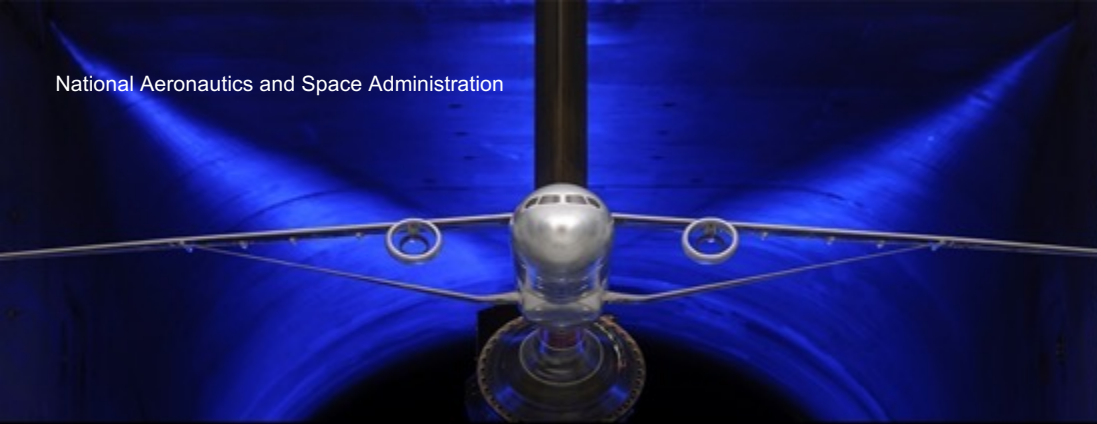




# NASA Hypersonic Capability Summary 2022

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Aerosciences Evaluation & Test Capability Portfolio





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- NASA Facilities & known upgrades
- Current known designs, studies, and awareness
- NPAT NASA/DoD listing of wind tunnels



## Ames Research Center

### **High Enthalpy Arc Jet Complex**

Providing ground-based hyperthermal environments in support of the nation's research and development activities in thermal protection materials, vehicle structures, aerothermodynamics and hypersonics.

<https://www.nasa.gov/centers/ames/thermophysics-facilities/arcjet-complex>

Modernization project at ~\$120M over 8-10 years.

### **Range Complex**

Providing critical testing support to the nation's research and development activities in hypervelocity impact physics, aerodynamics, aerothermodynamics, flow-field structure and chemistry.

<https://www.nasa.gov/centers/ames/thermophysics-facilities/ballistic-ranges>

No known upgrades



## Glenn Research Center/Armstrong Test Facility

### **Hypersonic Test Facility**

The Hypersonic Tunnel Facility (HTF) at NASA's Neil A. Armstrong Test Facility (ATF) Neil A. Armstrong Test Facility (ATF) located in Sandusky, OH, originally designed to test nuclear thermal rocket nozzles, is a hypersonic (Mach 5, 6, and 7) blowdown, nonvitrated freejet facility that tests large-scale hypersonic air-breathing propulsion systems.

<https://www1.grc.nasa.gov/facilities/htf/#facility-overview>

Returning to service requiring relocation of the "NASA Electric Aircraft Testbed" (NEAT) first.

## Langley Research Center

### **Aerothermodynamic Lab**

The Aerothermodynamics Laboratory is a collection of three hypersonic wind tunnels utilized for basic flow physics research, aerodynamic performance aeroheating assessment, optimization, and benchmarking of advanced space transportation vehicles.

<https://www.nasa.gov/aetc/hypersonic/al>

- 31” Mach 10
- 20” Mach 6 – replace steam ejector PLC and air heater bundle

### **8’ High Temperature Tunnel**

The 8-Foot High Temperature Tunnel (HTT) provides combustion-heated hypersonic blowdown-to-atmosphere simulation for Mach numbers of 3, 4, 5, and 6.5 through a range of altitude from 50,000 to 120,000 feet.

<https://www.nasa.gov/aetc/hypersonic/htt>

New Mach 6 nozzle

## Langley Research Center (cont'd)

### **4' Supersonic Unitary Plan Wind Tunnel**

The UPWT is equipped with asymmetric sliding-block-type nozzles for varying the ratio of nozzle throat to test section, thus providing continuous variation in Mach number.

<https://www.nasa.gov/aetc/supersonic/4-foot>

Numerous maintenance tasks.

### **Scramjet Test Complex**

The Supersonic Combustion Ramjet (Scramjet) Test Complex is a leading-edge ground test capability comprised of several distinct facilities. The complex includes a direct-connect combustor test facility, two small-scale complete engine test facilities, the Mach 4 Blow-Down Facility, and the 8-Foot High Temperature Tunnel, a large-scale complete engine test facility.

<https://researchdirectoratelarc.nasa.gov/supersonic-combustion-ramjet-scramjet-test-complex/>

### **Hypersonic Materials Environmental Test System (HyMETS)**

A small arc-jet facility that tests small (around 0.5" diameter) TPS coupons.



## Designs

- Hypersonic High Reynolds Number Tunnel (HHRNT), October 2020 by Jacobs  
Study done in case the Langley 4' UPWT was to be demolished and has since been removed from the demolition list.
- Langley 15" Mach 6 Low Disturbance Tunnel, June 2017 White Paper  
35% design completed in 2014 with a current 60% design in place resulting in a 100% design to follow

## Studies

- NASA Hypersonic Experimental Aerothermodynamics Capabilities (HEAC) Study  
Charter is to re-evaluate NASA testing capabilities and capacity as the demand for hypersonic aerothermodynamic ground testing increases...
- NASA High Speed Capabilities Assessment Team (HiSCAT)  
Identify current high-speed (~Mach 2-Mach 5) technical capabilities within NASA, other federal entities, academia, industry and others. Scope is to assess the current state of high-speed capabilities (workforce, tools, facilities) and technical disciplines.
- Institute for Defense Analyses (IDA) hypersonic study for the Test Resource Management Center (TRMC)

## Awareness

- Hypersonic Ground Test Center to be located at Purdue

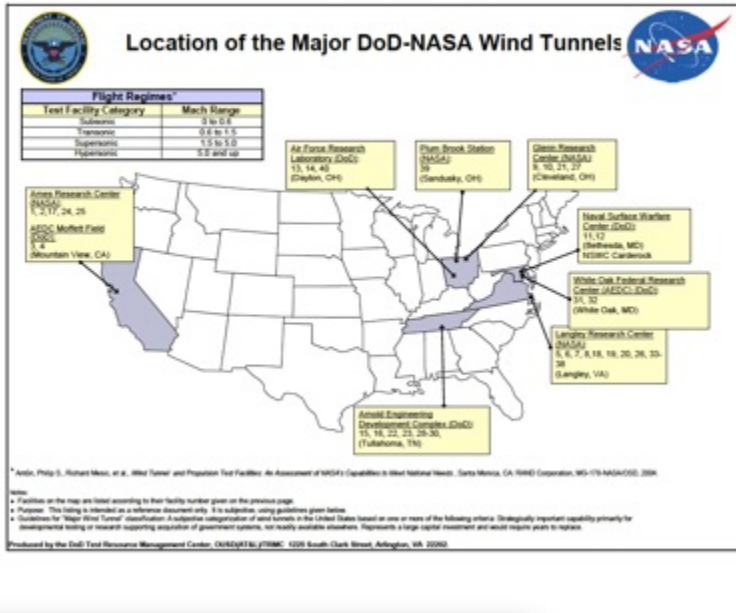


## Major DoD-NASA Wind Tunnels

Facility (Number and Name)	Site	Cross Section	Length	Current Status (Data current as of January 2017)	Reynolds # (per ft x 10 <sup>6</sup> )	Dynamic Pressure
<b>Subsonic</b>						
1 7' x 10' Subsonic Wind Tunnel #1	NASA Ames	7' x 10'	15'	Active, operated by Army	0 to 2.1	0 to 150 psf
2 12' Pressure Wind Tunnel	NASA Ames	11.25' x 11.25'	28'	Mohiballed in FY 2004	0 to 1.2	0 to 600 psf
3 National Full-Scale Aerodynamics Complex (NFAC) 40' x 80' x	AEDC Moffett Field	39' x 79'	80'	Active	0 to 3.0	0 to 262 psf
4 National Full-Scale Aerodynamics Complex (NFAC) 80' x 120' x	AEDC Moffett Field	39' x 118.3'	100'	Active	0 to 1.1	0 to 34 psf
5 14' x 27' Subsonic Wind Tunnel	NASA Langley	14.5' x 27.75'	50'	Active	0 to 2.2	Atmospheric
6 20' Vertical Spin Tunnel*	NASA Langley	20' diameter	20'	Active	0 to 0.55	0 to 8.5 psf
7 12-foot Low Speed Wind Tunnel	NASA Langley	12' x 12'	15'	Active	0 to 45	0 to 7 psf
8 Low Speed Aerodynamic Wind Tunnel (LSAWT)	NASA Langley	17' x 17'	34'	Active	0 to 2.2	Atmospheric
9 9' x 15' Low Speed Wind Tunnel	NASA Glenn	9' x 15'	33'	Active	0 to 1.4	0 to 72 psf
10 Ising Research Tunnel*	NASA Glenn	8' x 9'	20'	Active	0 to 3.8	0 to 230 psf
11 8' x 10' Subsonic	NSWC Carderock	8' x 10'	14'	Active	1.4 to 1.7	0 to 90 psf
12 Anechoic Flow Facility (AFF)	NSWC Carderock	8' x 8'	13.75'	Active	0 to 1.5	Atmospheric
13 Subsonic Aerodynamic Research Lab	AFRL	7' x 10'	15'	Active	0 to 3.5	up to 450 psf
14 12' vertical Wind Tunnel	AFRL	12' diameter	15'	Active	0 to 1.0	Atmospheric
<b>Transonic</b>						
15 161 Propulsion Wind Tunnel (PWT)	AEDC	16' x 16'	40'	Active	0.03 to 7.2	2 to 1100 psf
16 Aerodynamic Wind Tunnel 4†	AEDC	4' x 4'	62.5'	Active	0.3 to 7.1	20 to 2000 psf
17 11' x 11' Unitary Plan Transonic Wind Tunnel*	NASA Ames	11' x 11'	22'	Active	0.3 to 9.6	108 to 2000 psf
18 National Transonic Facility (NTF)†	NASA Langley	8.2' x 8.2'	25'	Active	4 to 145	60 to 4000 psf
19 Transonic Dynamics Tunnel (TDT)*	NASA Langley	16' x 16'	30'	Active	0.3 to 10	58 to 830 psf
20 0.3m Transonic Cryogenic Tunnel (TCT)	NASA Langley	13' x 13'	24'	Active	1 to 100	60 to 4000 psf
21 8' x 6' Supersonic Wind Tunnel	NASA Glenn	8' x 6'	23.5'	Active	5.5 to 5.5	100 to 1340 psf
<b>Supersonic</b>						
22 165 Propulsion Wind Tunnel (PWT)	AEDC	16' x 16'	40'	Standby	0.1 to 2.4	35 to 1161 psf
23 Supersonic Tunnel A	AEDC	3.3' x 3.3'	9'	Active	0.3 to 8.5	17 to 1445 psf
24 8' x 7' Unitary Plan Supersonic Wind Tunnel	NASA Ames	8' x 7'	16'	Active	0.5 to 5.7	260 to 1200 psf
25 8' x 7' Unitary Plan Supersonic Wind Tunnel	NASA Ames	8' x 7'	16'	Abandoned	0.6 to 5.2	100 to 1000 psf
26 Unitary Plan Wind Tunnel Test Section #1	NASA Langley	4' x 4'	7'	Standby	0.5 to 11.4	110 to 1080 psf
Unitary Plan Wind Tunnel Test Section #2	NASA Langley	4' x 4'	7'	Standby	0.5 to 8.4	95 to 1260 psf
27 10' x 10' Abe Silverstein Wind Tunnel	NASA Glenn	10' x 10'	40'	Active	0.12 to 3.4	20 to 720 psf
<b>Hypersonic</b>						
28 Tunnel B	AEDC	50" dia	9'	Active	0.4 to 5.27	66 to 620 psf
29 Tunnel C	AEDC	29" x 50" dia	11'	Active	0.3 to 7.9	48 to 2016 psf
30 Aerodynamic and Propulsion Test Unit (APTU)†	AEDC	32" x 42" dia	18' to 20'	Active	1.1 to 3.5	100 to 3700 psf
31 Tunnel 9 Simulation	AEDC White Oak	2.9' x 5' dia	9' & 12'	Active	0.05 to 48	9 to 11232 psf
32 Tunnel 9 Thermal/Structural	AEDC White Oak	11.3' dia	6'	Active	4.0 to 7.6	3500 to 6850 psf
33 8' High Temperature Tunnel*	NASA Langley	8' dia	12'	Active	0.4 to 6.8	320 to 3100 psf
34 31" Mach 10 Tunnel	NASA Langley	31" x 31"	34"	Active	0.5 to 2.2	100 to 350 psf
35 20" Mach 6 Tunnel	NASA Langley	20" x 20"	4"	Active	0.5 to 8.0	75 to 1100 psf
36 15" Mach 8 High Temperature Tunnel	NASA Langley	14.5" dia	3"	Active	0.5 to 6.0	115 to 360 psf
37 Arc-Heated Scramjet Test Facility	NASA Langley	10.89" x 10.89"	11"	Active	0.105 to 2.2	150 to 1500 psf
38 Direct-Connect Supersonic Combustion Test Facility	NASA Langley	1.52" x 3.46" x 2.88" x 5.2"	7"	Active	2 to 8	1300 to 2200 psf
39 Hypersonic Tunnel Facility (HTF)	NASA Plum Brook	42" dia	10'	Mohiballed: FY2012 decision	0.97 to 2.3	300 to 2200 psf
40 Mach 8 High Reynolds Facility	AFRL	12" dia	20'	Active	10 to 30	100000 to 301400 psf
<b>40 Total Wind Tunnels</b>						

\* NASA wind tunnel facilities deemed critical to DoD in the January 2007 NASA Aeronautics Facilities Critical to DoD Report to Congress.

† APTU and the 8-foot HTT are physically configured as blow-down wind tunnels and are thereby listed here. They are multiuse facilities, frequently being used for hypersonic propulsion testing.



\* Andri, Philip S., Richard Mox, et al. *Wind Tunnel and Propulsion Test Facilities: An Assessment of NASA's Capabilities to Meet National Needs*. Santa Monica, CA: RAND Corporation, 05-10-NASA-000-004.

- Facilities on the map are listed according to their facility number given on the previous page.
- Purpose: This listing is intended as a reference document only. It is subjective, using qualitative data below.
- Locations for "Major Wind Tunnel" classification: A subjective categorization of wind tunnels in the United States based on one or more of the following criteria: Originally important capability primarily for development testing or research supporting operation of government systems, not readily available elsewhere; Represents a large capital investment and would require years to replace.

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