The Flight Dynamics Research Facility

Image credit:
BL Harbert International

Pre-Tour Presentation to the Langley Alumni Association

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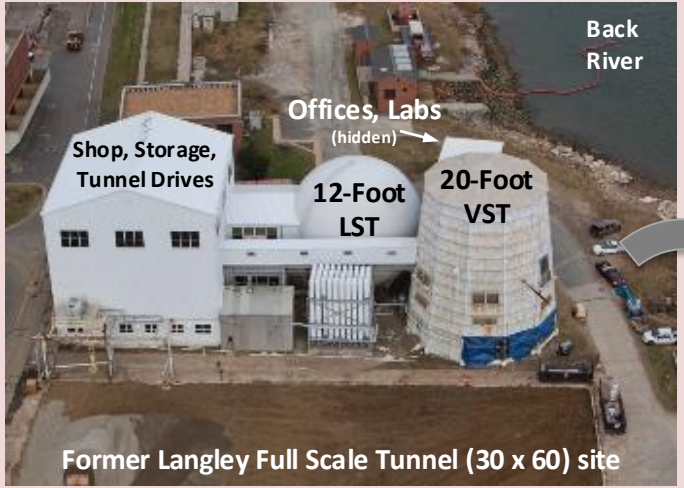
Background

Flight Dynamics Research Facility (FDRF)

- A state-of-the-art subsonic vertical wind tunnel at NASA Langley being built under a design-build contract that was let in September 2021
- First major wind tunnel built by NASA in over 40 years
- Leverages and expands the capabilities of the two legacy facilities being replaced
- Focuses on flow regimes that are difficult to reliably predict using CFD
- **Key attributes:** relatively inexpensive operations and model fab; small staff; advanced test techniques; rapid integration/characterization; designed-in flexibility and adaptability

Unique utility: FDRF will be the only modern U.S. wind tunnel capable of providing a comprehensive assessment of subsonic vehicle stability and controllability via both captive and free-flight dynamic test techniques

FDRF Will Replace the *20-Foot Vertical Spin Tunnel* and the *12-Foot Low Speed Tunnel*



Current Flight Dynamics Research and Support Facilities

LaRC East Area (Langley AFB)

Image credit: NASA

Specifications

- **12-Foot LST:** max speed = 77 ft/s (7 psf)
- **20-Foot VST:** max speed = 85 ft/s (8.6 psf)
- Reynolds Number = 0.5×10^6/ft
- Long. Turbulence intensity 1.5% - 2%
- Four buildings (2 tunnels + 2 support)
- Major flood zone

Some FDRF Requirements

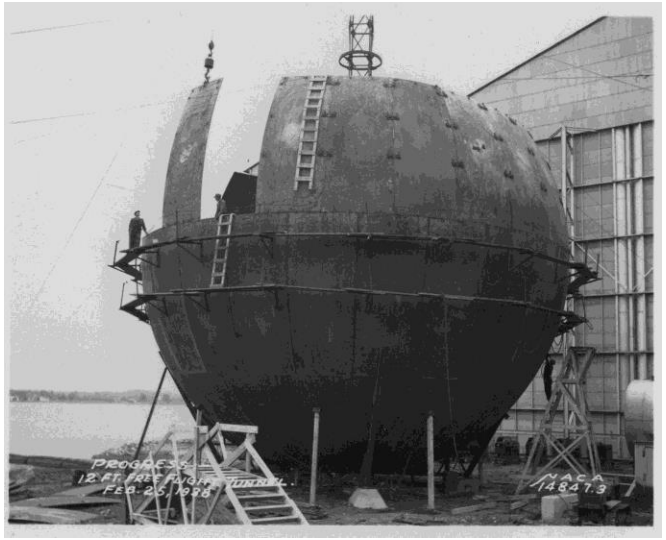
- 20-foot test section
- Max speed = 172 ft/s (35 psf)
- Reynolds Number = 1.1×10^6/ft
- Long. Turbulence intensity < 0.5%
- Active cooling
- Repurpose existing test rigs and DAS
- One building replaces four existing buildings
- Out of flood zone

Flight Dynamics Research Facility (FDRF)

LaRC West Area

Image credit: BL Harbert International

FDRF Predecessors: *12-Foot Free-Flight Tunnel* and *20-Foot Free Spinning Tunnel* Under Construction



1938

Designed for testing free-flight models to assess stability, controllability, and flying qualities

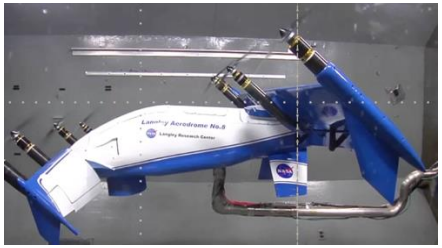
1940 (note proximity to Back River)

Designed for free-spin testing to quantify spin modes and recovery characteristics

Image credit NACA/NASA

Broad Support of NASA Missions Will Transfer to FDRF

Low Boom Flight Demonstrator/X-59

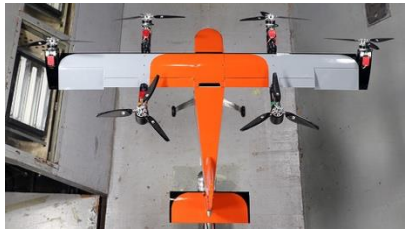


Urban Air Mobility/LA-8

Adaptable Distributed Electric Propulsion Testbed

Sustainable Flight Demonstrator/X-66

Stardust and OSIRIS REx



Raven Subscale Wind-Tunnel and Flight Test

Dragonfly Titan Mission

DAVINCI Venus Mission

Orion Crew Module and Launch Abort System

Commercial Space

Image credit NASA

Image credit NASA

FDRF Flow Path

Overall FDRF Building Dimensions: 130’ (H) x 177’ (W) x 41’ (D)

- Closed-throat, double-return circuit
- Test section is 20 ft across by 24 ft long
- Four 750 HP motors with eight-bladed, carbon fiber fans
- Actively cooled airflow via heat exchangers with 500 ton chiller

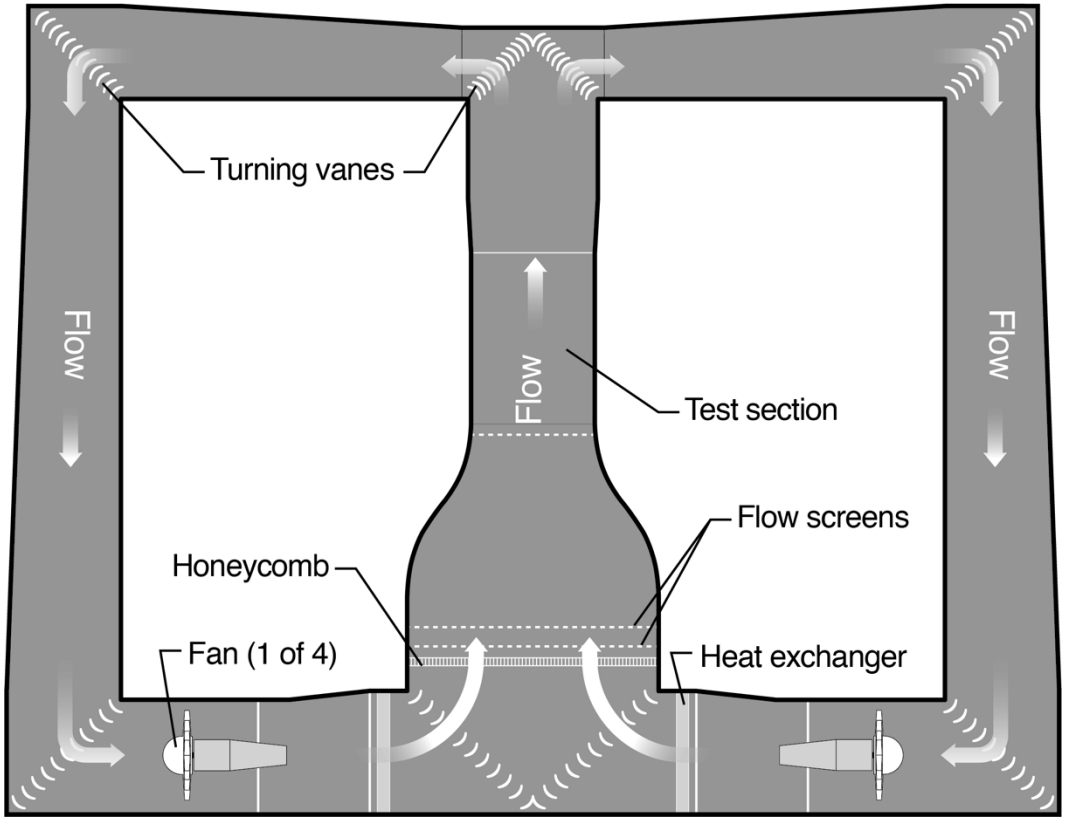


Image credit: BL Harbert International and North Wind

FDRF Ground Floor Layout

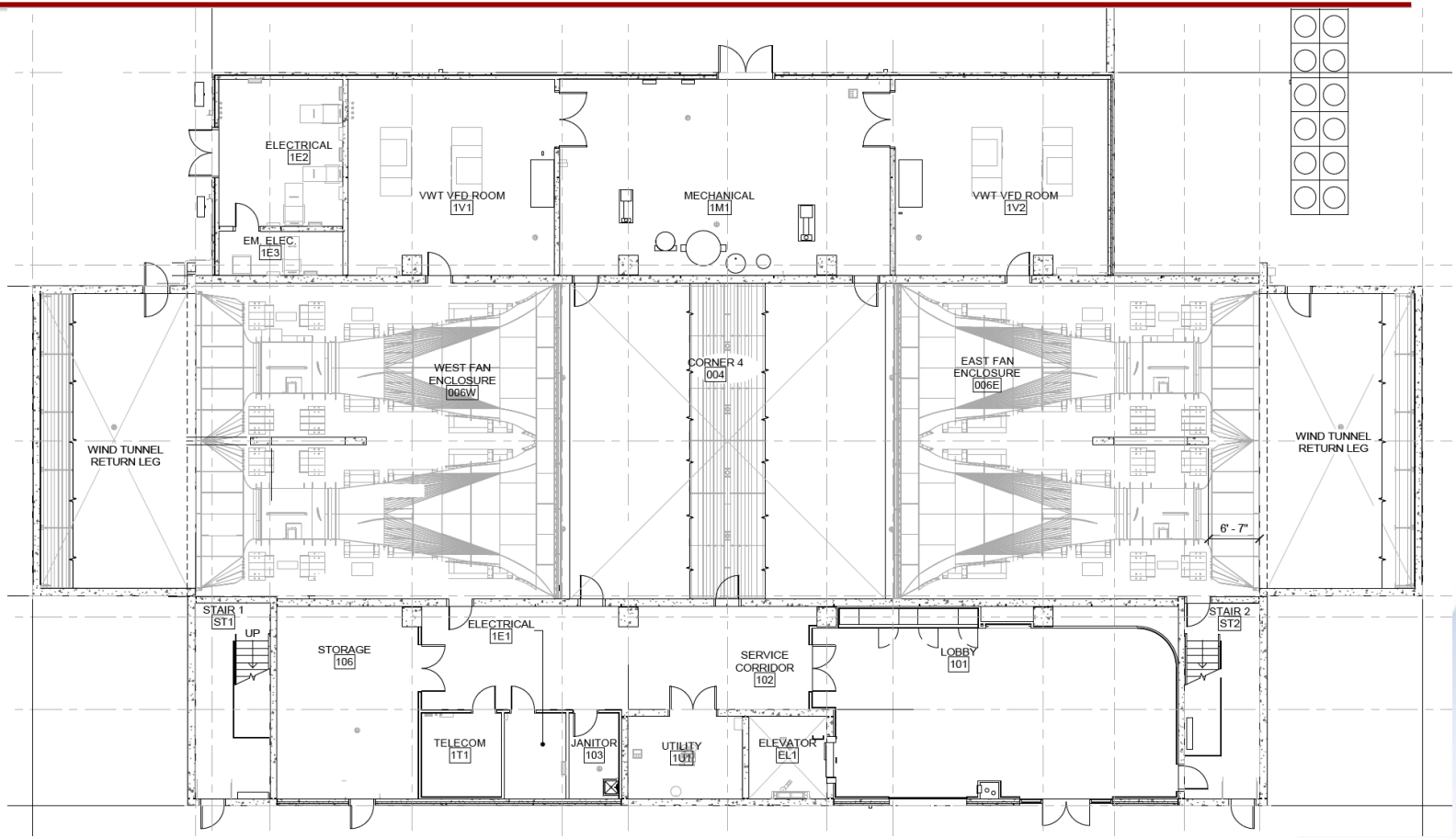
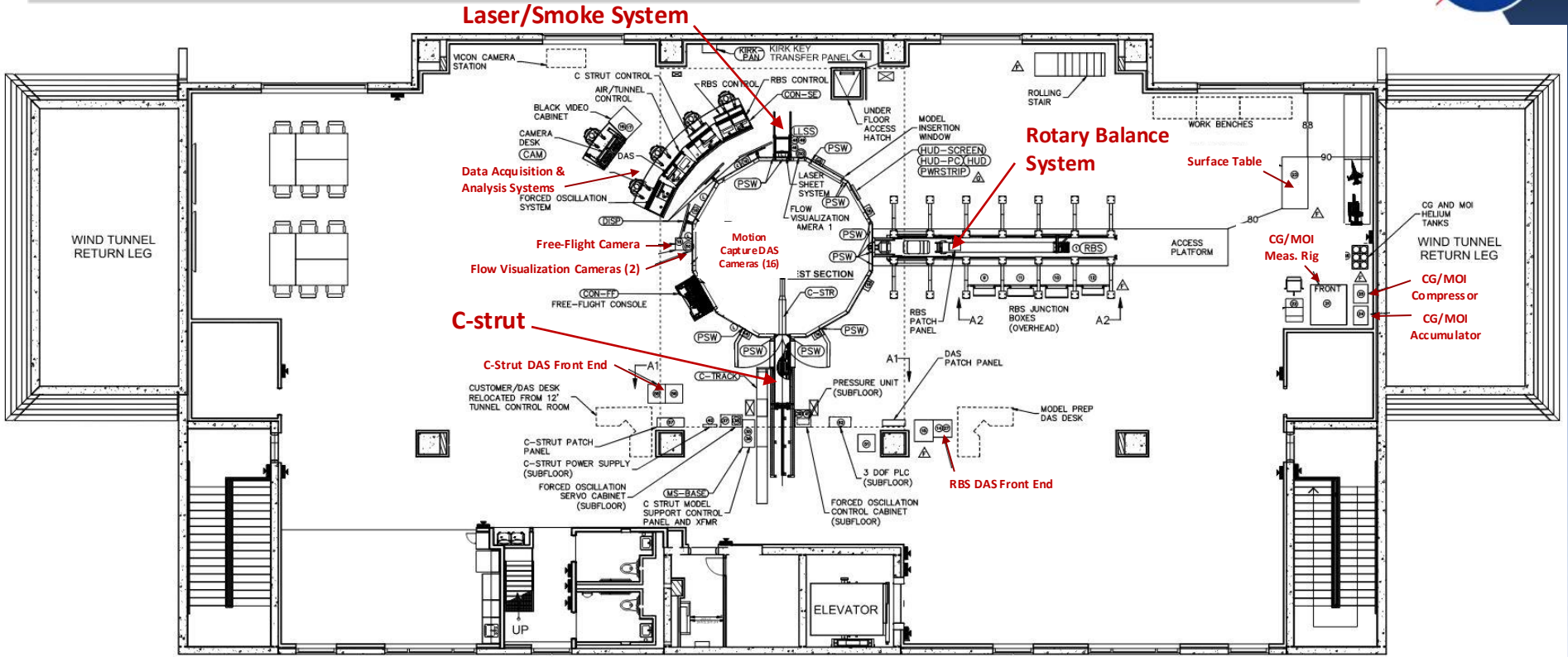


Image credit: BL Harbert International and North Wind

FDRF Control Room Layout*



*Red text indicates some of the existing equipment to be transferred from legacy facilities

Image credit: BL Harbert International and North Wind

Comparison of FDRF and VST Control Room Floor Space

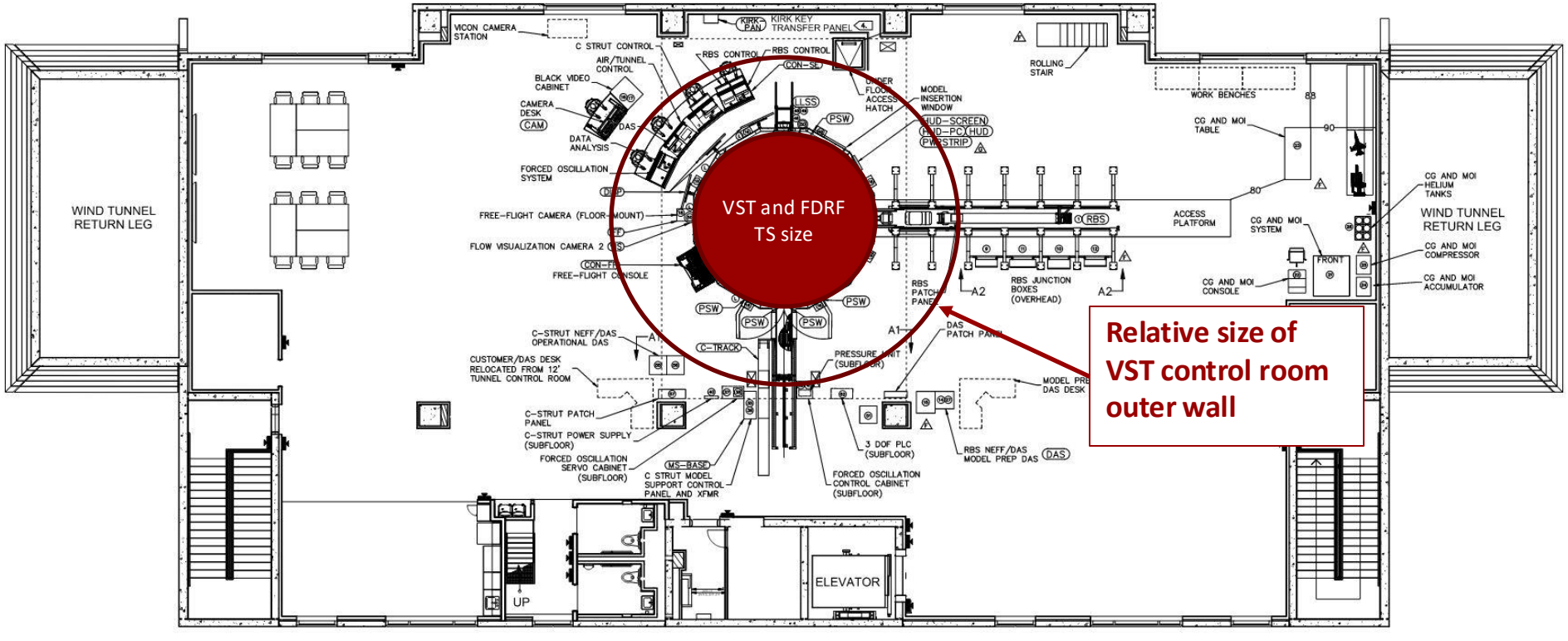


Image credit: BL Harbert International and North Wind

Test Techniques Transferring from the 20-Foot Vertical Spin Tunnel

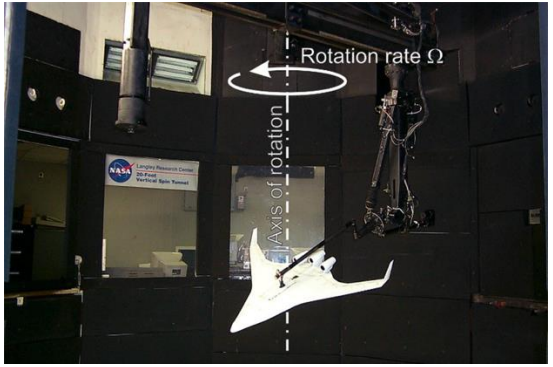
Dynamically-scaled 6-DOF free flight

Aircraft free spin/spin recovery

Entry vehicle free fall dynamic stability

Captive dynamic testing

Steady coning



Combined coning/forced oscillation

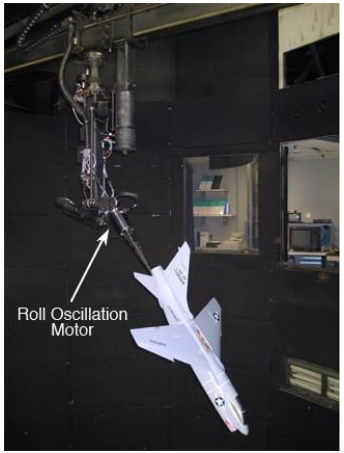
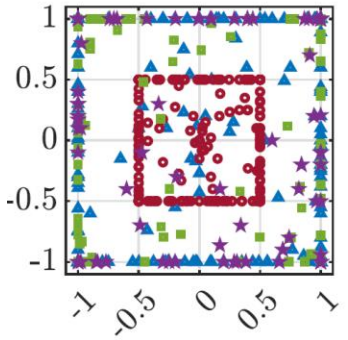


Image credit: NASA

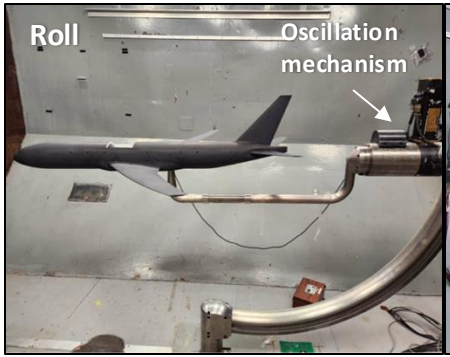
Test Techniques Transferring from the 12-Foot Low-Speed Tunnel

Static force and moment

Laser light sheet/smoke flow visualization



Design of experiments



Forced oscillation

Three degree-of-freedom

Image credit: NASA

FDRF Interior

Control room

Model build-up and shop area

Researcher collaboration area

Lobby with historical artifact display

Staff break area

FDRF building design emphasis

- Minimal staff (2-3 person ops)
- Large, open spaces
- Maximum flexibility/adaptability for future requirements
- Maintainability
- Energy efficiency (LEED Silver)

Image credit: BL Harbert International

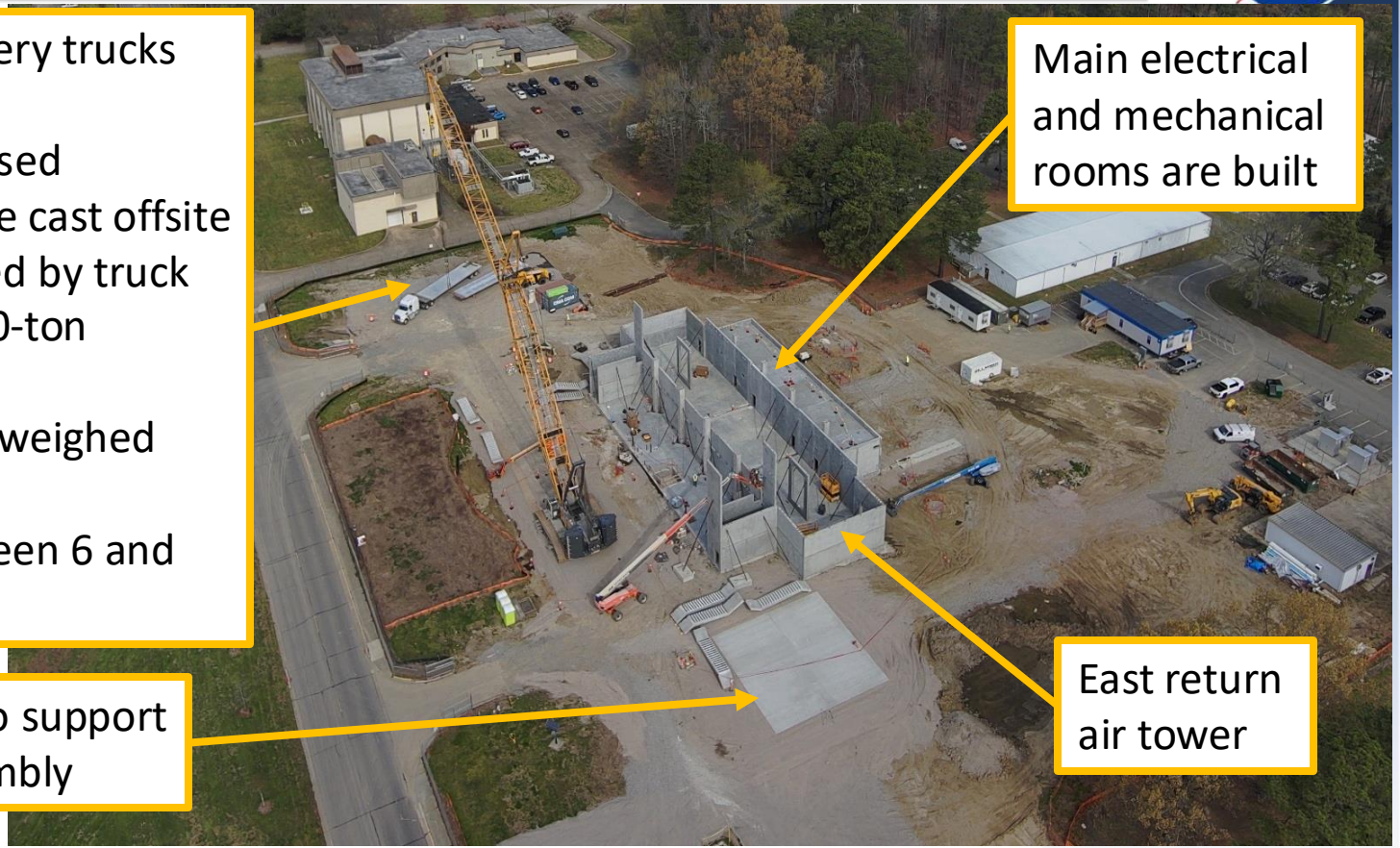
FDRF Construction Site – 1/5/23

Image credit: G. Banziger, NASA

FDRF Construction Site – 3/24/23

Precast concrete delivery trucks and crawler crane

- Nearly 450 pre-stressed concrete panels were cast offsite
- Panels were delivered by truck and erected by a 230-ton crawler crane
- The heaviest panels weighed 80,000 lbs
- Crews erected between 6 and 20 panels per day



Main electrical and mechanical rooms are built

East return air tower

Temporary slab to support component assembly

Image credit: G. Banziger, NASA

FDRF Construction Site – 6/5/23

Image credit G. Banziger, NASA

FDRF Construction Site – 8/30/23

Image credit: M. Fremaux, NASA

FDRF Construction Site – 9/14/23

Control Room level
- The floor and roof decks are installed
- Facade pieces are being installed

One module of the turning vanes for Corner 2

Image credit: G. Banziger, NASA

FDRF Construction Site – 7/15/24

Artist’s rendering

Construction photograph

FDRF Construction Site – 11/22/24

Image credit: G. Banziger, NASA

FDRF Construction Site – 12/16/24

Image credit: C. West, NASA

Interior Construction Progress (January 2025)

Artist's concepts

1 Control Consoles/Test Section

2 Entrance/ Lobby

Progress 17 January

Artists' concepts credit BL Harbert Intl.
Photos credit Jacobs

Fan Inlets (2 of 4)

- Four 14-foot diameter fans; 8 blades per fan
- Carbon fiber blades to minimize rotating mass (for best acceleration and deceleration performance during free-flight testing)
- Four medium-voltage 750 HP motors; controlled by variable frequency drives

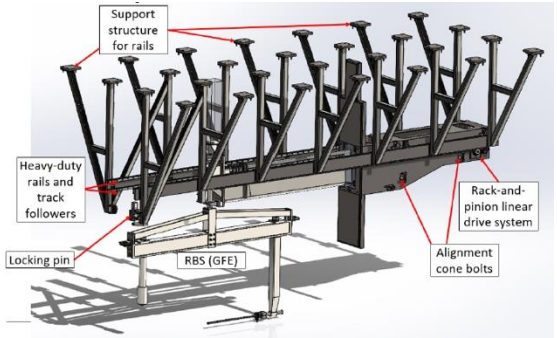
Image credit: NASA

Integration of Test Rigs Being Transferred to FDRF

Rotary Balance System (RBS) in VST

C-strut in 12-Foot

Sketch of RBS in FDRF (retracted)



Sketch of C-strut in FDRF (retracted)

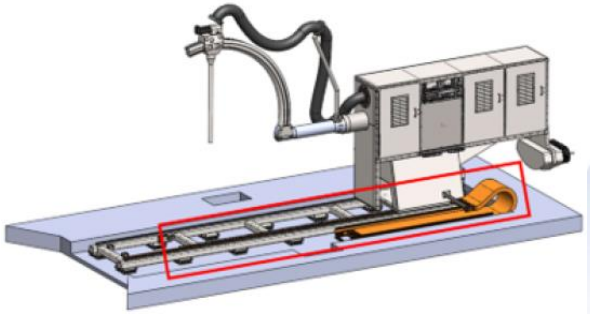


Image credit (photos): NASA
Image credit (artist's concepts): BL Harbert Intl. and North Wind

FDRF Project Timeline

- NASA worked with the General Services Administration (GSA) to award the design-build contract in September 2021, with support from Jacobs Engineering
- Awarded to the team of B.L. Harbert International, Mason & Hanger Group, and Calspan ASE (now North Wind)
- To minimize downtime, the project was divided into two phases:
  - **Phase 1:** design and construction of a fully-functional vertical wind tunnel (ongoing)
  - **Phase 2:** removal, modification, and installation of repurposed test equipment (late March)
- Projected timeline:
  - **July 2025:** Project achieves substantial completion
  - **August 2025:** NASA personnel will begin conducting flow surveys and tunnel calibrations
  - **November 2025:** FDRF operational

Questions?