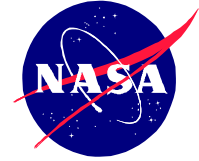


National Aeronautics and  
Space Administration

**Office of Inspector General**  
Washington, D.C. 20546-0001



Reply to Attn of: W

September 26, 2003

**TO:** R/Acting Associate Administrator for Aerospace Technology  
ARC/D/Director, Ames Research Center  
GRC/0100/Director, John H. Glenn Research Center at Lewis Field  
LaRC/106/Director, Langley Research Center

**FROM:** W/Assistant Inspector General for Auditing

**SUBJECT:** Final Management Letter on Audit of Wind Tunnel Utilization  
Assignment Number A-03-007-00  
Report Number IG-03-027

NASA's wind tunnels are national assets that help aeronautical researchers in NASA, the Department of Defense, and industry to understand the forces acting on an object as it moves through the atmosphere. In FY 2002, the Agency spent about \$102 million in providing wind tunnel services at the Ames Research Center (Ames), Glenn Research Center (Glenn), and Langley Research Center (Langley).

We conducted this audit to identify the historical use of NASA wind tunnels, gather information about planning and projections for wind tunnel utilization, compare historical use to planning and projections, and identify the number of wind tunnels mothballed or abandoned within the last 10 years. Additionally, we used the results of our work to augment the RAND Corporation's congressionally mandated Study of NASA's Aeronautical Test and Evaluation Facilities. We provided our preliminary audit results to the RAND Corporation on May 9, 2003. Enclosure 1 provides details on the scope and methodology of the audit.

We found that the three Centers reviewed can improve their utilization data recording, summarization, and reporting practices. Such improvements will allow the Agency to achieve more effective oversight and management of its wind tunnel operations.

We also found that NASA had not previously compared historical utilization with projected utilization; therefore, we gathered the information needed to make such comparisons (see Enclosures 2, 3, and 4). Wind tunnels that NASA mothballed or abandoned during the last 10 years are listed in Enclosure 5.

### *Data Recording, Summarization, and Reporting Practices Can Be Improved*

Ames, Glenn, and Langley had not routinely recorded, summarized, and reported comparable utilization data for their major wind tunnel facilities as illustrated below:

- The three Centers could readily provide comparable facilities utilization data, such as User Occupancy Hours (UOH), for only some of the Agency's major wind tunnel facilities. We compiled comparable utilization data for the remaining major facilities after extensive coordination with the applicable wind tunnel managers.
- The method of calculating utilization rates varied significantly from Center to Center. Ames calculated utilization rates to show the use of wind tunnel staff rather than use of wind tunnel facilities. Glenn calculated utilization rates based on available workdays per fiscal year, and Langley calculated utilization rates based on capacity days for operation in a typical year.
- Historical utilization records for NASA's wind tunnels had not been recorded, summarized, and reported to the Office of Aerospace Technology.
- The Office of Aerospace Technology had not requested that the Centers submit projected utilization data for the last 3 years.
- Some tunnel logs at Glenn and Langley were poorly organized and maintained.
- There was inconsistent record-keeping among the various Langley organizations that managed the day-to-day operations of the wind tunnels.

NASA's 2003 Strategic Plan recognizes the vital importance of comparability and consistency:

NASA is a large Agency, consisting of public servant and contractor employees, Field Centers across the United States, and facilities in foreign countries. With our new focus on a unified long-range Vision and Mission, it is **imperative that all elements of the Agency work together as a single team. By developing common procedures, capabilities, tools, and organizations, we will ensure that the overall functioning of the Agency is as smooth and efficient as possible** [emphasis added].

Wind tunnel utilization data was inconsistent among the Centers because the Office of Aerospace Technology had not established Enterprisewide standards for recording, summarizing, and reporting the data. Office of Aerospace Technology officials stated that the Centers had been responsible for the strategic and operational management of their respective wind tunnels because they were an integral part of the research programs that were best managed by the Centers. The officials also stated that the Centers maintained utilization data in a form that they, not the Office of Aerospace Technology, believed best suited the Centers' respective data needs. The Office of Aerospace

Technology indicated that when it required utilization data to carry out its Enterprise management responsibilities, it solicited and received such data from the Centers and was able to utilize the data in its varying forms to make required decisions.

Without the benefit of up-to-date and comparable utilization data, Office of Aerospace Technology management has a diminished ability to make well-informed strategic and operational decisions regarding current and future use of the Agency's wind tunnels. Further, wind tunnel management decisions may not always serve the best interests of the Agency or the nation.

***Recommendation, Management Response, and Evaluation of Management Response***

The Associate Administrator, Office of Aerospace Technology, should establish Enterprisewide standards for recording, summarizing, and reporting wind tunnel facilities utilization data.

**Management Response.** Concur. The Office of Aerospace Technology will develop and issue the required standards within 90 days of the release of this final management letter. The complete text of management's response is in Enclosure 6.

**Evaluation of Management Response.** Management's planned actions are responsive to the recommendation. The recommendation is resolved but will remain undispositioned and open until agreed-to corrective actions are completed.

We appreciate the courtesies and cooperation provided to the auditors during the audit. If you have questions, or would like to discuss this matter further, please contact Mr. Robert Wesolowski, Director, Institutional and Infrastructure Management Directorate, at (202) 358-2567, Mr. David Gandrud, Associate Director, at (650) 604-2672, or Mr. Tony Lawson, Project Manager, at (301) 286-6524.

[original signed by]

David M. Cushing

6 Enclosures

cc:

ADI/Associate Deputy Administrator for Institutions and Asset Management

ADT/Associate Deputy Administrator for Technical Programs

B/Deputy Chief Financial Officer for Financial Management

BF/Director, Financial Management Division

G/General Counsel

J/Assistant Administrator for Management Systems

JM/Director, Management Assessment Division

## **Objectives, Scope, and Methodology**

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We performed audit field work at Ames, Glenn, and Langley from January 2003 through May 2003. To accomplish our objectives of identifying the historical use of NASA wind tunnels, gathering information about planning and projections for wind tunnel utilization, comparing historical use to planning and projections, and identifying the number of wind tunnels mothballed or abandoned within the last 10 years, we performed the following work:

- Interviewed NASA Aerospace Technology personnel to identify the goals and objectives of the wind tunnel program.
- Interviewed wind tunnel personnel at Ames, Glenn, and Langley to determine how wind tunnel utilization is projected and actual rates are calculated and how utilization data is maintained.
- Interviewed Centers' wind tunnel personnel to determine the users of wind tunnel utilization data.
- Determined UOH for selected wind tunnels to provide a uniform basis for comparisons among tunnels and Centers.
- Compared the Centers' utilization data, methodologies, and terminology used to describe wind tunnel status.
- Obtained wind tunnel utilization data from Center personnel and randomly verified the information to individual wind tunnel logs.
- Researched requirements for recording, summarizing, and reporting wind tunnel utilization rates and data.

Additionally, we provided the preliminary results of our audit to the RAND Corporation study of NASA's Wind Tunnels and Propulsion Testing Facilities.

We interviewed officials at NASA Headquarters, Ames, Glenn, and Langley to identify and assess management controls related to the management of wind tunnel facilities and to identify the wind tunnel utilization information that each Center provided to Office of Aerospace Technology management. We consider the lack of comparable and consistently derived wind tunnel utilization data to be a control weakness that needs management attention. To facilitate more effective oversight of the Agency's wind tunnel operations, the Office of Aerospace Technology needs current, accurate, and consistent wind tunnel utilization data.

We conducted the audit in accordance with generally acceptable government auditing standards.

## Ames Wind Tunnel User Occupancy Hours

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### Fiscal Year

1997	1998	1999	2000	2001	2002
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#### Unitary Plan Wind Tunnel

Projected Hours	*	*	*	*	3,040	2,656
Actual Hours	*	*	*	*	2,201	1,146
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	NA	72.4%	43.1%

#### 12 Foot Wind Tunnel

Projected Hours	2,912	2,912	1,552	160	160	80
Actual Hours	1,870	3,000	1,582	119	120	54
Percentage Actual (Actual ÷ Projected)	64.2%	103.0%	101.9%	74.4%	75.0%	67.5%

#### National Full-Scale Aerodynamic Complex

Projected Hours	**	**	2,585	2,038	2,058	464
Actual Hours	**	**	1,801	1,481	2,343	197
Percentage Actual (Actual ÷ Projected)			69.7%	72.7%	113.8%	42.5%

#### Notes:

\* The Unitary Plan Wind Tunnel was not in operation during fiscal years 1997 through 2000 because of a facility modernization project.

\*\* The National Full-Scale Aerodynamic Complex was not in operation during fiscal years 1997 and 1998 because of a facility modernization project.

## Glenn Wind Tunnel User Occupancy Hours

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### Fiscal Year

1997	1998	1999	2000	2001	2002
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#### **Icing Research Tunnel**

Projected Hours	NA	NA	NA	1,632	3,744	3,672
Actual Hours	2,918	4,582	2,970	2,570	3,907	4,252
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	157.5%	104.4%	115.8%

#### **10 X 10 Supersonic Tunnel**

Projected Hours	NA	NA	NA	3,208	1,352	792
Actual Hours	2,894	1,406	2,233	1,311	488	128
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	40.9%	36.1%	16.2%

#### **8 X 6 Transonic Tunnel**

Projected Hours	NA	NA	NA	200	472	696
Actual Hours	921	1,192	250	320	270	597
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	160.0%	57.2%	85.8%

#### **9 X 15 Subsonic Tunnel**

Projected Hours	NA	NA	NA	3,712	2,232	3,280
Actual Hours	2,861	1,025	2,265	2,630	1,084	2,763
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	70.9%	48.6%	84.2%

#### **PSL 3 & 4 Air Breathing**

Projected Hours	NA	NA	NA	2,416	944	1,848
Actual Hours	2,040	456	2,152	1,976	1,272	2,512
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	81.8%	134.7%	135.9%

#### **Hypersonic Tunnel**

Projected Hours	NA	NA	NA	NA	NA	NA
Actual Hours	0	0	1,500	1,647	1,680	1,827
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	NA	NA	NA

## Langley Wind Tunnel User Occupancy Hours

### Fiscal Year

	1997	1998	1999	2000	2001	2002
<b>National Transonic Facility</b>						
Projected Hours	2,400	2,288	912	2,912	1,248	2,400
Actual Hours	NA	NA	3,056	2,688	3,776	2,160
Percentage Actual (Actual ÷ Projected)	NA	NA	335.1%	92.3%	302.6%	90.0%
<b>14 X 22 Foot Wind Tunnel</b>						
Projected Hours	3,200	2,320	1,940	3,120	1,968	1,088
Actual Hours	5,897	4,250	873	753	2,448	800
Percentage Actual (Actual ÷ Projected)	184.3%	183.2%	45.0%	24.1%	124.4%	73.5%
<b>Transonic Dynamics Tunnel</b>						
Projected Hours	0	2,880	2,880	2,400	1,088	1,760
Actual Hours	0	1,120	2,160	2,272	1,712	1,824
Percentage Actual (Actual ÷ Projected)	NA	38.9%	75.0%	94.7%	157.4%	103.6%
<b>Unitary Plan Wind Tunnel</b>						
Projected Hours	1,824	1,872	1,136	728	168	704
Actual Hours	1,642	1,739	302	797	960	1,204
Percentage Actual (Actual ÷ Projected)	90.0%	92.9%	26.6%	109.5%	571.4%	171.0%
<b>16 Foot Transonic Tunnel</b>						
Projected Hours	3,200	3,200	1,888	3,520	1,648	1,200
Actual Hours	2,456	2,933	3,085	2,618	713	2,602
Percentage Actual (Actual ÷ Projected)	76.8%	91.7%	163.4%	74.4%	43.3%	216.8%
<b>20 Foot Vertical Spin Tunnel</b>						
Projected Hours	NA	NA	NA	1,520	800	432
Actual Hours	206	717	161	815	1,326	319
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	53.6%	165.8%	73.8%
<b>20 Inch Supersonic Tunnel</b>						
Projected Hours	NA	NA	NA	400	400	360
Actual Hours	0	352	872	184	136	16
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	46.0%	34.0%	4.4%
<b>Low Turbulence Pressure Tunnel</b>						
Projected Hours	1,968	264	240	712	320	480
Actual Hours	1,768	1,204	1,479	1,064	736	837
Percentage Actual	89.8%	456.1%	616.3%	149.4%	230.0%	174.4%

**Fiscal Year**

1997	1998	1999	2000	2001	2002
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**.3 Meter Transonic Cryogenic Tunnel**

Projected Hours	800	1,784	NA	280	240	160
Actual Hours	1,868	1,972	1,230	0	0	483
Percentage Actual (Actual ÷ Projected)	233.5%	110.5%	NA	0%	0%	301.9%

**8 Foot High Temperature Tunnel**

Projected Hours	1,600	1,600	1,600	712	136	440
Actual Hours	1,376	1,304	2,024	1,688	424	2,024
Percentage Actual (Actual ÷ Projected)	86.0%	81.5%	126.5%	237.1%	311.8%	460.0%

**20 Inch Mach 6 Hypersonic Tunnel**

Projected Hours	NA	NA	NA	920	1,040	1,480
Actual Hours	NA	1,720	1,064	648	1,644	1,765
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	70.4%	158.1%	119.3%

**20 Inch Mach 6 CF4 Tunnel**

Projected Hours	NA	NA	NA	308	720	0
Actual Hours	NA	672	472	496	513	0
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	161.0%	71.3%	0%

**31 Inch Mach 10 Tunnel and  
15 Inch Mach 6 High Temperature Tunnel**

Projected Hours	NA	NA	NA	1,256	720	680
Actual Hours	NA	1,296	1,032	1,088	139	0
Percentage Actual (Actual ÷ Projected)	NA	NA	NA	86.6%	19.3%	0%

**Jet Exit Test Facility**

Projected Hours	1,392	NA	NA	688	200	640
Actual Hours	1,312	1,200	504	496	336	448
Percentage Actual (Actual ÷ Projected)	94.3%	NA	NA	72.1%	168.0%	70.0%



## NASA Wind Tunnels Mothballed or Abandoned Since Fiscal Year 1992

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NASA Center	Tunnel	Status	Fiscal Year
<b>Ames</b>	7 X 10 Foot Tunnel	Abandoned	1996
	14 Foot Transonic Tunnel	Mothballed	1997
	6 X 6 Foot Supersonic Tunnel	Mothballed	1997
	Experimental Fluid Dynamics Facility	Mothballed	1997
	Fluid Dynamics Laboratory	Mothballed	1997
	8 X 7 Foot Supersonic Tunnel	Mothballed	1998
<b>Glenn</b>	(No tunnel closures)		
<b>Langley</b>	7 X 10 Foot Tunnel	Abandoned	1994
	30 X 60 Foot Tunnel	Abandoned	1996
	8 Foot Transonic Pressure Tunnel	Abandoned	1996
	Transonic Tunnel (Building 585)	Abandoned	1996
	Transonic Tunnel (Building 583)	Abandoned	1996
	60 Inch Mach 18 Helium Tunnel	Abandoned	1996
	2 X 6 Inch LST	Abandoned	1996
	20 Inch Mach 17 N2 Tunnel	Abandoned	1996
	Open Jet Leg He Tunnel	Abandoned	1996
	12 Inch Mach 6 High Reynolds Tunnel	Abandoned	1996
	Nozzle Test Chamber	Abandoned	1997
	22 Inch Mach 20 Helium Tunnel	Abandoned	2001
	18 Inch Mach 8 Quiet Tunnel	Abandoned	2001

National Aeronautics and  
Space Administration  
**Headquarters**  
Washington, DC 20546-0001



September 3, 2003

Reply to Attn of: **RS**

**TO:** W/Assistant Inspector General for Auditing  
**FROM:** RS/Director, Research Support Division  
**SUBJECT:** Audit of Wind Tunnel Utilization, Assignment Number A-03-007-00

Thank you for the opportunity to review the draft management letter regarding the subject audit.

We offer one comment for your consideration. The draft letter states that "The Office of Aerospace Technology believed that incomplete and inconsistent utilization data was not a significant issue because it had not required the data to support its 'coordination' (i.e., nonmanagement) role for wind tunnels. We believe that a more accurate representation of our position is captured by the following sentence: "When the Office of Aerospace Technology required utilization data to carry out its Enterprise management responsibilities, it solicited and received such data from the Centers and was able to utilize the data in its varying forms to make required decisions."

This comment notwithstanding, we concur with the recommendation contained in the draft management letter, and will develop and issue the required standards within 90 days of the release of the final management letter.

If you have any questions, please do not hesitate to call me on 202-358-4741.

A handwritten signature in black ink, appearing to read "Jay M. Henn".

Jay M. Henn

cc:  
RS/S. Humphrey