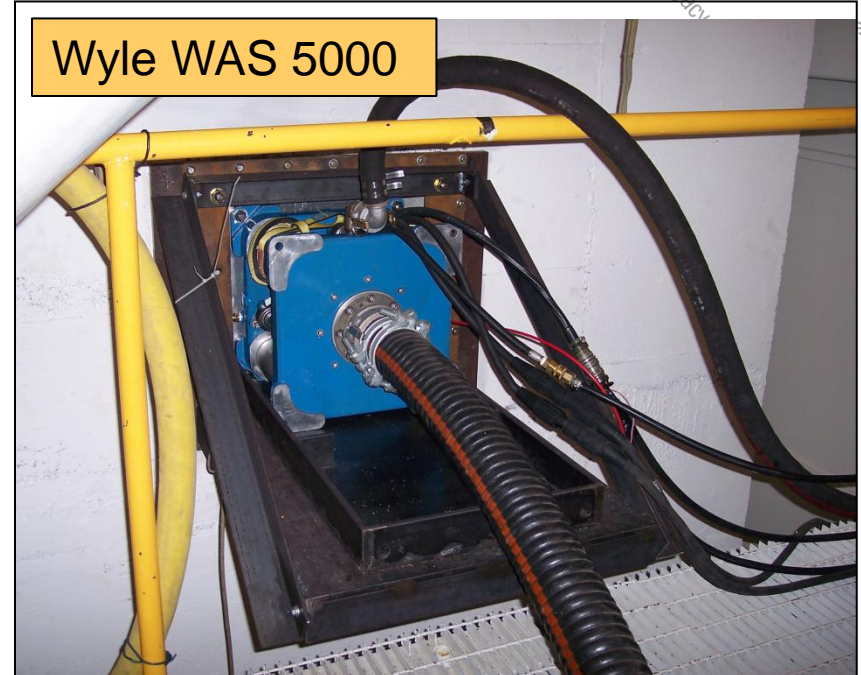
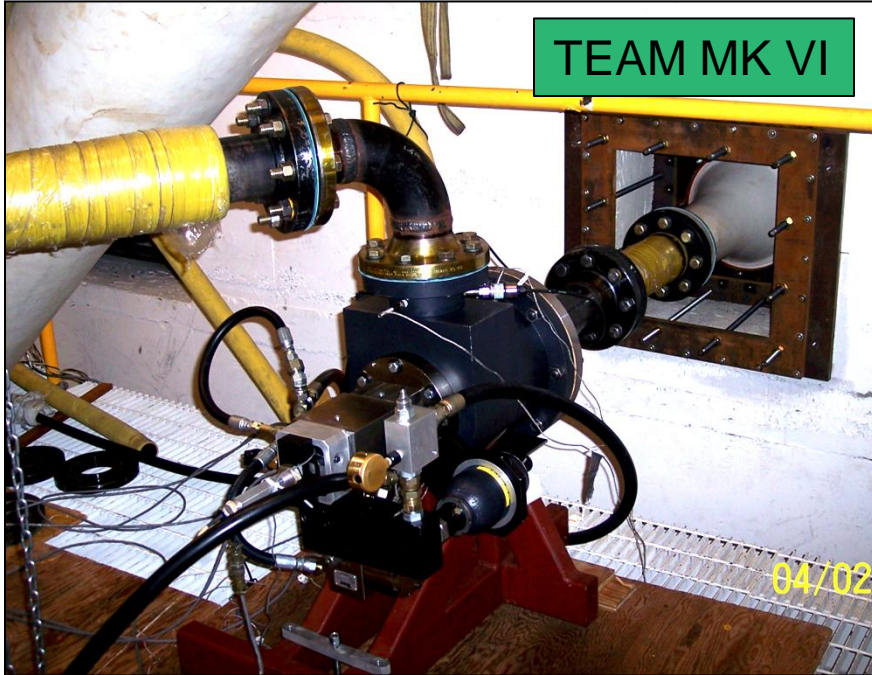
Reverberant Acoustic Test Facility (RATF)



Chamber Properties	
Chamber Size	47.5 ft L x 37.5 ft W x 57 ft H
Chamber Volume	101,189 ft ³
Acoustic Modulators	23 TEAM Modulators & 13 WAS 5000 Modulators
Horns	36 (grouped at 7 different horn cut-off frequencies)
Nominal GN ₂ flow rate	72,000 scfm
Main Door Opening	34.5 ft wide
Number of Main Doors	2
Door Type	Sliding and hinged
OASPL, empty	163 dB OASPL

Minimum 10 minute continuous run times (worst case)
 Designed for 47 ft tall x 20 ft diameter test article

RATF Modulators and Horns

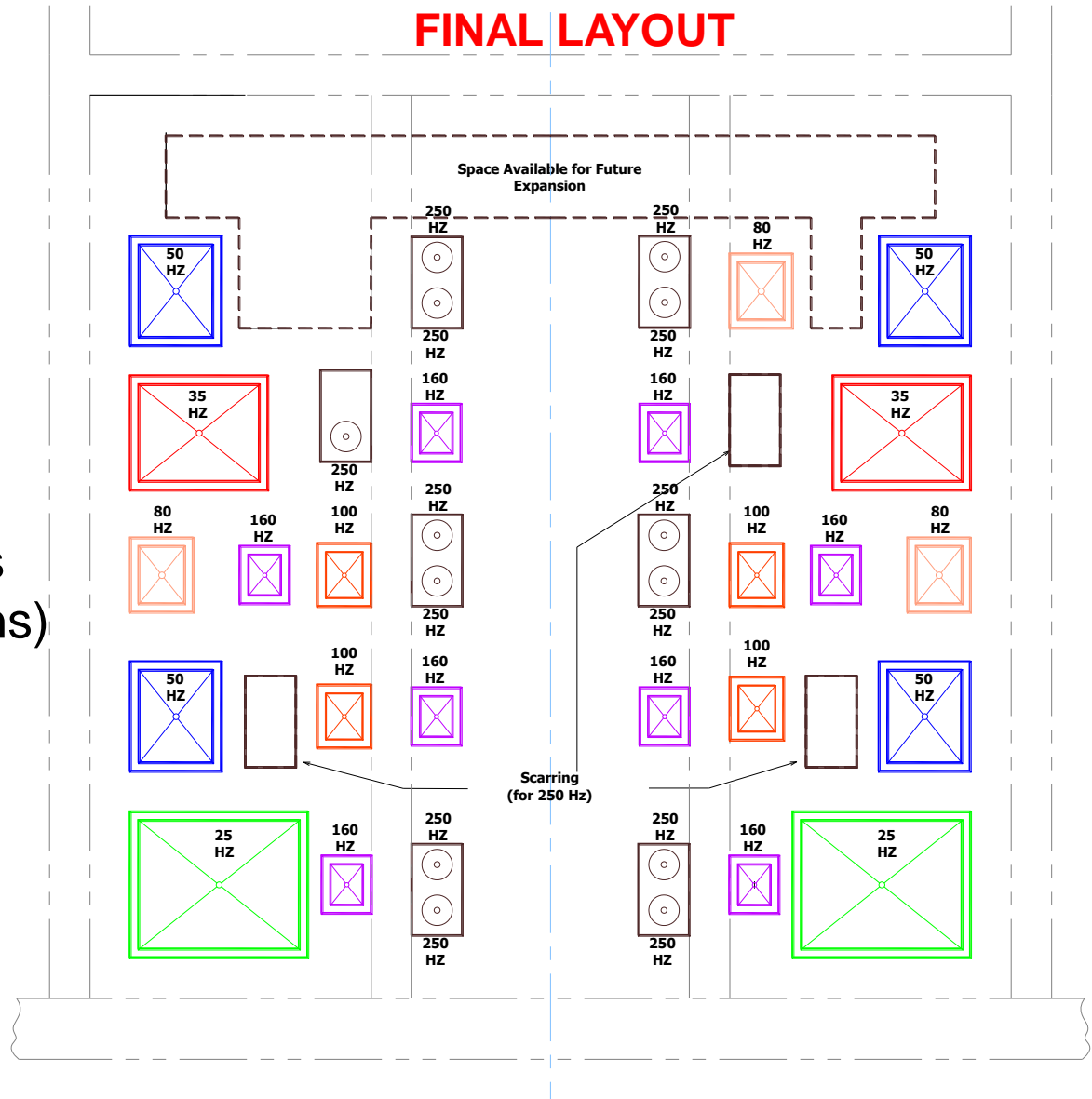


Horn	25 Hz	35 Hz	50 Hz	80 Hz	100 Hz	160 Hz	250 Hz	TOTAL
Modulator	MKVII	MKVII	MKVII	MKVII	MKVI	MKVI	WAS5000	36
Final Design Count	2	2	4	3	4	8	13	

RATF Horn Wall Layout

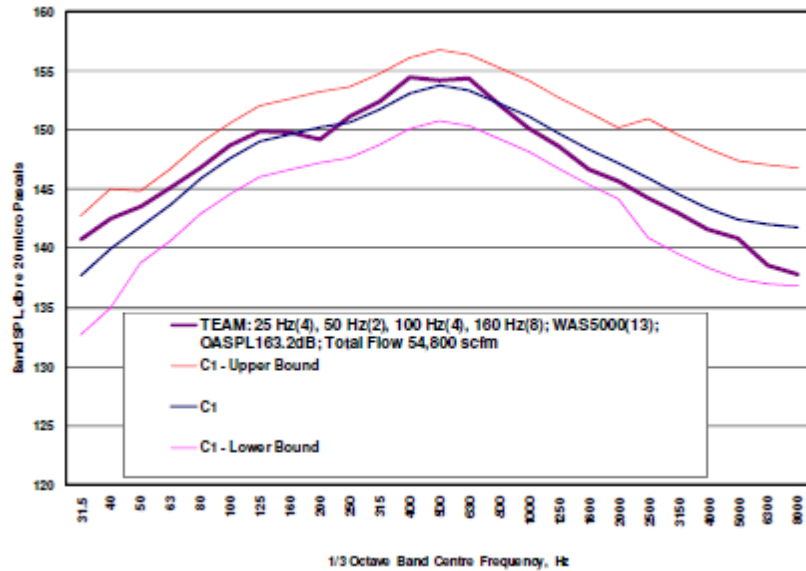
- Two 25 Hz horns
- Two 35 Hz horns
- Four 50 Hz horns
- Three 80 Hz horns
- Four 100 Hz horns
- Eight 160 Hz horns
- Thirteen 250 Hz horns (expandable to 20 horns)

Total: 36 horns

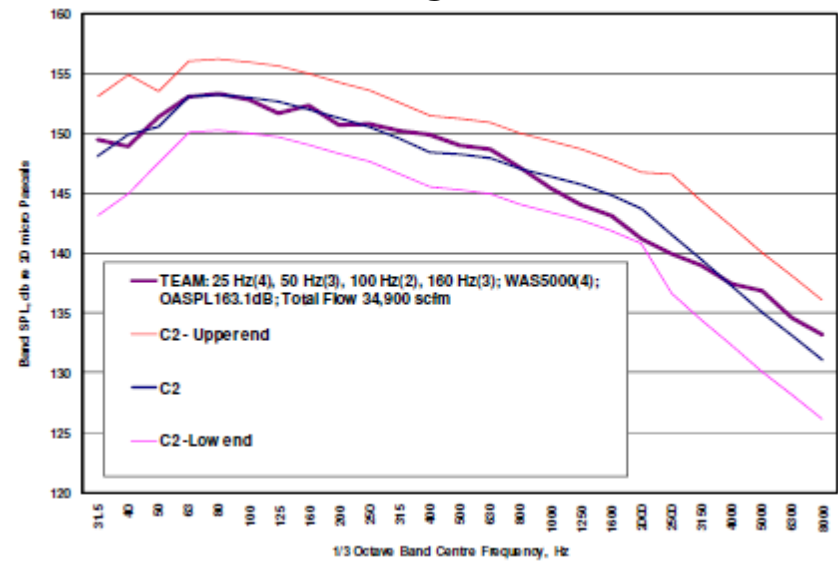


Aiolos' Predicted RATF Spectra

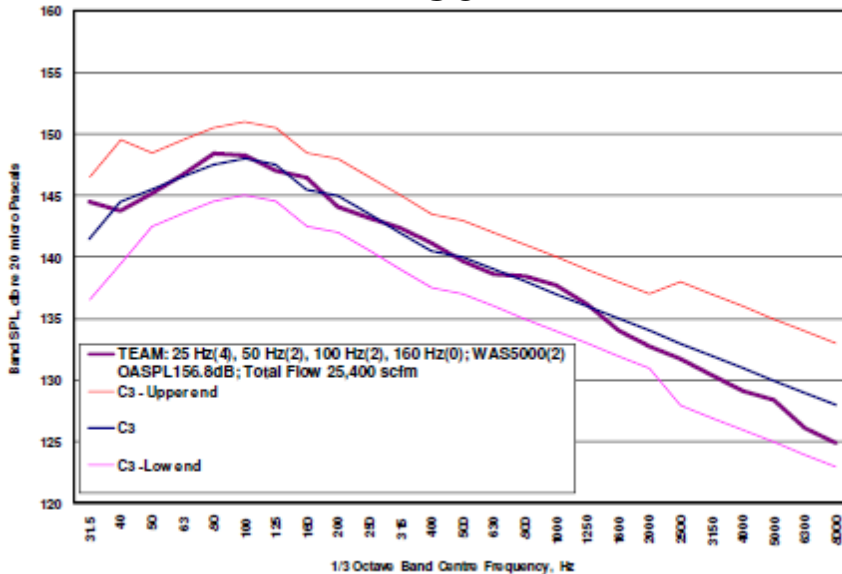
C1



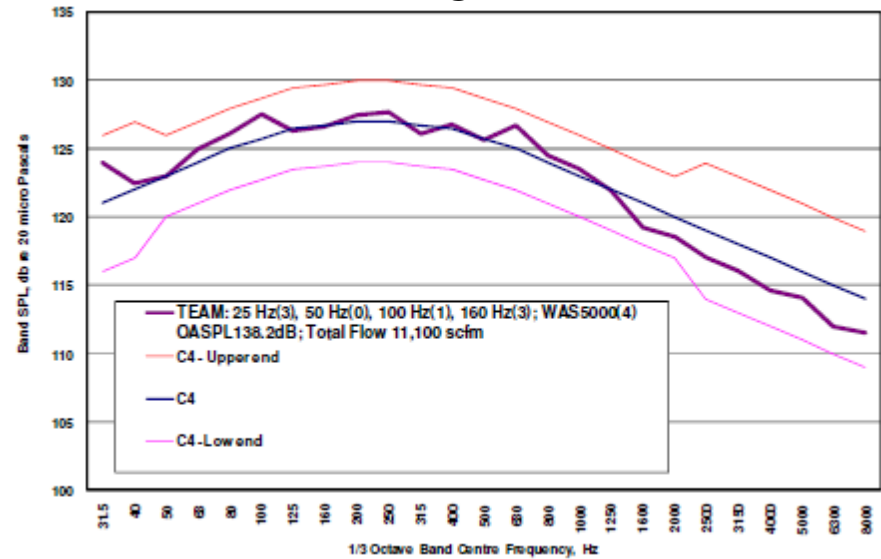
C2



C3

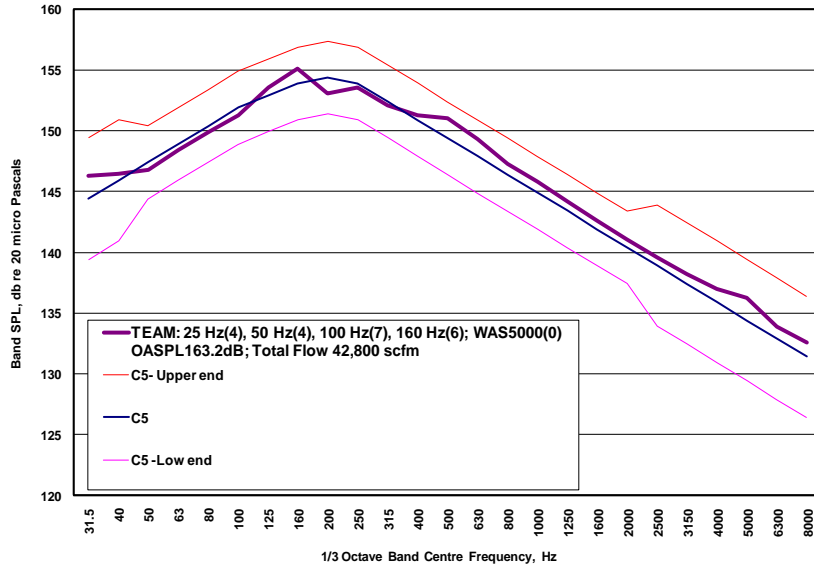


C4

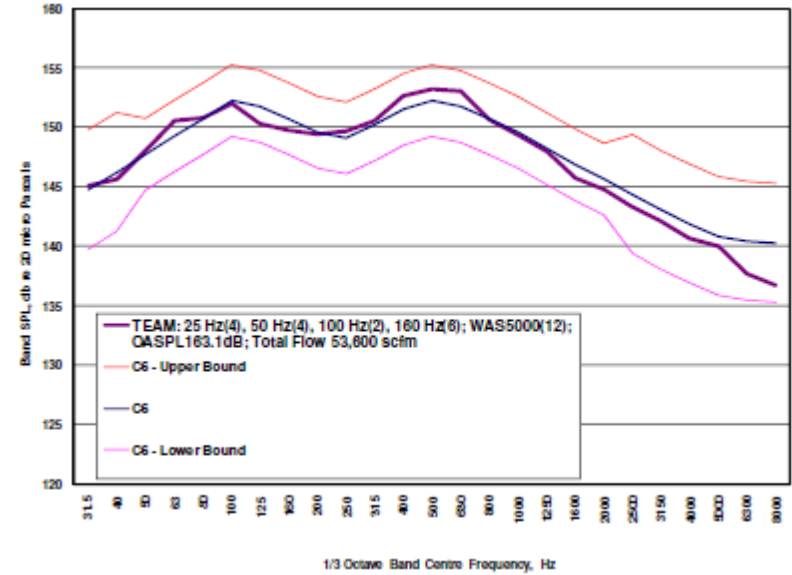


Aiolos' Predicted RATF Spectra

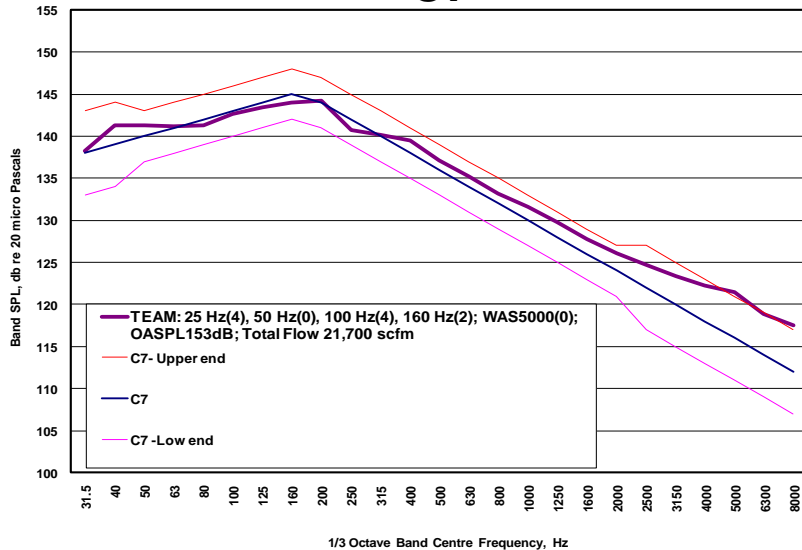
C5



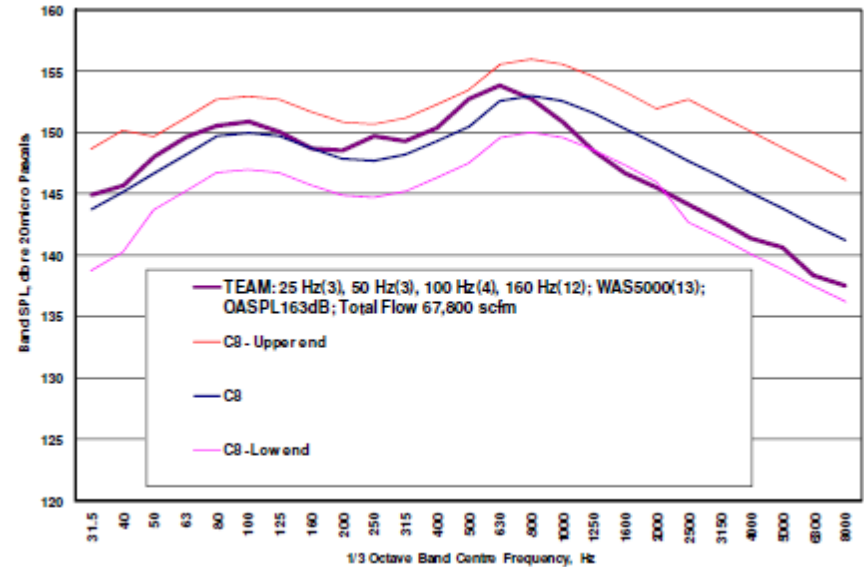
C6



C7



C8



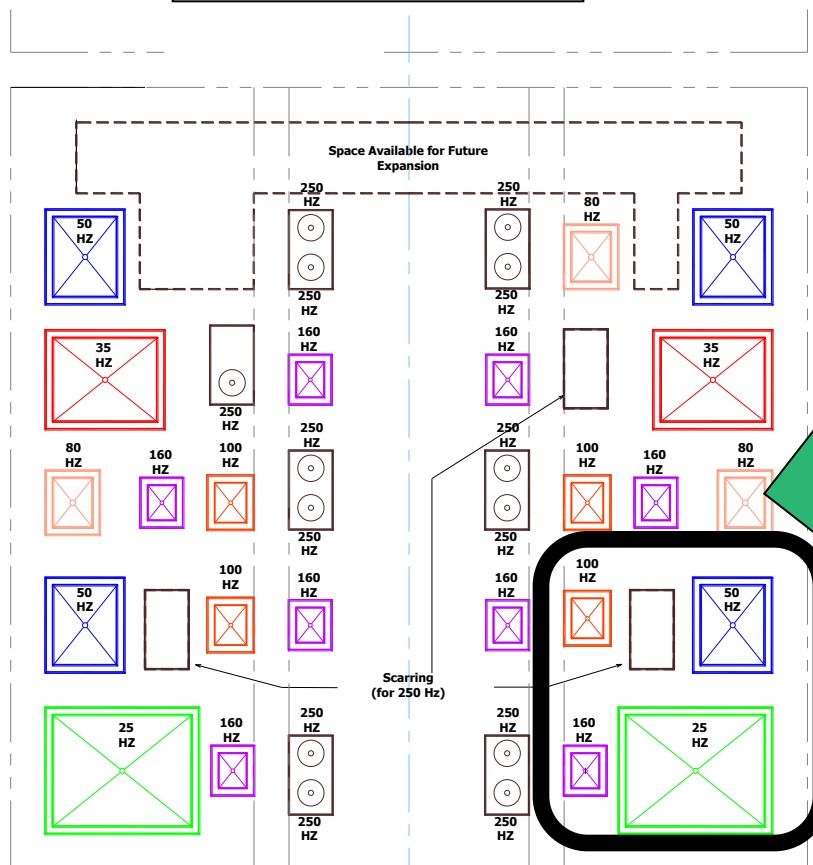
RATF Construction



Foundation started in April 2008

Horn Wall – Installation of Horn Frames

Legend	
80 Hz	100 Hz
25 Hz	160 Hz
35 Hz	250 Hz
50 Hz	



Overhead View – Preparation Horn Room Pour 1



Installation of horn frames and rebar

Overhead View – Horn Room Pour 1



Concrete pour #1 completed October 2009

Overhead View – Horn Room Pour 1



Concrete pour #1 completed with forms removed

Overhead View – Preparation Horn Room Pour 2



Horn wall level 2 horn frame and rebar installation

Overhead View – Horn Room Pour 2



Concrete pour #2 completed with forms removed

Looking Forward



Spring/Summer 2010:

Installation of vaporizer system, horns, and modulators

Fall 2010/Winter 2010-11:

Door installation; Benham Verification Testing with turnover to NASA

Spring/Summer 2011:

NASA Integrated Systems Testing (IST)

Fall 2011:

Available for Testing

RATF Facility Manager: Mr. Aron D. Hozman,
Phone: (419)-621-3301, Aron.D.Hozman@nasa.gov

RATF will be the most Powerful Large Reverberant Acoustic Chamber in the World!



(Active) Reverberant Acoustic Test Facility	Location	Volume (ft ³)	Max. OASPL (dB) Empty Chamber	Year Commissioned
Lockheed Martin Missiles and Space, bldg.156, cell no.1, LVATF	Sunnyvale, CA	189,200	156.5	1973
NASA Plum Brook Station	Sandusky, OH	101,200	163.0	Planned for 2011
Lockheed Martin Space Systems	Denver, CO	75,900	154.0	1985
Boeing Satellite Development Center (Boeing SDC)	El Segundo, CA	67,800	155.0	2004
Lockheed Martin Missiles and Space (LMMS), bldg.159	Sunnyvale, CA	64,000	157.3	1996
Mitsubishi Electronics	Kamakura, Japan	61,700	152.0	2002
Large European Acoustic Facility (LEAF) at ESTEC	Noordwijk, The Netherlands	59,000	154.5	1990
Northrop Grumman Space Technology (NGST), LATF	Redondo Beach, CA	51,600	154.0	1996



Thank you

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